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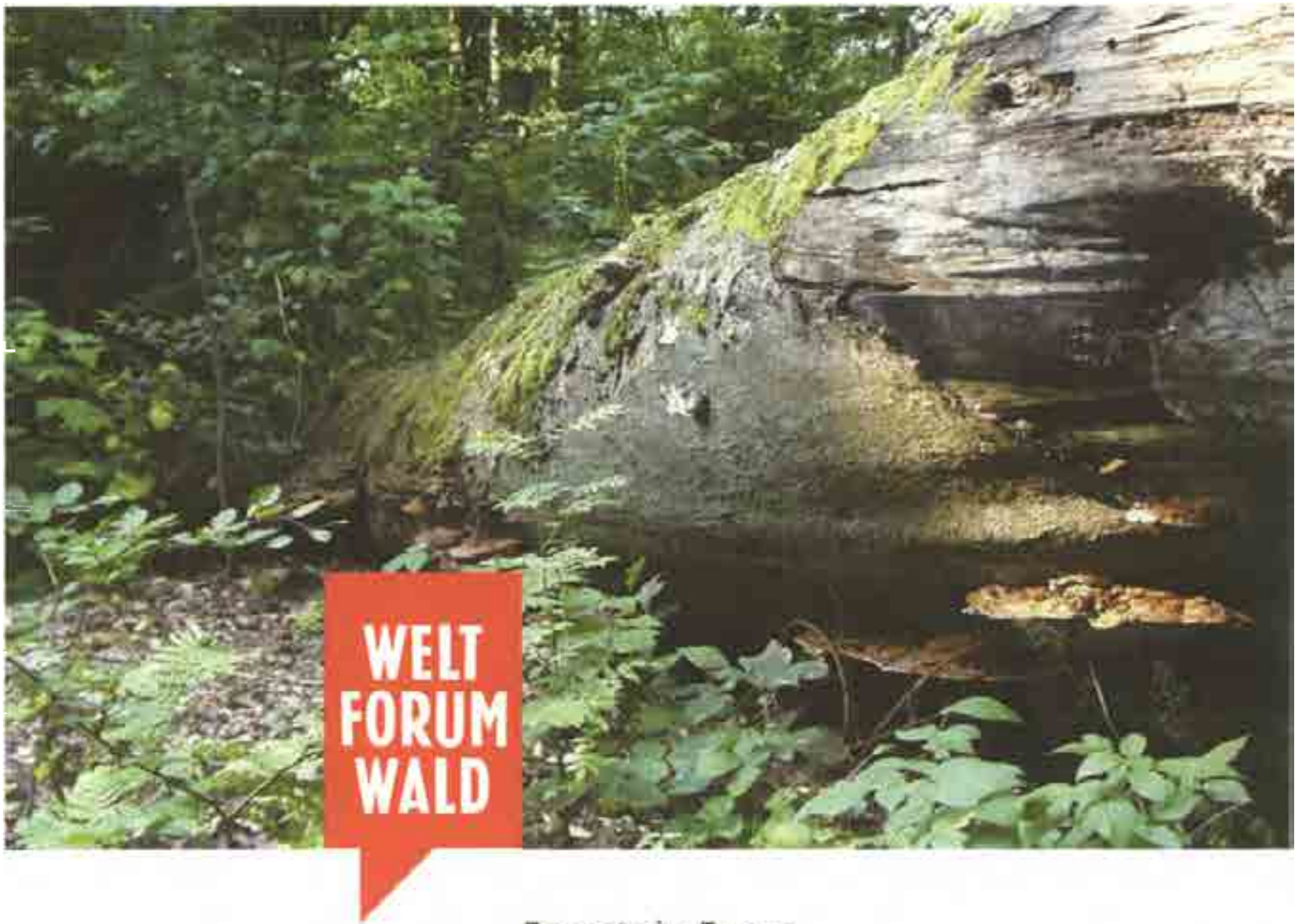

Forests in Focus

Proceedings Forum

Biodiversity – Treasures in the World's Forests

3 – 7 July 1998

EXPO2000 HANNOVER

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Responsible for the contents of each contribution is the respective author.
Editorial Remark:
The forum was open to various kinds of contributions by participants. Contributions were made in form of statements, abstracts of papers, scientific papers and posters. This publication includes all these various kinds of contributions without attempt to create a unified format.
Some texts were slightly modified by the editors, mainly in order to overcome language problems, and the text was not revised again by the author. It was not meant to change the contents, but if the modification resulted in a different meaning, it is solely the responsibility of the editors.

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Contents

Forests in Focus

within the framework of 'WELTFORUM WALD', official project of the World Exposition 2000

A series of fora focusing on global forests issues aims at achieving consensus among relevant interest parties on tools and concepts to sustainably develop the world's forests. The project 'Forests in Focus' adds operative recommendations for solving environmental problems concerning forests to current political negotiations and scientific meetings in the field of forestry. The fora act as an agent between politics, economics, science and public and provide condensed up-to-date knowledge as well as agreed upon proposals for action adequate to target groups. Thus, 'Forests in Focus' supports the local implementation of guidelines on forest management and enforces the forest related parts of the Agenda 21 process.

Background

The World Exposition 'EXPO 2000 Hannover' presents the concept of sustainable development as agreed upon in the Agenda 21 at the UNCED 1992 in Rio de Janeiro. EXPO 2000 includes various worldwide decentralised projects. One of these, 'WELTFORUM WALD' (World Forum on Forests) has been initiated by authorities of the district Soltau-Fallingbostel, Northern Germany, the Association for the Protection of Forests and Woodlands (SDW), the Forestry Commission of Lower Saxony and the Alfred Toepfer Academy for Nature Conservation (NNA).

The project includes various activities and exemplary projects demonstrating sustainable management and use of forests to local people and international visitors (reafforestation of degraded heathland, redevelopment of former military areas, environmentally sound wooden buildings, thermal use of wood, use of non-timber products, management of a nature reserve and tourism, etc.).

Within this frame, 'Forests in Focus' forms the professional backbone. The fora address institutions and social parties concerned with forests, particularly those which

- are directly connected to forests,
- play an active role in forest management
- are affected by forest management.

The fora intend to encourage the relevant social parties to participate efficiently in decision making on forest issues, thus promoting the worldwide implementation of the recommendations of the Agenda 21.

Auspices

'Forests in Focus' is performed under the auspices of the Federal Minister of Food, Agriculture and Forestry, Mr. Karl-Heinz Funke.

Time Schedule

Between 1998 and 2000, five fora take place. With respect to the multiple functions of forests, the fora focus from different perspectives on the worldwide sustainable co-existence of mankind and forest:

Forests and Energy (To what extent can forests contribute to the world's future energy supply?) January, 1998

Biodiversity – Treasures in the World's Forests (Prospects of conservation, use and sustainable development of biodiversity in forests) July, 1998

Forests Source of Raw Material (Potentials of forest products' use and marketing) May, 1999

Forests and Atmosphere-Water-Soil (Regulation of energy and matter cycles with respect to climate change, water cycles and soil degradation) July, 1999.

Forests and Society (Interrelation of cultures and environment, public awareness, public participation; integration of recommendations of the former fora) November, 1999.

The final events will be the presentations of the results and recommendations of all fora at the EXPO 2000 in Hannover in Summer 2000 and at the congress **Sustainability in Time and Space** – in cooperation with PRO SILVA (Implementation of forest management guidelines in divergent forest types.) June, 2000.

Biodiversity: Treasures in the World's Forests Concluding Statement of the Forum

Chairman: Prof. Jeff Sayer, Centre for International Research in Forestry (CIFOR), Bogor, Indonesia

In an event leading up to the EXPO 2000 Hannover World Exposition a group of 150 scientists, foresters, conservation practitioners and concerned individuals from 35 countries met for four days by invitation of the Alfred Toepfer Academy for Nature Conservation at Schneverdingen in Lower Saxony to discuss the issues confronting the use and conservation of the world's forest biodiversity. On the first day a plenary session was held at which 9 papers on different aspects of biodiversity were presented. On subsequent days the forum worked in four parallel sessions but gathered in plenary each evening to review the results of the day's work and consider general conclusions and recommendations. A number of technical papers were presented at each workshop but considerable time was allocated for debate. Transcripts of the papers presented and summaries of the debates, conclusions and recommendations of each workshop will be provided in the record of the Forum in the near future.

The Forum was characterized by the great diversity of the participants, many of whom had not previously met. Amongst the participants were people who had been closely involved in the various international and intergovernmental processes dealing with biodiversity, but others were people more concerned with practical conservation on the ground. Yet others came from industry, research institutes and NGOs. There were several persons from cultural minorities in tropical developing countries. A significant number of participants had personal experience of the management of central European woodlands for biodiversity. Everyone took part in their personal capacities and discussions were frank and free.

There was no attempt to conduct a comprehensive review of all global forest biodiversity issues. The group focussed on those issues that it considered to be of particular concern and for which it had special competence. The following therefore emerged as major themes of the forum:

■ The divergence between biodiversity as seen by "Western" science and as seen by the diverse communities of people more directly in contact with biodiversity in the forests: "Science" tends to reduce biodiversity to components through lists of species, hot spots, biodiversity indices etc. whereas most cultures see biodiversity in terms of assemblages of species and attach values according to the ecological services provided and the many uses made of these assemblages, many of which may be of cultural and spiritual significance. Participants stressed that the "whole" assemblage of biodiversity (ecological and human communities) have greater value than the "sum" of the parts.

■ The erosion of our knowledge of biodiversity caused by the loss of local cultures and languages: Since value is not an intrinsic feature of biodiversity but is a function of our knowledge of any species or community this loss of knowledge represents a loss of value and undermines the stability of communities and their conservation.

■ The relative merits of biodiversity conservation being an indispensable component of integrated multiple-use forest management systems as in much of central Europe or alternative approaches based on a clear segregation between "production forests" and "conservation forests" as in Australia, New Zealand and some tropical countries.

■ The potential impacts on biodiversity of the globalization of economies and the "information technology" revolution: Globalization will lessen the "control" that sovereign governments can exercise over their natural resources whilst the greatly improved communications resulting from information technology should lead to greater empowerment of hitherto marginal peoples.

■ The recognition that solutions to biodiversity problems will usually be location-specific and will depend on the social and economic conditions of a location as well as on the biophysical characteristics of the forests and their biodiversity.

■ Solutions appropriate to the biologically simple forests of temperate and boreal countries with advanced economies may not be applicable to the biologically much richer forests of the less developed economies of tropical regions.

■ Economics has a valuable role to play in helping to make better decisions relating to biodiversity but participants were concerned that conventional economics does not yet adequately capture many of the cultural, spiritual or ecological values of biodiversity.

The forum recognized the valuable achievements of the processes occurring under the Convention on Biological Diversity and the great potential of the CBD to have real impacts on the ground. It saw the CBD as continuing to be the prime focus for international action but recognized that there are limits to what can be achieved through *"intergovernmental"* action and that there is a need for parallel actions at the national and local levels and in the corporate sector.

The forum also noted the potential for the Intergovernmental Forum on Forests to play an important role but felt that the IFF had as yet only made modest progress on biodiversity. The IFF also has potential but again it was emphasized that intergovernmental negotiation is not a substitute for local action.

The workshops elaborated a number of conclusions and recommendations which are included in their reports. The workshop recommendations are not repeated here, instead this summary presents a number of more general conclusions and recommendations which emerged from the discussions. These are presented as a record of our views and are addressed to the participants in international debates on biodiversity as well as to "actors" in society whose activities have an impact on forests and their biodiversity.

■ The work of the CBD has benefited greatly from contributions provided by science. However the full potential of the scientific community has not yet been mobilized. It is recommended that there should be greater engagement of social scientists familiar with traditional ecological knowledge (TEK), and of practitioners of "informal" science – the specialists, often from cultural minorities, who are the repositories of much traditional knowledge.

■ Economic analysis has a major role to play in improving decision making on forest biodiversity but it is recommended that further development of techniques is needed to recognize the values that different cultures attach to biodiversity and to better capture the cultural, spiritual and functional values of biodiversity.

■ "Western" science and "economic globalization" may tend to favor outcomes in which biodiversity conservation (nature reserves) are segregated from production forests (plantations). It was noted that these tendencies may run counter to the interests of cultural minorities for whom integrated multiple-use solutions may be more desirable. It is therefore recommended that bio-regional approaches be adopted for conservation planning with full participation of all concerned people in order to optimize all products and services of forests and achieve better allocation of land.

■ There has been considerable achievement in central Europe in reconciling natural forest management and the conservation of biodiversity. Whilst recognizing that this experience cannot be transferred directly into the very different conditions of the biodiverse forests of the tropics it is nonetheless recommended that attempts to achieve biodiversity conservation in the context of locally driven multiple-use forest management systems in the tropics should be vigorously pursued.

■ Protected areas allocated primarily for biodiversity will remain a central element of conservation. It is recommended that renewed efforts be made under the CBD and IFF to achieve the medium-term security of a core set of forests sites of recognized international value for forest biodiversity and that opportunities already provided by ongoing activities such as the WWF "Global 200 forest ecoregions" program and the forest initiative under the World Heritage Convention be supported.

■ Although Integrated Conservation and Development Programs have been a principal mechanism of channeling international support to the conservation of forest biodiversity, these have in general produced disappointing results. It is recommended that ICDP approaches should be led by local communities and not imposed upon them and that the likelihood of ICDPs succeeding will be enhanced if they are based upon local understanding and valuation of biodiversity.

■ Developing countries and cultural minorities ought in principle to be able to derive greater economic benefits from the exploitation of their biodiversity for use in the pharmaceutical, fibre, food and technology based industries. There is however a danger that the benefits of "bio-prospecting" accrue largely to industry and not to the communities of people who are the traditional users of the resource. It is recommended that bio-prospecting be promoted as a legitimate way to access a valuable natural resource but that institutional arrangements to ensure the equitable sharing of benefits be further studied and where appropriate strengthened.

■ It was recognized that biotechnology can play a major role in determining the future uses of components of biodiversity. Genetic engineering and other molecular biology techniques have allowed the transfer of genes between species. This results in many new options and may lead to increased economic benefits. However great uncertainty persists on the possible impacts of genetically modified organisms on humans and on biodiversity as a whole. In this context the protocol on biosafety under negotiation within the CBD is an important contribution. In this context it is recommended that technology transfer (including biotechnology) and capacity building in developing countries should be facilitated and biosafety considerations should be incorporated in the development of forest management practices and products.

■ Non-timber forest products are a vital resource for very large numbers of people in the forested regions of the world. The value of this resource is often underestimated in formal decision making, partly because many of the products are not traded in the formal economy. It is recommended that greater attention be given to the sustainability of NTFP resources in multiple-use systems and that the interests of the people who depend upon them be given greater weight in decisions relating to the use of forest lands.

■ Technological options exist to restore forest cover of degraded lands in many parts of the world. At present much reforestation and afforestation uses techniques which lead to biologically impoverished forests. It is recommended that greater attention be given to increasing the species richness of artificially established forests.

■ Information gives value to biodiversity. The globalization of information systems creates opportunities but also creates some threats. Information may not be available equally to all stakeholders. It is therefore recommended that the recording and protection of traditional information be given more attention and that attempts be made to make information available locally so as to counter the present trend towards domination by a small minority of global news and information sources.

■ Protecting forests and biodiversity requires protecting the cultural and linguistic diversity of indigenous peoples. Scientists must recognize that the existing biodiversity paradigm has in the past been misused to alienate and disenfranchise peoples from their spiritual and natural resources and that future scientific endeavors must be built upon recognition of basic rights and recognition of traditional ecological knowledge.

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Workshop: Biodiversity as Value in Society

Chairman: Dr. Cristian Samper, Instituto Humboldt, Bogota, Colombia

Valuation of forest biodiversity

Biodiversity can provide different kinds of goods and services that are the basis of our welfare on this planet. Human activities influence biodiversity in a variety of ways, and we are constantly choosing alternatives about the way we use resources. Determining these kinds of values can be useful in this context of societal choice; and valuation can influence the way we use or abuse forest resources.

Biodiversity can have many different kinds of values, and these often differ among individuals and societies. Some of these values are related to the use of biodiversity by humans, and others are related to cultural and spiritual values of biodiversity for society. Furthermore, the value of biodiversity as a whole may be more than the sum of its components.

The value of biodiversity should not just be measured through price. Some of these values are utilitarian in nature, and include goods and services that are the basis for consumption and production, which are often traded through markets. However, there are other kinds of values, such as option values, bequest values and existence values, that are not traded through markets. Economists have developed tools and methodologies (i.e. contingent valuation) that can be used to measure preferences and simulate markets. The sum of these values can provide an estimate of the total economic value of biodiversity.

Distribution of costs and benefits

The choices we make can influence our options for future choices, so there is a cost associated with resource use. In this context, it is crucial to develop ways and means to achieve the equitable distribution of costs and benefits in society. There is a trend toward an increase in the concentration of benefits and the socialization of costs. The underlying problem is that often some of the costs are passed on to society or to future generations, that is, the private cost is less than the social cost.

It is important to design ways and means to add value to forests and biodiversity. Information can change perceptions, alter values and influence choices. Technological developments and technology transfer (including biotechnology) can also increase the possibilities for use, improve efficiency and add value. The correction of market and institutional failures can also influence choice. Overall, the development and valuation of multiple-use systems can be important to achieve a greater total value for forests and biodiversity.

The socio-economic framework

The socio-economic forces driving biodiversity loss are complex, and include aspects such as demographic change, poverty and inequality, public policies, markets and trade. These forces generate a change in resource use patterns and can lead to habitat loss and degradation. All of these forces operate at the local, national and international level, with a growing impact of global forces on local decisions.

One of the driving forces at the local level is related to property rights and land tenure. In general, secure property rights may promote sustainable use of forest biodiversity, as they may affect the level and nature of investments, capital markets, rent dissipation, enable land transactions, and favor conservation of natural resources for the future. However, land tenure and property rights by themselves do not guarantee sustainable use, since there may be important changes in cultural values and markets over time.

The current trend toward globalization can have important social and economic impacts on resource use, including, but not limed to, access to new markets, increased capital flow, labor movements and training, increased information exchange, a change in consumption patterns, technology transfer, loss of national sovereignty and loss of cultures and languages. Some of these changes may promote sustainable use, whereas others may result in increased degradation.

Information and awareness

Information is an important element of value, and communication and awareness raising can have an impact on individuals and society through the influence on choice.

The communication of information needs to seeks four elements: (I) the right information, (II) to the right people, (III) in the right form, (IV) at the right time. In the short term special emphasis needs to be placed on raising awareness among decision makers and the general audience, where the media can play a critical role. At the same time we need to include environmental considerations into education programs, which will have a longer term impact.

There is a trend toward globalization of information. Technological developments, including satellite communications, are resulting in faster and broader information exchange. This means that local communication and information systems have to be reinforced and we need to seek more equitable and unbiased information exchange at the global level.

Recommendations:

Further research needs to be undertaken to develop methodologies that enable valuation of non-direct uses of biodiversity, including ecosystem services.

There is a need to reinforce multi-disciplinary approaches to valuation of biodiversity, including economic, social and cultural values.

We must promote the valuation of multiple uses of forest biodiversity and multiple use systems.

There is an urgent need to correct market and institutional failures, and to design mechanisms that internalize social costs.

It is important to strengthen international regulation mechanisms, such as international treaties and conventions.

Instruments such as certification of forest products can operate though global markets and should be implemented, taking special care not to impose market barriers for developing countries.

There is an urgent need to strengthen means to communicate information at the local and national levels, and at the same time seek ways to achieve a more balanced and unbiased exchange of information at the local level.

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Workshop: Biodiversity as a Resource

Chairman: Prof. Dr. Jean-Philippe Schütz, Dept. Forestry and Wood Research, ETH Zürich, Switzerland

Preamble

The perception for the notion of biodiversity is different between industrialized countries, in international organizations and countries of the South. Within industrialized countries the nature conservation movements (governmental and non-governmental) utilize the notion of Biodiversity to validate and promote nature conservation policies and to raise awareness of a sound lifestyle for the preservation of the environment. They refer to Agenda 21 of the Rio Conference. International oriented organizations have mostly other perceptions of the significance of biodiversity, more as awareness of necessities to preserve global biodiversity where it is endangered world wide. Therefore there are two very different angles regarding the priorities and measures concerning solutions.

These two different meanings and perceptions for biodiversity, one more or less **in situ** perception and the other **ex situ** perception, had initially some influence on coherency of discussion in the workshop. They are not exclusive mutually, on the contrary; awareness of rich populations of the necessity of global conservation could begin with developing awareness for harmonic behaviour with one's own environment. It seems realistic to combine these two methods of realization.

The declared aim of Workshop II was to discuss whether economical returns of using biodiversity or its components have a positive or negative influence on overall conservation targets.

Recommendations:

For debating coherency it is necessary to distinguish the two different ways to conceive promoting of biodiversity. There is a strong interest to develop jointly both policies because their effects converge.

a) **in situ** policy: How to live in harmony with nature

Identify the way of cohabitation with regard to the different needs and uses. Multiple uses represent a relevant way of solution. It is important to find out win-win solutions in respect of all interest. The development of a close-to-nature silviculture including a network of preserved areas has been recognized as a relevant prospect. In the future silvicultural solutions should be enlarged with respect to a combination of diverse silvicultural techniques (so called polyvalent silviculture) combined with accessory prerequisites (dead wood).

In a definition of biodiversity in this sense it is necessary to include the synecological dimension for biocenotic cohabitation, and a genetical dimension in relation with evolutionary conditions. Biodiversity is to be interpreted as evolutionary continuum.

Biodiversity has its own value. It could be defined as 'indigenous life form patterns'.

There are a lot of successful silvicultural concepts respecting multiple use conditions (selection forest, regeneration systems respecting need for horizontal structure or patchiness). They should be enlarged for a wider application.

b) **ex situ** policy:

Find out sound ways of supporting conservation goals. Multiple use does not seem to be the only correct solution, but there is a strong necessity for solutions integrated in coherent management concepts. They must include welfare of the local population.

Importance of ecotourism: Interest of companies are too strong and negative impacts of tourism are too serious. Ecotourism would be perceived as a kind of neocolonialism if the principle of causality is not respected. External costs have to be internalized to the local populations.

There are many successful projects which are integrating respectfully the main constraints in different regions of the world.

There is a vast need for research, especially respecting the long run and the slow reaction of forest on impacts and its resiliency. The reaction of forest ecosystems to different kinds of perturbations inclusive pests requires further research.

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Workshop: Interrelationship of Cultural and Biological Diversity

Chairman: Prof. Darrell Posey, Institute of Social and Cultural Anthropology, Oxford, United Kingdom

1 – Historically, indigenous and traditional peoples have been seen only as inhabitants of the forest and objects of study like 'natural species'. However, since the Convention on Biological Diversity (CBD) was signed in Rio in 1992, 'knowledge innovations and practices' of 'indigenous and local communities embodying traditional lifestyles' (Art. 8–j), customary practice (Art. 10–c), and traditional technologies (Art. 18–4) have been guaranteed by over 177 signatory countries. Increasingly, international organisations (including UNESCO, FAO, UNEP, ILO, WTO, UNDP, IUCN, etc.) are recognising the central importance of local communities and their traditional ecological knowledge – expressed in their languages and cultures – in the conservation of forests and biodiversity.

This includes the recognition of:

- the active participation of communities in all phases of biodiversity conservation and forest management;
- destruction of forest resources provokes loss of knowledge and cultures, ignoring the fundamental importance of the spiritual connection with the land and nature;
- sacred sites as centres of important forest and biological diversity, and that many presumed 'natural ecosystems' have been moulded by human intervention as anthropogenic or cultural landscapes (as recognised by the UNESCO World Heritage Convention);
- biodiversity as being holistic and inseparable from the human family and society, and therefore can never be reduced merely to components or molecules;
- the need for consent and benefit-sharing agreements including full disclosure, prior informed consent and equity;
- indigenous and traditional peoples' alliances and the need to support their own efforts and activities, and especially their self-determination;
- specialised knowledge of women, elders, children and knowledge specialists, often expressed through the collective knowledge of gender and age groups, lineages, clans and local associations;
- the central importance of land, territorial and tenural rights, given that many state policies alienate community lands and resources;
- the identification of who precisely are 'indigenous peoples' should principally be left with the peoples and communities themselves to decide, as guaranteed by the UN Working Group on Indigenous Peoples, ILO, and the Draft Declaration on the Rights of Indigenous Peoples;
- nation state sovereignty cannot override basic indigenous and human rights.

2 – There is an "inextricable link" between linguistic, cultural and biological diversity. Indigenous and local peoples see language, culture, nature and land as intimately related parts of the same whole. Language is the main carrier of culture and main instrument for creating, transmitting and developing knowledge, including knowledge about the environment, the forests and biodiversity;

- The loss of linguistic diversity is estimated to be even greater and faster than the loss of biodiversity (possibly up to 90% of the 5–7000 existing languages becoming extinct before the end of the next century). This loss of languages leads to loss of knowledge, including ecological knowledge, with grave consequences for humans and the earth.
- Therefore, indigenous and local peoples are engaging in a struggle to maintain or revitalise their languages and cultures at the same time that they struggle to preserve or recover their lands and resources.

3 – In view of these international activities and processes, the 'ecodiversity-geodiversity-biodiversity' model (expressed in the opening session of this conference) must include cultural and language diversity of different peoples, and their knowledge systems. Unfortunately, the prevailing scientific/economic paradigm has been used to separate indigenous peoples from their land bases and natural and intellectual resources by ignoring their cultural and spiritual values. This dominant, top-down approach has fuelled biopiracy and other forms of exploitation and destruction of bio-cultural diversity.

4 – Traditional Ecological Knowledge (TEK) encodes the relationship of human beings with their natural and spiritual environment. It is holistic and encapsulates intellectual, cultural, spiritual, behavioural and material elements transferred over generations, including:

- perceptions, beliefs, cosmologies, attitudes, opinions, practices, experiences, skills, technologies, traditions, innovations,
- artefacts, tools, and other material objects,
- trees, seeds, plants, crops, animals,
- local institutions, such as women groups, tenure systems, healers associations,
- procedures, processes and local authority structures,

TEK should not be seen in opposition to 'Scientific Ecological Knowledge'. Rather, common ground, complementarity, collaboration and synergism should be sought to better tackle the conservation of forests and biodiversity. Both are part of the same human endeavour to create order out of disorder;

The TEK approach specifically focuses on the philosophies and cosmovisions on which indigenous peoples base their management and conservation perceptions and practices, but it also develops specific research methodologies to extrapolate 'subjective' factors at the individual level to 'objective' variables at the system level;

TEK is relevant for bio-cultural diversity conservation & management of forest resources, as it:

- provides new opportunities for collaborative R&D
- provides alternatives for sustainable use
- provides indigenous environmental assessment
- provides alternative conservation methods & practices
- contributes to the development of alternative philosophies of nature and the environment
- contributes to the policy planning & implementation process at various levels.

Recommendations:

1. Protecting forests and biodiversity requires protecting the cultural and linguistic diversity of the indigenous peoples, traditional societies, and local communities living in forests and other biodiversity-rich environments – including their cultural and spiritual values.
2. The land, territorial and human rights – including linguistic and cultural rights – of these groups must be recognised within the principle of self-determination to guarantee negotiation and representation as equal parties at all levels and in all processes that affect them.
3. Scientists must recognise that the existing biodiversity-geodiversity-ecodiversity paradigm has been misused to alienate and disenfranchise peoples from their spiritual and natural resources, and that future scientific endeavours must be built upon:

- recognition of basic rights including full disclosure to, prior informed consent from and authorisation by the local communities and appropriate representatives;
- recognition and use of Traditional Ecological Knowledge;
- collaborative research and development of the role of the researcher as a true partner in biodiversity conservation;
- equitable benefit-sharing with local groups.

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Workshop: Tools and Measures for Conservation, Rehabilitation and Development of Biodiversity

Chairman: Prof. Dato' Zakri A. Hamid, University Kebangsaan, Malaysia

Principal Conclusions and Recommendations

I Cross-Cutting Concerns

Protected Areas remain a keystone for conserving forest biodiversity, but will never be large enough to comprehensively conserve the full range of forest biodiversity.

A broader "bioregional" approach to biodiversity conservation is therefore necessary, which incorporates BD conservation objectives into timber production, plantation development, agriculture, and other resource uses – and promotes job creation to draw people away from the forest frontier.

A bioregional approach under both qualitative and quantitative aspects in turn requires a broader conception of "biodiversity conservation" including not only protection, but also ensuring that uses of biological resources are sustainable, and more equitable sharing of the benefits of the uses of biodiversity.

This requires new processes for involving a broader range of "stakeholders" in decision-making and management.

We must deepen our knowledge of biodiversity and ecological processes – as well as related socio-economic issues – and disseminate that information in ways that are useful to biodiversity managers and policy makers.

Public awareness, through schools and training centers and the media, is very important for building public support for biodiversity conservation.

Community participation in biodiversity conservation is a crucial tool for success across many types of forests and forest uses. Some key tools for encouraging community participation are:

– the role of NGOs as catalysts and communicators

– specific attention to the roles and involvement of women

– realistic attention to the priority social welfare needs of the community

– effective local stakeholder dialogue mechanisms

– development and use of conflict resolution skills and mechanisms

– attention to the social geography of the "community" – not all groups of people living together are cohesive communities!

"In stimulating sustainable forestry for rural development it is important that local people should not be conceived as an unnatural factor to forests, but rather as a highly specialized ecological agent acting within the forest."

II Can Biodiversity be Conserved in Large Scale Timber Production Forests?

There are great ecological differences between tropical and temperate forests, and between the socio-economic and governmental structures in which they are managed (or mismanaged).

Experience from Sweden shows that biodiversity conservation objectives can be successfully integrated into large-scale timber production in a temperate, developed country with a large forest products industry. Timber certification has been an important tool for doing this in Sweden. Certification can also be a feasible way to promote BD-friendly ways of producing NTFP goods and services.

Under present institutional conditions in most major tropical timber producing countries large-scale logging is a major catalyst for processes of forest degradation and biodiversity loss.

Nevertheless, since large-scale timber production from natural forests is likely to continue in both temperate and tropical areas, development of both technical and institutional innovations to improve the prospects for biodiversity in production forests must be a priority. One way in which such biodiversity and the ecological processes that maintain biodiversity may be protected is through a network of protected areas including habitats within production forests.

III Protected Areas

Historical concepts of protected areas as pristine ecosystems walled off from human influence have failed in many parts of the world – pressures from local needs and larger-scale development activities (and global markets) are too strong, while defensive measures are too weak.

Recent efforts in developing countries to establish "integrated conservation and development projects" (ICDPs) sound good in theory, but have largely failed to conserve the core protected areas they are intended to serve.

Needed is a new "bioregional" approach with three key elements:

– Planning and management of biodiversity and related human activities across whole landscapes-including urban, industrial, and demographic factors – with a related broadening of the sectors and stakeholders involved in the process.

– A return to stricter protection – backed by adequate resources – for areas where biodiversity conservation is a top priority and is not compatible with human uses (e.g. tigers versus farmers).

– Transition from state- and corporate-dominated forest ownership and control to far wider applications of community-based and community-managed forestry in non-core areas

– Equitable sharing of burdens and benefits, with specific attention to the rights of indigenous communities with long-standing claims on forest areas.

– Some of the most important protected areas in the world should perhaps be designated as world heritage sites under the world heritage convention.

IV Non-Timber (Non-Wood) Forest Products and Services

NTFPs add value to the forest resource, particularly for local communities, promote strategies and measures to increase its production and provide an incentive to conserve the forest.

NTFPs are not, in many places, "minor" forest products – rattan, forest-related fisheries, aquaculture and hunting, and many leaves and nuts in India are examples. But it is difficult to quantify their value, as many NTFPs do not enter formal markets.

As market access grows, however, the risk of over-exploitation becomes acute, even for NTFP uses that were formerly "traditional" and "sustainable."

Forest-related fisheries and aquaculture (e.g. flooded forests and pond-systems of the Amazon, mangroves of SE Asia) are an extremely important NTFP with key nutritional as well as income benefits for local communities.

Given the high economic and conservation value of NTFPs, policies need to be changed to provide greater incentives for their sustainable utilization.

Biodiversity prospecting for the development of new pharmaceuticals, pesticides, transgenic plants gain increasing importance and will contribute significantly to the valorization of forests. Royalty agreements, technology transfer and adding value to primary materials for product development within the source country are important conditions and implicated by the CBD.

Whole forest product and services can contribute significantly to human welfare and might include carbon, oxygen, water, litter, honey, habitats of fauna, landscape, recreation, education, ecotourism and units of unique scientific value.

As NTFPs increasingly enter mainstream markets, local economic institutions must be developed (e.g. co-operatives) to ensure that local people receive fair prices and improved market access for their NTFPs.

V Restoration and Rehabilitation

Timber plantations are going to be a key component of fibre production system in the 21st Century.

Current timber plantation models, however, are not supportive of biodiversity - often they are replacing diverse natural forests, and are in many cases composed of monocultural stands.

Innovative technologies and management strategies that better incorporate biodiversity into plantation planning, siting, species composition, and management are urgently needed.

Apart from reinforcing traditional agroforestry systems the socio-economic dimensions of plantation establishment (e.g. displacement of local farming communities who then turn to the natural forest for subsistence) must be carefully considered as well.

Restoration of natural forest ecosystems is technically feasible in many cases, and should be utilized for restoring degraded parts of forests landscapes.

Tree plantings do have a catalytic effect on the regeneration of native shade-tolerant forest species and therefore restoration of native forest biodiversity, across a broad range of site conditions under many different plantation species. Planting of fast growing, useful tree species, preferably native species, could therefore be used efficiently to restore the biodiversity and productivity of degraded land.

Recent developments of "carbon forestry" as presently often used in the context of the Climate Change Convention have increasingly become a source of funding for biodiversity conservation. However, it is crucial that the imperative of tree-planting to sequester carbon do not become an excuse for the replacement of natural forests with plantations.

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Congress Programme

Friday, 3 July 1998

Ellenberg, H.	Round Table: How to Count and Compare Biological Diversity in Forests? Definitions and Decisions needed

Saturday, 4 July 1998

Schreiner, J.	Opening address
Vauk, G.	Opening address
Wermann, E.	Opening address
Key-notes	
Sayer, J.	Introduction
Zakri A. H.	Challenges of Implementing the Convention on Biological Diversity
Barthlott, W.	The Uneven Distribution of a Treasure
Ganguly, A.	Drugs from Natural Sources
Iwand, W. M.	Supporting Biodiversity: Taking the Benefits of Tourism into Account
Ellenberg, H.	Results of the Round Table: How to Count and Compare Biological Diversity in Forests? Definition and Decisions Needed
Palmberg-Lerche, C.	Conservation of Biological Diversity with Special Reference to the Conservation of Forest Genetic Resources
Turok, J.	Regional Cooperation on Forest Genetic Resources: Conserving a Common Heritage
Martin-Jones, J.	Global 200 Forest Ecoregions
Boyle, T.	The Impacts of Human Activities on Biodiversity in Natural Tropical Forests

Sunday and Monday, 5 and 6 July 1998

Workshop	**Biodiversity as Value within Society**
Samper, C.	Introduction: Cultural and Spiritual Values of Biodiversity
Ramos, A.	Why Does Biodiversity Loss Occur in Many Places if it is Socially Better to Give it a Persistent Use?
Nader, W.	Biodiversity – Source of Inspiration and Innovation
Samper, C.	Introduction: Underlying Socio-Economic Forces Behind Biodiversity Loss
Forje, J. W.	Conserving Biological Diversity in Cameroon's Forests: Problems and Prospects for the Future
Walker, R.	Conserving the Tropical Resource Base: Do we Title Land or Organize Community?
Anane, M.	Role of the Media in Biodiversity Conservation Challenges and Opportunities
Workshop	**Biodiversity as a Resource**
Schütz, J.-P.	Introduction
Geldenhuys, C. J.	Requirements for Improved and Sustainable Use of Forest Biodiversity: Examples of South Africa
Scherzinger, W.	Importance of Vertical Stratification and Horizontal Patchiness Concerning Species-Diversity in Managed Forests – A Comparison
Kushalappa, C.	Impact Assessment of Working of Western Ghats Forests in Kodagu District, Karnataka State, South India
Kleinschmit, J.	Forest Management and the Conservation of Rare Species
Hanewinkel, M.	Successful Examples of Multiple Forest Use – The Model of Selection Forests
Bittner, J.	Reserva Natural La Planada – 15 Years Experience in Protection, Conservation and Research for a Sustainable Development
Geldenhuys, C. J.	Potential of and Development for Ecotourism in the Tsingy de Bemaraha near Bekopaka, Madagascar
Sunaryo	Ecotourism is a Viable Way of Using Resources
Workshop	**Interrelationship of Cultural and Biological Diversity**
Posey, D. A.	Introduction: Cultural and Spiritual Values of Biodiversity
Maffi, L.	Language: A Resource for Nature
Slikkerveer, J.	Traditional Ecological Knowledge Systems: Peoples, Forests and Plants
Carino, J.	Indigenous Peoples' Views and Concerns: An International Perspective
Hilario, M.	Forests of the Peruvian Amazon
Ruttanakrajangsri, K.	Indigenous Views from Thailand
Bone, R.	Community Use of Eucalyptus Plantation and Regenerating Miombo Woodland Resources at Aliseni Village, Ulumba Mountain, Southern Malawi
Gobulev, A.	Spring Ecosystems as the Unique Components of Natural and Cultural Environment

Workshop	**Tools and Measures for Conservation, Rehabilitation and Development of Biodiversity**
Zakri A.H.	Introduction
Barber, C. V.	The Diverse Tools and Measures Needed to Conserve, Rehabilitate, and Sustainably Use Forest Biodiversity
Jansons, J.	Forest Management and Biological Diversity in Latvia
Holesgrove, R.	Conservation of Biodiversity in Australia's Forests
Jack, J. B.	Analogue Forestry as a Process of Biodiversity Management
Gustafsson, L.	Integration of Biodiversity into Timber Production – the Swedish Approach
Barber, C. V.	Conserving Forest Biodiversity in Protected Areas: Can Conservation and Development Co-Exist?
John Joseph, S.	Community Participation
Nader, W.	Use it or Loose it: INBIO's Integrative Concept for Biodiversity Conservation
Werder, U.	Sustainable Aquaculture-Systems in the Rainforest – Fish Culture in the Surroundings of Manaus
Manokaran, N.	Rattan Utilization
John Joseph, S.	Non Timber Forest Products of India
Manokaran, N.	Management of Mangroves at Matang Peninsular Malaysia – A Case Study on Conservation, Rehabilitation and Development of Biodiversity
Halbritter, K.	Quantification of Forest Biodiversity by Remote Sensing
Enescu, V.	Challenges to the Forest Genetic Resources in Romania
Marku, V.	Biodiversity and some Aspects of its Management in Albania

Sunday and Tuesday, 5 and 7 July 1998

Poster Presentations and Additional Contributions
Chairmen: Wolfgang Kuhlmann, Prof. Dr. Hans-J. Muhs

Brüggemann, J.	The EUROPARC Partnership & Exchange Programme
Gustafsson, L.	Hot Spots for Biodiversity in Swedish Forests
Nino, E.	Reserva Natural La Planada – 15 Years Experiences in Protection, Conservation and Research for a Sustainable Development
Schilder, K.	Sustainable Use of the Gallip Nut *Canarium indicum* and Rainforest Conservation on Siassi, Papua New Guinea
Spanos, K.	A Special Biotope in a *Pinus halepensis* Forest in Chalkidiki – N. Greece
Velarde, M.	Woodlands Pattern and Territorial Diversity in Madrid

Opening Address

Ernst Wermann

Abstract

From the German point of view conservation and sustainable management have been and will be essential for maintaining the biological diversity of forests. Together with improved monitoring, research and protection of forests against pressures from outside (e.g. air pollution), they will be main elements of an integrated concepts on regional level, for which European ministers responsible for forests paved the way in Lisbon in June 1998 by adopting a work programme for enhancement of biological diversity in forests.

On the international level the various bi- and multilateral efforts to slow down forest loss and forest degradation could be facilitated by a legally binding instrument on the conservation and sustainable management of forests worldwide. Since more information is needed on details, options, pros and cons of the various options etc. etc., Germany will continue to be an active partner in the ongoing IFF-process.

Grußwort

Auf der Umweltkonferenz der Vereinten Nationen 1992 in Rio de Janeiro wurde der Durchbruch erzielt: Nach mehrjährigen Verhandlungen beschloss man dort einstimmig das Übereinkommen über biologische Vielfalt, das inzwischen von 170 Staaten weltweit gezeichnet ist. Sein Ziel ist die Erhaltung von Ökosystemen, der Artenvielfalt und der genetischen Vielfalt.

Auf dieser Konferenz wurde auch deutlich, dass die Umweltprobleme nicht allein durch Schutz in den Griff zu bekommen sind, sondern auch durch Nutzung und zwar durch nachhaltige Nutzung. Das gilt auch für die Sicherung der Biodiversität in Wäldern.

Nachhaltigkeit ist ein Begriff, der von der Forstwirtschaft geprägt wurde – in Mitteleuropa bereits 250 Jahre vor der Brundtlandkommission. In Frankreich verweist man sogar auf ein königliches Dekret von 1348, in dem im Zusammenhang mit forstlicher Nutzung der Begriff „soutenu" verwendet wird; „soutenu" hat die gleiche (lateinische) Wurzel wie – englisch – „sustainable", heißt also nachhaltig.

Nachhaltigkeit in der Forstwirtschaft hat sich als Begriff und Handlungsmaxime ständig weiterentwickelt, ist bedeutend erweitert worden, umfasst heute ökonomische, ökologische und soziale Ziele, auch die Erhaltung der biologischen Vielfalt, und hat das Wohl künftiger Generationen im Auge. Diese Art von Selbstverpflichtung der Forstwirtschaft scheint mir angemessen und wesentlich auch für die zukünftige Sicherung der Biodiversität in den Wäldern zu sein.

Die europäischen Forstminister haben dies bereits 1993 bei ihrer Konferenz in Helsinki ausdrücklich in dieser Weise bekräftigt und damit sozusagen die europäische Antwort auf Rio im Waldbereich gegeben.

Der Wiederaufbau der Wälder in Europa beweist: Nachhaltige Forstwirtschaft mehrt die natürlichen Ressourcen, die sie nutzt und indem sie sie nutzt. Wie viele andere Wirtschaftszweige können dies von sich behaupten?

Jahrhunderte nachhaltiger Forstwirtschaft haben in den Wäldern einen beachtlichen Schatz an Biodiversität erhalten (um das Leitmotiv Ihres Forums aufzugreifen). Aus Vergleichsstudien, z. B. von Prof. Ammer, München, wissen wir, dass Artenvielfalt in naturnah bewirtschafteten Mischwäldern nicht geringer zu sein braucht als in total geschützten Reservaten.

Unter naturnaher Waldwirtschaft stellen wir uns in Mitteleuropa vor:

- kleinflächige Nutzung,
- standortgerechte Baumartenwahl,
- Bevorzugung der Naturverjüngung,
- Integrierung von Alters- und Zerfallsphasen,
- Schutz wertvoller Biotope,
- waldschonende Erschließung,
- boden- und bestandsschonende Technik,
- integrierter Pflanzenschutz,
- und als Ergebnis strukturreiche, ungleichaltrige Mischwälder mit ausreichend totem Holz, mit der Fülle auch seltener Baum- und Straucharten und mit besonders sorgfältig gestalteten Waldrändern.

Kurz: Der Vielfalt der Standorte soll die Vielfalt der Waldökosysteme entsprechen.

Man nutzt klug natürliche Abläufe. Und man greift zurück auf die Vielfalt der Waldbehandlungsmöglichkeiten, die über Jahrhunderte entwickelt und erprobt wurden. Stützen kann sich naturnahe Waldwirtschaft auf entsprechende Planungen (Waldfunktionskartierung, Standortkartierung etc). und unterstützt wird sie durch die Forstpolitik mit Instrumenten wie finanzieller Förderung, Aus- und Weiterbildung und flächendeckender Beratung. Naturschutzrechtliche Anreize wie Vertragsnaturschutz kommen hinzu.

Meine Ausführungen zur „Erhaltung von Biodiversität durch nachhaltige Nutzung" zeigen, dass wir fortschrittlich genug sind, uns nicht allein auf ein Netz von Schutzgebieten zu verlassen. Schon in Rio wurde darauf Wert gelegt; ich führte dieses aus. Hinzu kommt ein europaspezifischer Aspekt, der zugleich zeigt, dass man Modelle, die anderswo unter anderen Bedingungen entwickelt wurden, nicht ungeprüft übertragen sollte.

Die Ausscheidung großflächiger Schutzgebiete leuchtet ein in Regionen mit großflächigen Naturwäldern in staatlichem Eigentum, wie im Norden von Nordamerika. In Europa überwiegt der private Waldbesitz und hier der relativ kleine Familienbetrieb. Daraus entwickelt sich eine Vielgestaltigkeit der Waldstrukturen und eine biologische Vielfalt, die über die natürliche Vielfalt noch hinausgeht. Ist sie durch verantwortungsvolle Nutzung entstanden, kann sie auch nur durch Fortsetzung der Bewirtschaftung erhalten werden.

Unter solchen Bedingungen würden allzu ehrgeizige Stillegungs- und Totalschutzprogramme biologische Vielfalt eher gefährden.

Den richtigen Weg in der Schutzgebietsfrage wies m. E. die jüngste Vertragsstaatenkonferenz zum Übereinkommen in Bratislava. Dort beschloss man, vordringlich eine saubere Analyse des Bedarfs vorzunehmen (gap analysis). Im übrigen war man in Deutschland keineswegs untätig. Hier sind immerhin 4% der Waldfläche (400000 ha) unter strengen Schutz nach Forstrecht und Naturschutzrecht gestellt. Dazu gehören die Wälder in Nationalparken, Naturschutzgebieten, Waldschutzgebieten und Naturwaldreservaten.

Zusätzliche 2% betreffen Wälder in Biosphärenreservaten, die auf Teilflächen ebenfalls strengen Schutz vorsehen.

Auch auf die seit langem eingeleiteten speziellen Maßnahmen zur Erhaltung der forstgenetischen Ressourcen ist zu verweisen (*in situ*, d. h. im Wald, oder *ex situ*, d. h. in Samenplantagen oder in Genbanken). Ein Programm zum genetischen Langzeitmonitoring gem. Art. 7b des Übereinkommens über biologische Vielfalt ist geplant. Auf europäischer Ebene wird im Rahmen des seit 1995 bestehenden Europäischen Programms für forstgenetische Ressourcen (EUFORGEN) zusammengearbeitet.

Zur Sicherung der Biodiversität in Wäldern beschlossen die europäischen Forstminister soeben in Lissabon ein umfangreiches Arbeitsprogramm, das den Weg ebnen soll zu einem integrierten Gesamtkonzept. Es soll nachhaltige Nutzung und Gebietsschutz, aber auch Monitoring, Aufklärung und Weiterbildung, Forschung und – besonders wichtig – den immer noch notwendigen Schutz der Wälder gegen Belastungen von außen (z. B. gegen Luftschadstoff- und Nährstoffemissionen) behandeln. Um Doppelarbeit zu vermeiden, wurde das Arbeitsprogramm mit der europäischen Umweltministerkonferenz abgestimmt.

In Deutschland arbeiten Bund und Länder gemeinsam bereits an einem solchen integrierten Konzept. Auch die Verbände werden beteiligt werden. Speziell für die Forschung bleibt noch ein weites Feld. Ich denke, dazu wird dieses Forum einiges ausführen.

Ich benutze die heutige Gelegenheit, auch noch mehr Dialog zwischen Wissenschaft und Politik über prioritären Informationsbedarf anzuregen. Wir finanzieren in Deutschland z. B. ein Verbundprojekt „Auswirkung forstlicher Maßnahmen und anderer Einflussfaktoren auf die Biodiversität in Wäldern". Dafür wurde ein Simulationsmodell entwickelt, genannt Ökogen, das auch in anderen Ländern Beachtung findet. Wir würden es z. B. begrüßen, wenn Vergleichsstudien wie die eingangs erwähnte auch in anderen Waldgebieten durchgeführt würden.

Wir würden es noch mehr begrüßen, wenn solche Studien im Zusammenwirken über Ländergrenzen hinweg betrieben werden könnten. Vielleicht kann das Forum auch dazu Anstöße geben. IUFRO, CIFOR und das European Forest Institute bieten dazu alle Möglichkeiten der Netzwerkforschung.

In Europa und Nordamerika wachsen Waldfläche, Holzvorräte und Holzzuwachs. In anderen Regionen der Erde ist Forstpolitik darauf angelegt, aus einer stetig schrumpfenden Waldfläche immer mehr Bedürfnisse einer immer größeren Bevölkerung zu befriedigen und gleichzeitig die schlimmsten Angriffe auf die Wälder, die von außen kommen, abzuwehren. Deutschland versucht dabei zu helfen: 250 Mio. DM werden jedes Jahr allein für forstliche Projekte in der Welt bereitgestellt. Ländern, die die gewünschte wirtschaftliche, technische und industrielle Entwicklung erleben, soll geholfen werden, in ihre Entwicklungsstrategien frühzeitig den Schutz von Natur und Umwelt zu integrieren. Dies führt zu wechselseitigem Geben und Nehmen. Auch wir wollen daraus lernen.

Diese Politik der Bundesregierung zur Erhaltung der Tropenwälder dient auch nicht zum geringsten Teil der Erhaltung der biologischen Vielfalt. Die Tropenwälder zählen zu den vielfältigsten und artenreichsten Ökosystemen, die es auf der Erde gibt, und es war die Sorge um die Erhaltung dieser Wälder, die mit zum Abschluss des Übereinkommens geführt hat. Bei der Unterstützung von Tropenländern zur Erhaltung und nachhaltigen Bewirtschaftung ihrer Wälder verfolgt die Bundesregierung einen integrativen Ansatz. Es kann auch hier nicht einfach nur darum gehen, große Flächen unter Schutz zu stellen. Die ansässige Bevölkerung sollte nicht ausgeschlossen werden von der Nutzung des Waldes, der gerade in den Tropen meist nicht nur Holz, sondern eine Fülle weiterer Güter bietet. Die Integration von Walderhaltung und Waldschutz, nachhaltiger Nutzung und ergänzenden Maßnahmen zur Verbesserung der Lebensbedingungen der örtlichen Bevölkerung hat noch einen weiteren Vorteil. Wald erlangt über seinen Wert als Lebensraum hinaus einen wirtschaftlichen Wert als Einkommensquelle. Damit wächst die Bereitschaft der Menschen, sich für seinen Schutz einzusetzen.

Forstliche Projekte müssen ihrerseits integriert werden in geeignete Landnutzungskonzepte, die die Armut bekämpfen und Ernährung und Beschäftigung sichern. Die tieferen Ursachen der Waldvernichtung liegen nämlich außerhalb der Forstwirtschaft. Von großer Bedeutung ist auch die Lösung sozialer Probleme. Eine Politik zur Tropenwalderhaltung muss sich daher mit Bemühungen um faire Entwicklungschancen für die Menschen verbinden. Darüber hinaus strebt die Bundesregierung den Abschluss eines völkerrechtlich verbindlichen Übereinkommens über die Walderhaltung (Waldkonvention) an. Wir wissen, dass noch viele Details zu klären sind. Länder, die noch zögern, möchten einfach besser informiert sein über Inhalte, Optionen, Vorteile der verschiedenen Optionen etc.

Deshalb wird sich Deutschland weiterhin aktiv an den Arbeiten des zwischenstaatlichen Waldforums (Intergovernmental Forum on Forests, IFF) beteiligen, das bis zum Jahr 2000 den Beschluss über ein eventuelles Verhandlungsmandat für eine Waldkonvention vorbereiten soll. Das IFF wird Ende August zu seiner 2. Sitzung zusammentreten.

Deutschland war auch Gastgeber eines internationalen Experten-Workshops über nationale Forstprogramme, der gestern endete. Nationale Forstprogramme wurden, wie Sie sich erinnern werden, von der Vorläuferorganisation des IFF, dem Zwischenstaatlichen Waldausschuss (Intergovernmental Panel on Forests, IPF) besonders empfohlen als geeignetes Instrument zur Verwirklichung einer nachhaltigen Waldbewirtschaftung. Auch diese internationalen Aktivitäten gehören zum forstpolitischen Konzept von Bundesminister Borchert. Ich habe Ihnen daraus einige Gedanken vorgetragen, auch um das Interesse deutlich zu machen, das der Schirmherr dieser Veranstaltung beimisst. Aus den Ergebnissen des Forums wollen wir lernen. Es ist also durchaus Eigennutz im Spiel, wenn ich Ihnen den bestmöglichen Erfolg wünsche.

Die Aufzählung von Aktivitäten zur Walderhaltung und zur Integration der Erhaltung der biologischen Vielfalt in die nachhaltige Bewirtschaftung der Wälder war nicht erschöpfend. Zu einem vollständigen Bild gehören auch die zahlreichen Initiativen von nichtstaatlichen Organisationen sowie der Wissenschaft. Hier reiht sich Ihre Veranstaltung vorbildlich ein.

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Challenges of Implementing the Convention on Biological Diversity

Zakri A. Hamid

Abstract

Biodiversity supports society in many important and real ways. Food security, climatic stability, freshwater security and the health needs of humans around the world all depend directly upon maintaining and using the world's biodiversity. More than 40% of the world's economy and some 80% of the needs of the world's poor are derived from biodiversity. Loss of biological diversity threatens these services and hence society generally.

The Convention on Biological Diversity (CBD) is an international treaty with near universal membership (as of May 1998, 172 countries have ratified the Convention). It is conceived as an ambitious project to arrest the pace of biodiversity destruction. The principal objectives of the CBD are the conservation, sustainable use and equitable sharing of the benefits of the use of genetic resources. The CBD recognizes that the key to maintaining biological diversity depends upon using this diversity in a sustainable manner. A central purpose of the CBD is to promote the concept of sustainable development as envisaged in the instruments arising from the UNCED process with which the CBD was negotiated contemporaneously. The CBD is therefore not simply a conservation treaty: It assumes human use and benefit as the fundamental purpose for achieving its objectives.

The Convention translates its objectives in its normative provisions contained in Article 6 to 20. These articles contain key provisions on: measures for the conservation of biodiversity, both *in situ* and *ex situ*; incentives for the conservation and sustainable use of biodiversity; research; education; assessing the environmental impacts of projects; regulating access to genetic resources and the technology to use these resources; and, financial resources. The Convention also establishes the standard institutional elements of a modern treaty, namely a COP, a Secretariat, advisory bodies, a clearing-house mechanism and a financial mechanism.

Among the substantive elements of the Convention that have been deliberated by the Parties are programs of work on coastal and marine biodiversity, forest biodiversity and agricultural biodiversity; negotiations on a Biosafety Protocol; and an international initiative to further consider the rights of indigenous and local communities under the CBD.

The challenge for the process as it moves into its implementation phase is to develop an approach which will find a balance between pursuing a truly holistic and integrative approach demanded by the Convention whilst at the same time being focused enough to allow development of its provisions.

Transcript of the presentation by Prof. Dato' Zakri A. Hamid based on tapes

Responsible editors: Inge Stein, Jutta Poker

In a world of increasing globalization and environmental degradation, biological diversity is one of the outstanding issues which humankind has to address in order to survive. It is a common concern to all of us and therefore not surprising that biological diversity is along with climate change addressed by the international community not only in political but also in legal terms. The Convention on Biological Diversity (CBD) is an international treaty with near universal membership. It entered into force five years ago and now has established most of the elements required to be operational. Attention within the process is now moving towards implementation. By a way of context and in order to understand the issues at stake in this move towards implementation, I will briefly describe the importance of biodiversity and the history of the Convention and we will then try to elaborate under provision of the Convention its institutional structure and the processes on substantive elements which the parties have initiated to develop the substantive provision of the Convention.

Biological Diversity

The term is used to describe the number and variety of living organisms. It is defined in terms of genes, species and ecosystems which are the outcome of 3.000 million years of evolution. Although the concept is not fully understood in terms of numbers of species and genes or even what an ecosystem exactly is, it is widely accepted that globally biodiversity is being lost at all levels. For example, current rates of extinction of species are unprecedented which in turn directly diminishes genetic variability. Ecosystems around the world are under increasing pressure from human activities.

Biological diversity supports society in many important and real ways. Food security, climatic stability, fresh water security and the health needs of humans around the world all depend directly upon maintaining and using the world's biological diversity. More than 40% of the world's economy and some 80% of the needs of the world's poor are derived from biological diversity. Loss of biological diversity threatens these services and consequently society generally. Accordingly, the UN Conference on Human Environment in Stockholm in 1972 identified as a priority the need for the conservation of biological diversity. The number of international legal instruments related to biological diversity adopted during the 1970s reflect such a priority. The Ramsar Convention on Wetlands in 1971, the Convention for the Protection of the World Cultural and Natural Heritage in 1972, the Convention on International Trade in Endangered Species of Wild Fauna and Flora in 1973 and the Bern Convention on the Conservation of Migratory Species or Wild Animals in 1979 are a testimony to these efforts and the importance attached to the issues by the international community. However, these early initiatives emphasize conservation. It is only through the report 'Our Common Future', the 1978 report of the World Commission on Environment and Development, that strides the new challenge facing the conservation and sustainable use.

* Chairman, Subsidiary Body on Science, Technical & Technological Advice (SBSTTA), Convention on Biological Diversity

History of the CBD

The origin or the negotiation of the Convention lies in the 1987 Governing Council of UNEP which called upon UNEP to convene an ad hoc Working Group of Experts on biological diversity for the harmonization of the existing conventions related to biological diversity. At its first meeting the group of experts agreed on the need to elaborate an internationally binding instrument on biological diversity. This was followed in May 1989 by an ad hoc Working Group of Experts on biological diversity. In February 1990 the ad hoc Working Group was turned into the Intergovernmental Negotiating Committee which held seven working sessions, which combined, in adoption of the Nairobi Final Act of the conference, the agreed text of the CBD. The Convention was opened for signature in June 1992 during UNCED and entered into force on 29 December 1993. As of May 1998, that is at the fourth Conference of Parties in Bratislava, 172 countries and the European Union have ratified the Convention and further 18 countries have signed it.

There are some provisions which are important in the context of the treaty. The principle objectives, as we are fully aware, are three prongs, namely the conservation, sustainable use and equitable sharing of the benefits of the use of genetic resources. The Convention recognizes that the key to maintaining biological diversity depends upon using this diversity in a sustainable manner. A central purpose of the BCD is to promote the concept of sustainable development as envisaged in the instruments arising from the UNCED process with which the CBD was negotiated contemporaneously. Therefore, the CBD is not simply a conservation treaty. It assumes human use and benefit as the fundamental purpose for achieving its objectives. The Convention translates its guiding principles of conservation, sustainable use and equitable sharing of genetic resources into binding commitments in its normative provisions contained in article 6–20. These include key provision on:

- measures for the conservation of biological diversity, both *in situ* and *ex situ*
- incentives for conservation and sustainable use
- research
- education
- assessing the environmental impacts of projects
- regulating access to genetic resources and the technology to use these resources
- financial resources.

The Convention also establishes the standard institutional elements of a modern treaty, namely the Conference of the Parties (COP), a Secretariat, advisory bodies, a clearing house mechanism and a financial mechanism. Article 23 establishes a Conference of the Parties which is the supreme party of the Convention. The principle function of the COP is to regularly review the implementation of the Convention. Today, the COP has met four times, in the Bahamas in 1994, Jakarta in 1995, Buenos Aires in 1996 and recently in Bratislava in May 1998.

Some of the components of the Convention will be the Secretariat and also the SBSTTA, the Subsidiary Body on Scientific, Technical and Technological Advice, a mechanism of provision of financial resources, namely at this point the Global Environment Facility (GEF) which is deemed as an interim basis to operate the financial mechanism of the Convention, and also the establishment of the Clearing House Mechanism to promote and facilitate technical and scientific co-operation. In this last context the government of Germany has been very forthcoming in supporting the establishment and also the implementation of the Clearing House Mechanism.

The nature of the issues which the Convention seeks to address means that it is heavily dependent on the effectiveness of the actions of parties in other institutions. The need to develop institutional links with other international bodies, to develop co-operative relationships with such bodies and hands-mechanism for coordinating this relationship is fundamental to the implementation of the CBD. The importance of co-operation and co-ordination between the CBD and other conventions, institutions and processes of relevance has been affirmed at every meeting of the COP. Consequently, it is not accurate to simply think of the institutional structure of the Convention in terms of those institutions established by the process itself.

Some of the substantive elements of the Convention are the following:

- Bio-safety is an important issue. Despite the considerable benefits which biotechnology may bring, the technology does also have the potential to cause harm to the environment and human health. Mindful of these dangers, the COP established an ad hoc Working Group of Experts on bio-safety to develop an internationally legally binding Protocol, specifically focusing on the transboundary movement of any living modified organism that may have an adverse impact on the conservation and sustainable use of biodiversity. These negotiations have been conducted in earnest, and it is anticipated that it should complete its work early next year in 1999.
- Another issue that has been brought up by the Convention will be on the marine and coastal biodiversity. At the second meeting of the COP a program of work was initiated known as the Jakarta Mandate which proposes a framework for global actions to maintain marine and coastal biodiversity.
- An issue which is most pertinent to the scheduling in this turn will be on forests. As we are fully aware, forests provide the most diverse sets of habitats for plants, animals and micro-organisms, holding the vast majority of the world's terrestrial species. Consequently, the maintenance of forest ecosystems is crucial to the conservation of biological diversity and degradation of forests has a dramatic impact on biodiversity. The importance of forests for the purposes of the Convention and the mandate of the CBD in issues of forest biological diversity has been confirmed repeatedly by the COP. As for now, focus work program for forest biological diversity has been on the card, whereby some elements for such a work program include focus on research, co-operation and development of technologies necessary for the conservation and sustainable use of forest biological diversity. The program will also compliment existing national, regional or international criteria and indicators of frameworks for sustainable forest management and it would also incorporate traditional systems of forest biological diversity conservation. This will build upon the co-operation with other relevant fora that the CBD has already undertaken, e. g. the close linkage that we have with the Intergovernmental Forum on Forest.
- Another main issue dealt by the CBD will be agriculture and, as we know, promoting sustainable agriculture and rural development have been acknowledged within the CBD as central to achieving the

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Contents

Forests in Focus

within the framework of 'WELTFORUM WALD', official project of the World Exposition 2000

A series of fora focusing on global forests issues aims at achieving consensus among relevant interest parties on tools and concepts to sustainably develop the world's forests. The project 'Forests in Focus' adds operative recommendations for solving environmental problems concerning forests to current political negotiations and scientific meetings in the field of forestry. The fora act as an agent between politics, economics, science and public and provide condensed up-to-date knowledge as well as agreed upon proposals for action adequate to target groups. Thus, 'Forests in Focus' supports the local implementation of guidelines on forest management and enforces the forest related parts of the Agenda 21 process.

Background

The World Exposition 'EXPO 2000 Hannover' presents the concept of sustainable development as agreed upon in the Agenda 21 at the UNCED 1992 in Rio de Janeiro. EXPO 2000 includes various worldwide decentralised projects. One of these, 'WELTFORUM WALD' (World Forum on Forests) has been initiated by authorities of the district Soltau-Fallingbostel, Northern Germany, the Association for the Protection of Forests and Woodlands (SDW), the Forestry Commission of Lower Saxony and the Alfred Toepfer Academy for Nature Conservation (NNA).

The project includes various activities and exemplary projects demonstrating sustainable management and use of forests to local people and international visitors (reafforestation of degraded heathland, redevelopment of former military areas, environmentally sound wooden buildings, thermal use of wood, use of non-timber products, management of a nature reserve and tourism, etc.).

Within this frame, 'Forests in Focus' forms the professional backbone. The fora address institutions and social parties concerned with forests, particularly those which

- are directly connected to forests,
- play an active role in forest management
- are affected by forest management.

The fora intend to encourage the relevant social parties to participate efficiently in decision making on forest issues, thus promoting the worldwide implementation of the recommendations of the Agenda 21.

Auspices

'Forests in Focus' is performed under the auspices of the Federal Minister of Food, Agriculture and Forestry, Mr. Karl-Heinz Funke.

Time Schedule

Between 1998 and 2000, five fora take place. With respect to the multiple functions of forests, the fora focus from different perspectives on the worldwide sustainable co-existence of mankind and forest:

Forests and Energy (To what extent can forests contribute to the world's future energy supply?) January, 1998

Biodiversity – Treasures in the World's Forests (Prospects of conservation, use and sustainable development of biodiversity in forests) July, 1998

Forests Source of Raw Material (Potentials of forest products' use and marketing) May, 1999

Forests and Atmosphere-Water-Soil (Regulation of energy and matter cycles with respect to climate change, water cycles and soil degradation) July, 1999.

Forests and Society (Interrelation of cultures and environment, public awareness, public participation; integration of recommendations of the former fora) November, 1999.

The final events will be the presentations of the results and recommendations of all fora at the EXPO 2000 in Hannover in Summer 2000 and at the congress **Sustainability in Time and Space** – in cooperation with PRO SILVA (Implementation of forest management guidelines in divergent forest types.) June, 2000.

Biodiversity:
Treasures in the World's Forests
Concluding Statement of the Forum

Chairman: Prof. Jeff Sayer, Centre for International Research in Forestry (CIFOR), Bogor, Indonesia

In an event leading up to the EXPO 2000 Hannover World Exposition a group of 150 scientists, foresters, conservation practitioners and concerned individuals from 35 countries met for four days by invitation of the Alfred Toepfer Academy for Nature Conservation at Schneverdingen in Lower Saxony to discuss the issues confronting the use and conservation of the world's forest biodiversity. On the first day a plenary session was held at which 9 papers on different aspects of biodiversity were presented. On subsequent days the forum worked in four parallel sessions but gathered in plenary each evening to review the results of the day's work and consider general conclusions and recommendations. A number of technical papers were presented at each workshop but considerable time was allocated for debate. Transcripts of the papers presented and summaries of the debates, conclusions and recommendations of each workshop will be provided in the record of the Forum in the near future.

The Forum was characterized by the great diversity of the participants, many of whom had not previously met. Amongst the participants were people who had been closely involved in the various international and intergovernmental processes dealing with biodiversity, but others were people more concerned with practical conservation on the ground. Yet others came from industry, research institutes and NGOs. There were several persons from cultural minorities in tropical developing countries. A significant number of participants had personal experience of the management of central European woodlands for biodiversity. Everyone took part in their personal capacities and discussions were frank and free.

There was no attempt to conduct a comprehensive review of all global forest biodiversity issues. The group focussed on those issues that it considered to be of particular concern and for which it had special competence. The following therefore emerged as major themes of the forum:

- The divergence between biodiversity as seen by "Western" science and as seen by the diverse communities of people more directly in contact with biodiversity in the forests: "Science" tends to reduce biodiversity to components through lists of species, hot spots, biodiversity indices etc. whereas most cultures see biodiversity in terms of assemblages of species and attach values according to the ecological services provided and the many uses made of these assemblages, many of which may be of cultural and spiritual significance. Participants stressed that the "whole" assemblage of biodiversity (ecological and human communities) have greater value than the "sum" of the parts.
- The erosion of our knowledge of biodiversity caused by the loss of local cultures and languages: Since value is not an intrinsic feature of biodiversity but is a function of our knowledge of any species or community this loss of knowledge represents a loss of value and undermines the stability of communities and their conservation.
- The relative merits of biodiversity conservation being an indispensable component of integrated multiple-use forest management systems as in much of central Europe or alternative approaches based on a clear segregation between "production forests" and "conservation forests" as in Australia, New Zealand and some tropical countries.
- The potential impacts on biodiversity of the globalization of economies and the "information technology" revolution: Globalization will lessen the "control" that sovereign governments can exercise over their natural resources whilst the greatly improved communications resulting from information technology should lead to greater empowerment of hitherto marginal peoples.
- The recognition that solutions to biodiversity problems will usually be location-specific and will depend on the social and economic conditions of a location as well as on the biophysical characteristics of the forests and their biodiversity.
- Solutions appropriate to the biologically simple forests of temperate and boreal countries with advanced economies may not be applicable to the biologically much richer forests of the less developed economies of tropical regions.
- Economics has a valuable role to play in helping to make better decisions relating to biodiversity but participants were concerned that conventional economics does not yet adequately capture many of the cultural, spiritual or ecological values of biodiversity.

The forum recognized the valuable achievements of the processes occurring under the Convention on Biological Diversity and the great potential of the CBD to have real impacts on the ground. It saw the CBD as continuing to be the prime focus for international action but recognized that there are limits to what can be achieved through *"intergovernmental"* action and that there is a need for parallel actions at the national and local levels and in the corporate sector.

The forum also noted the potential for the Intergovernmental Forum on Forests to play an important role but felt that the IFF had as yet only made modest progress on biodiversity. The IFF also has potential but again it was emphasized that intergovernmental negotiation is not a substitute for local action.

The workshops elaborated a number of conclusions and recommendations which are included in their reports. The workshop recommendations are not repeated here, instead this summary presents a number of more general conclusions and recommendations which emerged from the discussions. These are presented as a record of our views and are addressed to the participants in international debates on biodiversity as well as to "actors" in society whose activities have an impact on forests and their biodiversity.

- The work of the CBD has benefited greatly from contributions provided by science. However the full potential of the scientific community has not yet been mobilized. It is recommended that there should be greater engagement of social scientists familiar with traditional ecological knowledge (TEK), and of practitioners of "informal" science – the specialists, often from cultural minorities, who are the repositories of much traditional knowledge.

■ Economic analysis has a major role to play in improving decision making on forest biodiversity but it is recommended that further development of techniques is needed to recognize the values that different cultures attach to biodiversity and to better capture the cultural, spiritual and functional values of biodiversity.

■ "Western" science and "economic globalization" may tend to favor outcomes in which biodiversity conservation (nature reserves) are segregated from production forests (plantations). It was noted that these tendencies may run counter to the interests of cultural minorities for whom integrated multiple-use solutions may be more desirable. It is therefore recommended that bio-regional approaches be adopted for conservation planning with full participation of all concerned people in order to optimize all products and services of forests and achieve better allocation of land.

■ There has been considerable achievement in central Europe in reconciling natural forest management and the conservation of biodiversity. Whilst recognizing that this experience cannot be transferred directly into the very different conditions of the biodiverse forests of the tropics it is nonetheless recommended that attempts to achieve biodiversity conservation in the context of locally driven multiple-use forest management systems in the tropics should be vigorously pursued.

■ Protected areas allocated primarily for biodiversity will remain a central element of conservation. It is recommended that renewed efforts be made under the CBD and IFF to achieve the medium-term security of a core set of forests sites of recognized international value for forest biodiversity and that opportunities already provided by ongoing activities such as the WWF "Global 200 forest ecoregions" program and the forest initiative under the World Heritage Convention be supported.

■ Although Integrated Conservation and Development Programs have been a principal mechanism of channeling international support to the conservation of forest biodiversity, these have in general produced disappointing results. It is recommended that ICDP approaches should be led by local communities and not imposed upon them and that the likelihood of ICDPs succeeding will be enhanced if they are based upon local understanding and valuation of biodiversity.

■ Developing countries and cultural minorities ought in principle to be able to derive greater economic benefits from the exploitation of their biodiversity for use in the pharmaceutical, fibre, food and technology based industries. There is however a danger that the benefits of "bio-prospecting" accrue largely to industry and not to the communities of people who are the traditional users of the resource. It is recommended that bio-prospecting be promoted as a legitimate way to access a valuable natural resource but that institutional arrangements to ensure the equitable sharing of benefits be further studied and where appropriate strengthened.

■ It was recognized that biotechnology can play a major role in determining the future uses of components of biodiversity. Genetic engineering and other molecular biology techniques have allowed the transfer of genes between species. This results in many new options and may lead to increased economic benefits. However great uncertainty persists on the possible impacts of genetically modified organisms on humans and on biodiversity as a whole. In this context the protocol on biosafety under negotiation within the CBD is an important contribution. In this context it is recommended that technology transfer (including biotechnology) and capacity building in developing countries should be facilitated and biosafety considerations should be incorporated in the development of forest management practices and products.

■ Non-timber forest products are a vital resource for very large numbers of people in the forested regions of the world. The value of this resource is often underestimated in formal decision making, partly because many of the products are not traded in the formal economy. It is recommended that greater attention be given to the sustainability of NTFP resources in multiple-use systems and that the interests of the people who depend upon them be given greater weight in decisions relating to the use of forest lands.

■ Technological options exist to restore forest cover of degraded lands in many parts of the world. At present much reforestation and afforestation uses techniques which lead to biologically impoverished forests. It is recommended that greater attention be given to increasing the species richness of artificially established forests.

■ Information gives value to biodiversity. The globalization of information systems creates opportunities but also creates some threats. Information may not be available equally to all stakeholders. It is therefore recommended that the recording and protection of traditional information be given more attention and that attempts be made to make information available locally so as to counter the present trend towards domination by a small minority of global news and information sources.

■ Protecting forests and biodiversity requires protecting the cultural and linguistic diversity of indigenous peoples. Scientists must recognize that the existing biodiversity paradigm has in the past been misused to alienate and disenfranchise peoples from their spiritual and natural resources and that future scientific endeavors must be built upon recognition of basic rights and recognition of traditional ecological knowledge.

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Workshop: Biodiversity as Value in Society

Chairman: Dr. Cristian Samper, Instituto Humboldt, Bogota, Colombia

Valuation of forest biodiversity

Biodiversity can provide different kinds of goods and services that are the basis of our welfare on this planet. Human activities influence biodiversity in a variety of ways, and we are constantly choosing alternatives about the way we use resources. Determining these kinds of values can be useful in this context of societal choice; and valuation can influence the way we use or abuse forest resources.

Biodiversity can have many different kinds of values, and these often differ among individuals and societies. Some of these values are related to the use of biodiversity by humans, and others are related to cultural and spiritual values of biodiversity for society. Furthermore, the value of biodiversity as a whole may be more than the sum of its components.

The value of biodiversity should not just be measured through price. Some of these values are utilitarian in nature, and include goods and services that are the basis for consumption and production, which are often traded through markets. However, there are other kinds of values, such as option values, bequest values and existence values, that are not traded through markets. Economists have developed tools and methodologies (i.e. contingent valuation) that can be used to measure preferences and simulate markets. The sum of these values can provide an estimate of the total economic value of biodiversity.

Distribution of costs and benefits

The choices we make can influence our options for future choices, so there is a cost associated with resource use. In this context, it is crucial to develop ways and means to achieve the equitable distribution of costs and benefits in society. There is a trend toward an increase in the concentration of benefits and the socialization of costs. The underlying problem is that often some of the costs are passed on to society or to future generations, that is, the private cost is less than the social cost.

It is important to design ways and means to add value to forests and biodiversity. Information can change perceptions, alter values and influence choices. Technological developments and technology transfer (including biotechnology) can also increase the possibilities for use, improve efficiency and add value. The correction of market and institutional failures can also influence choice. Overall, the development and valuation of multiple-use systems can be important to achieve a greater total value for forests and biodiversity.

The socio-economic framework

The socio-economic forces driving biodiversity loss are complex, and include aspects such as demographic change, poverty and inequality, public policies, markets and trade. These forces generate a change in resource use patterns and can lead to habitat loss and degradation. All of these forces operate at the local, national and international level, with a growing impact of global forces on local decisions.

One of the driving forces at the local level is related to property rights and land tenure. In general, secure property rights may promote sustainable use of forest biodiversity, as they may affect the level and nature of investments, capital markets, rent dissipation, enable land transactions, and favor conservation of natural resources for the future. However, land tenure and property rights by themselves do not guarantee sustainable use, since there may be important changes in cultural values and markets over time.

The current trend toward globalization can have important social and economic impacts on resource use, including, but not limed to, access to new markets, increased capital flow, labor movements and training, increased information exchange, a change in consumption patterns, technology transfer, loss of national sovereignty and loss of cultures and languages. Some of these changes may promote sustainable use, whereas others may result in increased degradation.

Information and awareness

Information is an important element of value, and communication and awareness raising can have an impact on individuals and society through the influence on choice.

The communication of information needs to seeks four elements: (I) the right information, (II) to the right people, (III) in the right form, (IV) at the right time. In the short term special emphasis needs to be placed on raising awareness among decision makers and the general audience, where the media can play a critical role. At the same time we need to include environmental considerations into education programs, which will have a longer term impact.

There is a trend toward globalization of information. Technological developments, including satellite communications, are resulting in faster and broader information exchange. This means that local communication and information systems have to be reinforced and we need to seek more equitable and unbiased information exchange at the global level.

Recommendations:

Further research needs to be undertaken to develop methodologies that enable valuation of non-direct uses of biodiversity, including ecosystem services.

There is a need to reinforce multi-disciplinary approaches to valuation of biodiversity, including economic, social and cultural values.

We must promote the valuation of multiple uses of forest biodiversity and multiple use systems.

There is an urgent need to correct market and institutional failures, and to design mechanisms that internalize social costs.

It is important to strengthen international regulation mechanisms, such as international treaties and conventions.

Instruments such as certification of forest products can operate though global markets and should be implemented, taking special care not to impose market barriers for developing countries.

There is an urgent need to strengthen means to communicate information at the local and national levels, and at the same time seek ways to achieve a more balanced and unbiased exchange of information at the local level.

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Workshop: Biodiversity as a Resource

Chairman: Prof. Dr. Jean-Philippe Schütz, Dept. Forestry and Wood Research, ETH Zürich, Switzerland

Preamble

The perception for the notion of biodiversity is different between industrialized countries, in international organizations and countries of the South. Within industrialized countries the nature conservation movements (governmental and non-governmental) utilize the notion of Biodiversity to validate and promote nature conservation policies and to raise awareness of a sound lifestyle for the preservation of the environment. They refer to Agenda 21 of the Rio Conference. International oriented organizations have mostly other perceptions of the significance of biodiversity, more as awareness of necessities to preserve global biodiversity where it is endangered world wide. Therefore there are two very different angles regarding the priorities and measures concerning solutions.

These two different meanings and perceptions for biodiversity, one more or less **in situ** perception and the other **ex situ** perception, had initially some influence on coherency of discussion in the workshop. They are not exclusive mutually, on the contrary; awareness of rich populations of the necessity of global conservation could begin with developing awareness for harmonic behaviour with one's own environment. It seems realistic to combine these two methods of realization.

The declared aim of Workshop II was to discuss whether economical returns of using biodiversity or its components have a positive or negative influence on overall conservation targets.

Recommendations:

For debating coherency it is necessary to distinguish the two different ways to conceive promoting of biodiversity. There is a strong interest to develop jointly both policies because their effects converge.

a) **in situ** policy: How to live in harmony with nature

Identify the way of cohabitation with regard to the different needs and uses. Multiple uses represent a relevant way of solution. It is important to find out win-win solutions in respect of all interest. The development of a close-to-nature silviculture including a network of preserved areas has been recognized as a relevant prospect. In the future silvicultural solutions should be enlarged with respect to a combination of diverse silvicultural techniques (so called polyvalent silviculture) combined with accessory prerequisites (dead wood).

In a definition of biodiversity in this sense it is necessary to include the synecological dimension for biocenotic cohabitation, and a genetical dimension in relation with evolutionary conditions. Biodiversity is to be interpreted as evolutionary continuum.

Biodiversity has its own value. It could be defined as 'indigenous life form patterns'.

There are a lot of successful silvicultural concepts respecting multiple use conditions (selection forest, regeneration systems respecting need for horizontal structure or patchiness). They should be enlarged for a wider application.

b) **ex situ** policy:

Find out sound ways of supporting conservation goals. Multiple use does not seem to be the only correct solution, but there is a strong necessity for solutions integrated in coherent management concepts. They must include welfare of the local population.

Importance of ecotourism: Interest of companies are too strong and negative impacts of tourism are too serious. Ecotourism would be perceived as a kind of neocolonialism if the principle of causality is not respected. External costs have to be internalized to the local populations.

There are many successful projects which are integrating respectfully the main constraints in different regions of the world.

There is a vast need for research, especially respecting the long run and the slow reaction of forest on impacts and its resiliency. The reaction of forest ecosystems to different kinds of perturbations inclusive pests requires further research.

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Workshop: Interrelationship of Cultural and Biological Diversity

Chairman: Prof. Darrell Posey, Institute of Social and Cultural Anthropology, Oxford, United Kingdom

1 – Historically, indigenous and traditional peoples have been seen only as inhabitants of the forest and objects of study like 'natural species'. However, since the Convention on Biological Diversity (CBD) was signed in Rio in 1992, 'knowledge innovations and practices' of 'indigenous and local communities embodying traditional lifestyles' (Art. 8–j), customary practice (Art. 10–c), and traditional technologies (Art. 18–4) have been guaranteed by over 177 signatory countries. Increasingly, international organisations (including UNESCO, FAO, UNEP, ILO, WTO, UNDP, IUCN, etc.) are recognising the central importance of local communities and their traditional ecological knowledge – expressed in their languages and cultures – in the conservation of forests and biodiversity.

This includes the recognition of:

- the active participation of communities in all phases of biodiversity conservation and forest management;
- destruction of forest resources provokes loss of knowledge and cultures, ignoring the fundamental importance of the spiritual connection with the land and nature;
- sacred sites as centres of important forest and biological diversity, and that many presumed 'natural ecosystems' have been moulded by human intervention as anthropogenic or cultural landscapes (as recognised by the UNESCO World Heritage Convention);
- biodiversity as being holistic and inseparable from the human family and society, and therefore can never be reduced merely to components or molecules;
- the need for consent and benefit-sharing agreements including full disclosure, prior informed consent and equity;
- indigenous and traditional peoples' alliances and the need to support their own efforts and activities, and especially their self-determination;
- specialised knowledge of women, elders, children and knowledge specialists, often expressed through the collective knowledge of gender and age groups, lineages, clans and local associations;
- the central importance of land, territorial and tenural rights, given that many state policies alienate community lands and resources;
- the identification of who precisely are 'indigenous peoples' should principally be left with the peoples and communities themselves to decide, as guaranteed by the UN Working Group on Indigenous Peoples, ILO, and the Draft Declaration on the Rights of Indigenous Peoples;
- nation state sovereignty cannot override basic indigenous and human rights.

2 – There is an "inextricable link" between linguistic, cultural and biological diversity. Indigenous and local peoples see language, culture, nature and land as intimately related parts of the same whole. Language is the main carrier of culture and main instrument for creating, transmitting and developing knowledge, including knowledge about the environment, the forests and biodiversity;

- The loss of linguistic diversity is estimated to be even greater and faster than the loss of biodiversity (possibly up to 90% of the 5–7000 existing languages becoming extinct before the end of the next century). This loss of languages leads to loss of knowledge, including ecological knowledge, with grave consequences for humans and the earth.
- Therefore, indigenous and local peoples are engaging in a struggle to maintain or revitalise their languages and cultures at the same time that they struggle to preserve or recover their lands and resources.

3 – In view of these international activities and processes, the 'ecodiversity-geodiversity-biodiversity' model (expressed in the opening session of this conference) must include cultural and language diversity of different peoples, and their knowledge systems. Unfortunately, the prevailing scientific/economic paradigm has been used to separate indigenous peoples from their land bases and natural and intellectual resources by ignoring their cultural and spiritual values. This dominant, top-down approach has fuelled biopiracy and other forms of exploitation and destruction of bio-cultural diversity.

4 – Traditional Ecological Knowledge (TEK) encodes the relationship of human beings with their natural and spiritual environment. It is holistic and encapsulates intellectual, cultural, spiritual, behavioural and material elements transferred over generations, including:

- perceptions, beliefs, cosmologies, attitudes, opinions, practices, experiences, skills, technologies, traditions, innovations,
- artefacts, tools, and other material objects,
- trees, seeds, plants, crops, animals,
- local institutions, such as women groups, tenure systems, healers associations,
- procedures, processes and local authority structures,

TEK should not be seen in opposition to 'Scientific Ecological Knowledge'. Rather, common ground, complementarity, collaboration and synergism should be sought to better tackle the conservation of forests and biodiversity. Both are part of the same human endeavour to create order out of disorder;

The TEK approach specifically focuses on the philosophies and cosmovisions on which indigenous peoples base their management and conservation perceptions and practices, but it also develops specific research methodologies to extrapolate 'subjective' factors at the individual level to 'objective' variables at the system level;

TEK is relevant for bio-cultural diversity conservation & management of forest resources, as it:

- provides new opportunities for collaborative R&D
- provides alternatives for sustainable use
- provides indigenous environmental assessment
- provides alternative conservation methods & practices
- contributes to the development of alternative philosophies of nature and the environment
- contributes to the policy planning & implementation process at various levels.

Recommendations:

1. Protecting forests and biodiversity requires protecting the cultural and linguistic diversity of the indigenous peoples, traditional societies, and local communities living in forests and other biodiversity-rich environments – including their cultural and spiritual values.
2. The land, territorial and human rights – including linguistic and cultural rights – of these groups must be recognised within the principle of self-determination to guarantee negotiation and representation as equal parties at all levels and in all processes that affect them.
3. Scientists must recognise that the existing biodiversity-geodiversity-ecodiversity paradigm has been misused to alienate and disenfranchise peoples from their spiritual and natural resources, and that future scientific endeavours must be built upon:

- recognition of basic rights including full disclosure to, prior informed consent from and authorisation by the local communities and appropriate representatives;
- recognition and use of Traditional Ecological Knowledge;
- collaborative research and development of the role of the researcher as a true partner in biodiversity conservation;
- equitable benefit-sharing with local groups.

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Workshop: Tools and Measures for Conservation, Rehabilitation and Development of Biodiversity

Chairman: Prof. Dato' Zakri A. Hamid, University Kebangsaan, Malaysia

Principal Conclusions and Recommendations

I Cross-Cutting Concerns

Protected Areas remain a keystone for conserving forest biodiversity, but will never be large enough to comprehensively conserve the full range of forest biodiversity.

A broader "bioregional" approach to biodiversity conservation is therefore necessary, which incorporates BD conservation objectives into timber production, plantation development, agriculture, and other resource uses – and promotes job creation to draw people away from the forest frontier.

A bioregional approach under both qualitative and quantitative aspects in turn requires a broader conception of "biodiversity conservation" including not only protection, but also ensuring that uses of biological resources are sustainable, and more equitable sharing of the benefits of the uses of biodiversity.

This requires new processes for involving a broader range of "stakeholders" in decision-making and management.

We must deepen our knowledge of biodiversity and ecological processes – as well as related socio-economic issues – and disseminate that information in ways that are useful to biodiversity managers and policy makers.

Public awareness, through schools and training centers and the media, is very important for building public support for biodiversity conservation.

Community participation in biodiversity conservation is a crucial tool for success across many types of forests and forest uses. Some key tools for encouraging community participation are:

– the role of NGOs as catalysts and communicators

– specific attention to the roles and involvement of women

– realistic attention to the priority social welfare needs of the community

– effective local stakeholder dialogue mechanisms

– development and use of conflict resolution skills and mechanisms

– attention to the social geography of the "community" – not all groups of people living together are cohesive communities!

"In stimulating sustainable forestry for rural development it is important that local people should not be conceived as an unnatural factor to forests, but rather as a highly specialized ecological agent acting within the forest."

II Can Biodiversity be Conserved in Large Scale Timber Production Forests?

There are great ecological differences between tropical and temperate forests, and between the socio-economic and governmental structures in which they are managed (or mismanaged).

Experience from Sweden shows that biodiversity conservation objectives can be successfully integrated into large-scale timber production in a temperate, developed country with a large forest products industry. Timber certification has been an important tool for doing this in Sweden. Certification can also be a feasible way to promote BD-friendly ways of producing NTFP goods and services.

Under present institutional conditions in most major tropical timber producing countries large-scale logging is a major catalyst for processes of forest degradation and biodiversity loss.

Nevertheless, since large-scale timber production from natural forests is likely to continue in both temperate and tropical areas, development of both technical and institutional innovations to improve the prospects for biodiversity in production forests must be a priority. One way in which such biodiversity and the ecological processes that maintain biodiversity may be protected is through a network of protected areas including habitats within production forests.

III Protected Areas

Historical concepts of protected areas as pristine ecosystems walled off from human influence have failed in many parts of the world – pressures from local needs and larger-scale development activities (and global markets) are too strong, while defensive measures are too weak.

Recent efforts in developing countries to establish "integrated conservation and development projects" (ICDPs) sound good in theory, but have largely failed to conserve the core protected areas they are intended to serve.

Needed is a new "bioregional" approach with three key elements:

– Planning and management of biodiversity and related human activities across whole landscapes-including urban, industrial, and demographic factors – with a related broadening of the sectors and stakeholders involved in the process.

– A return to stricter protection – backed by adequate resources – for areas where biodiversity conservation is a top priority and is not compatible with human uses (e.g. tigers versus farmers).

– Transition from state- and corporate-dominated forest ownership and control to far wider applications of community-based and community-managed forestry in non-core areas

– Equitable sharing of burdens and benefits, with specific attention to the rights of indigenous communities with long-standing claims on forest areas.

– Some of the most important protected areas in the world should perhaps be designated as world heritage sites under the world heritage convention.

IV Non-Timber (Non-Wood) Forest Products and Services

NTFPs add value to the forest resource, particularly for local communities, promote strategies and measures to increase its production and provide an incentive to conserve the forest.

NTFPs are not, in many places, "minor" forest products – rattan, forest-related fisheries, aquaculture and hunting, and many leaves and nuts in India are examples. But it is difficult to quantify their value, as many NTFPs do not enter formal markets.

As market access grows, however, the risk of over-exploitation becomes acute, even for NTFP uses that were formerly "traditional" and "sustainable."

Forest-related fisheries and aquaculture (e.g. flooded forests and pond-systems of the Amazon, mangroves of SE Asia) are an extremely important NTFP with key nutritional as well as income benefits for local communities.

Given the high economic and conservation value of NTFPs, policies need to be changed to provide greater incentives for their sustainable utilization.

Biodiversity prospecting for the development of new pharmaceuticals, pesticides, transgenic plants gain increasing importance and will contribute significantly to the valorization of forests. Royalty agreements, technology transfer and adding value to primary materials for product development within the source country are important conditions and implicated by the CBD.

Whole forest product and services can contribute significantly to human welfare and might include carbon, oxygen, water, litter, honey, habitats of fauna, landscape, recreation, education, ecotourism and units of unique scientific value.

As NTFPs increasingly enter mainstream markets, local economic institutions must be developed (e.g. co-operatives) to ensure that local people receive fair prices and improved market access for their NTFPs.

V Restoration and Rehabilitation

Timber plantations are going to be a key component of fibre production system in the 21st Century.

Current timber plantation models, however, are not supportive of biodiversity - often they are replacing diverse natural forests, and are in many cases composed of monocultural stands.

Innovative technologies and management strategies that better incorporate biodiversity into plantation planning, siting, species composition, and management are urgently needed.

Apart from reinforcing traditional agroforestry systems the socio-economic dimensions of plantation establishment (e.g. displacement of local farming communities who then turn to the natural forest for subsistence) must be carefully considered as well.

Restoration of natural forest ecosystems is technically feasible in many cases, and should be utilized for restoring degraded parts of forests landscapes.

Tree plantings do have a catalytic effect on the regeneration of native shade-tolerant forest species and therefore restoration of native forest biodiversity, across a broad range of site conditions under many different plantation species. Planting of fast growing, useful tree species, preferably native species, could therefore be used efficiently to restore the biodiversity and productivity of degraded land.

Recent developments of "carbon forestry" as presently often used in the context of the Climate Change Convention have increasingly become a source of funding for biodiversity conservation. However, it is crucial that the imperative of tree-planting to sequester carbon do not become an excuse for the replacement of natural forests with plantations.

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Congress Programme

Friday, 3 July 1998

Ellenberg, H.	Round Table: How to Count and Compare Biological Diversity in Forests? Definitions and Decisions needed

Saturday, 4 July 1998

Schreiner, J.	Opening address
Vauk, G.	Opening address
Wermann, E.	Opening address
Key-notes	
Sayer, J.	Introduction
Zakri A. H.	Challenges of Implementing the Convention on Biological Diversity
Barthlott, W.	The Uneven Distribution of a Treasure
Ganguly, A.	Drugs from Natural Sources
Iwand, W. M.	Supporting Biodiversity: Taking the Benefits of Tourism into Account
Ellenberg, H.	Results of the Round Table: How to Count and Compare Biological Diversity in Forests? Definition and Decisions Needed
Palmberg-Lerche, C.	Conservation of Biological Diversity with Special Reference to the Conservation of Forest Genetic Resources
Turok, J.	Regional Cooperation on Forest Genetic Resources: Conserving a Common Heritage
Martin-Jones, J.	Global 200 Forest Ecoregions
Boyle, T.	The Impacts of Human Activities on Biodiversity in Natural Tropical Forests

Sunday and Monday, 5 and 6 July 1998

Workshop	**Biodiversity as Value within Society**
Samper, C.	Introduction: Cultural and Spiritual Values of Biodiversity
Ramos, A.	Why Does Biodiversity Loss Occur in Many Places if it is Socially Better to Give it a Persistent Use?
Nader, W.	Biodiversity – Source of Inspiration and Innovation
Samper, C.	Introduction: Underlying Socio-Economic Forces Behind Biodiversity Loss
Forje, J. W.	Conserving Biological Diversity in Cameroon's Forests: Problems and Prospects for the Future
Walker, R.	Conserving the Tropical Resource Base: Do we Title Land or Organize Community?
Anane, M.	Role of the Media in Biodiversity Conservation Challenges and Opportunities
Workshop	**Biodiversity as a Resource**
Schütz, J.-P.	Introduction
Geldenhuys, C. J.	Requirements for Improved and Sustainable Use of Forest Biodiversity: Examples of South Africa
Scherzinger, W.	Importance of Vertical Stratification and Horizontal Patchiness Concerning Species-Diversity in Managed Forests – A Comparison
Kushalappa, C.	Impact Assessment of Working of Western Ghats Forests in Kodagu District, Karnataka State, South India
Kleinschmit, J.	Forest Management and the Conservation of Rare Species
Hanewinkel, M.	Successful Examples of Multiple Forest Use – The Model of Selection Forests
Bittner, J.	Reserva Natural La Planada – 15 Years Experience in Protection, Conservation and Research for a Sustainable Development
Geldenhuys, C. J.	Potential of and Development for Ecotourism in the Tsingy de Bemaraha near Bekopaka, Madagascar
Sunaryo	Ecotourism is a Viable Way of Using Resources
Workshop	**Interrelationship of Cultural and Biological Diversity**
Posey, D. A.	Introduction: Cultural and Spiritual Values of Biodiversity
Maffi, L.	Language: A Resource for Nature
Slikkerveer, J.	Traditional Ecological Knowledge Systems: Peoples, Forests and Plants
Carino, J.	Indigenous Peoples' Views and Concerns: An International Perspective
Hilario, M.	Forests of the Peruvian Amazon
Ruttanakrajangsri, K.	Indigenous Views from Thailand
Bone, R.	Community Use of Eucalyptus Plantation and Regenerating Miombo Woodland Resources at Aliseni Village, Ulumba Mountain, Southern Malawi
Gobulev, A.	Spring Ecosystems as the Unique Components of Natural and Cultural Environment

Workshop	**Tools and Measures for Conservation, Rehabilitation and Development of Biodiversity**
Zakri A.H.	Introduction
Barber, C. V.	The Diverse Tools and Measures Needed to Conserve, Rehabilitate, and Sustainably Use Forest Biodiversity
Jansons, J.	Forest Management and Biological Diversity in Latvia
Holesgrove, R.	Conservation of Biodiversity in Australia's Forests
Jack, J. B.	Analogue Forestry as a Process of Biodiversity Management
Gustafsson, L.	Integration of Biodiversity into Timber Production – the Swedish Approach
Barber, C. V.	Conserving Forest Biodiversity in Protected Areas: Can Conservation and Development Co-Exist?
John Joseph, S.	Community Participation
Nader, W.	Use it or Loose it: INBIO's Integrative Concept for Biodiversity Conservation
Werder, U.	Sustainable Aquaculture-Systems in the Rainforest – Fish Culture in the Surroundings of Manaus
Manokaran, N.	Rattan Utilization
John Joseph, S.	Non Timber Forest Products of India
Manokaran, N.	Management of Mangroves at Matang Peninsular Malaysia – A Case Study on Conservation, Rehabilitation and Development of Biodiversity
Halbritter, K.	Quantification of Forest Biodiversity by Remote Sensing
Enescu, V.	Challenges to the Forest Genetic Resources in Romania
Marku, V.	Biodiversity and some Aspects of its Management in Albania

Sunday and Tuesday, 5 and 7 July 1998

Poster Presentations and Additional Contributions
Chairmen: Wolfgang Kuhlmann, Prof. Dr. Hans-J. Muhs

Brüggemann, J.	The EUROPARC Partnership & Exchange Programme
Gustafsson, L.	Hot Spots for Biodiversity in Swedish Forests
Nino, E.	Reserva Natural La Planada – 15 Years Experiences in Protection, Conservation and Research for a Sustainable Development
Schilder, K.	Sustainable Use of the Gallip Nut *Canarium indicum* and Rainforest Conservation on Siassi, Papua New Guinea
Spanos, K.	A Special Biotope in a *Pinus halepensis* Forest in Chalkidiki – N. Greece
Velarde, M.	Woodlands Pattern and Territorial Diversity in Madrid

Opening Address

Ernst Wermann

Abstract

From the German point of view conservation and sustainable management have been and will be essential for maintaining the biological diversity of forests. Together with improved monitoring, research and protection of forests against pressures from outside (e.g. air pollution), they will be main elements of an integrated concepts on regional level, for which European ministers responsible for forests paved the way in Lisbon in June 1998 by adopting a work programme for enhancement of biological diversity in forests.

On the international level the various bi- and multilateral efforts to slow down forest loss and forest degradation could be facilitated by a legally binding instrument on the conservation and sustainable management of forests worldwide. Since more information is needed on details, options, pros and cons of the various options etc. etc., Germany will continue to be an active partner in the ongoing IFF-process.

Grußwort

Auf der Umweltkonferenz der Vereinten Nationen 1992 in Rio de Janeiro wurde der Durchbruch erzielt: Nach mehrjährigen Verhandlungen beschloss man dort einstimmig das Übereinkommen über biologische Vielfalt, das inzwischen von 170 Staaten weltweit gezeichnet ist. Sein Ziel ist die Erhaltung von Ökosystemen, der Artenvielfalt und der genetischen Vielfalt.

Auf dieser Konferenz wurde auch deutlich, dass die Umweltprobleme nicht allein durch Schutz in den Griff zu bekommen sind, sondern auch durch Nutzung und zwar durch nachhaltige Nutzung. Das gilt auch für die Sicherung der Biodiversität in Wäldern.

Nachhaltigkeit ist ein Begriff, der von der Forstwirtschaft geprägt wurde – in Mitteleuropa bereits 250 Jahre vor der Brundtlandkommission. In Frankreich verweist man sogar auf ein königliches Dekret von 1348, in dem im Zusammenhang mit forstlicher Nutzung der Begriff „soutenu" verwendet wird; „soutenu" hat die gleiche (lateinische) Wurzel wie – englisch – „sustainable", heißt also nachhaltig.

Nachhaltigkeit in der Forstwirtschaft hat sich als Begriff und Handlungsmaxime ständig weiterentwickelt, ist bedeutend erweitert worden, umfasst heute ökonomische, ökologische und soziale Ziele, auch die Erhaltung der biologischen Vielfalt, und hat das Wohl künftiger Generationen im Auge. Diese Art von Selbstverpflichtung der Forstwirtschaft scheint mir angemessen und wesentlich auch für die zukünftige Sicherung der Biodiversität in den Wäldern zu sein.

Die europäischen Forstminister haben dies bereits 1993 bei ihrer Konferenz in Helsinki ausdrücklich in dieser Weise bekräftigt und damit sozusagen die europäische Antwort auf Rio im Waldbereich gegeben.

Der Wiederaufbau der Wälder in Europa beweist: Nachhaltige Forstwirtschaft mehrt die natürlichen Ressourcen, die sie nutzt und indem sie sie nutzt. Wie viele andere Wirtschaftszweige können dies von sich behaupten?

Jahrhunderte nachhaltiger Forstwirtschaft haben in den Wäldern einen beachtlichen Schatz an Biodiversität erhalten (um das Leitmotiv Ihres Forums aufzugreifen). Aus Vergleichsstudien, z. B. von Prof. Ammer, München, wissen wir, dass Artenvielfalt in naturnah bewirtschafteten Mischwäldern nicht geringer zu sein braucht als in total geschützten Reservaten.

Unter naturnaher Waldwirtschaft stellen wir uns in Mitteleuropa vor:

- kleinflächige Nutzung,
- standortgerechte Baumartenwahl,
- Bevorzugung der Naturverjüngung,
- Integrierung von Alters- und Zerfallsphasen,
- Schutz wertvoller Biotope,
- waldschonende Erschließung,
- boden- und bestandsschonende Technik,
- integrierter Pflanzenschutz,
- und als Ergebnis strukturreiche, ungleichaltrige Mischwälder mit ausreichend totem Holz, mit der Fülle auch seltener Baum- und Straucharten und mit besonders sorgfältig gestalteten Waldrändern.

Kurz: Der Vielfalt der Standorte soll die Vielfalt der Waldökosysteme entsprechen.

Man nutzt klug natürliche Abläufe. Und man greift zurück auf die Vielfalt der Waldbehandlungsmöglichkeiten, die über Jahrhunderte entwickelt und erprobt wurden. Stützen kann sich naturnahe Waldwirtschaft auf entsprechende Planungen (Waldfunktionskartierung, Standortkartierung etc). und unterstützt wird sie durch die Forstpolitik mit Instrumenten wie finanzieller Förderung, Aus- und Weiterbildung und flächendeckender Beratung. Naturschutzrechtliche Anreize wie Vertragsnaturschutz kommen hinzu.

Meine Ausführungen zur „Erhaltung von Biodiversität durch nachhaltige Nutzung" zeigen, dass wir fortschrittlich genug sind, uns nicht allein auf ein Netz von Schutzgebieten zu verlassen. Schon in Rio wurde darauf Wert gelegt; ich führte dieses aus. Hinzu kommt ein europaspezifischer Aspekt, der zugleich zeigt, dass man Modelle, die anderswo unter anderen Bedingungen entwickelt wurden, nicht ungeprüft übertragen sollte.

Die Ausscheidung großflächiger Schutzgebiete leuchtet ein in Regionen mit großflächigen Naturwäldern in staatlichem Eigentum, wie im Norden von Nordamerika. In Europa überwiegt der private Waldbesitz und hier der relativ kleine Familienbetrieb. Daraus entwickelt sich eine Vielgestaltigkeit der Waldstrukturen und eine biologische Vielfalt, die über die natürliche Vielfalt noch hinausgeht. Ist sie durch verantwortungsvolle Nutzung entstanden, kann sie auch nur durch Fortsetzung der Bewirtschaftung erhalten werden.

Unter solchen Bedingungen würden allzu ehrgeizige Stillegungs- und Totalschutzprogramme biologische Vielfalt eher gefährden.

Den richtigen Weg in der Schutzgebietsfrage wies m. E. die jüngste Vertragsstaatenkonferenz zum Übereinkommen in Bratislava. Dort beschloss man, vordringlich eine saubere Analyse des Bedarfs vorzunehmen (gap analysis). Im übrigen war man in Deutschland keineswegs untätig. Hier sind immerhin 4% der Waldfläche (400000 ha) unter strengen Schutz nach Forstrecht und Naturschutzrecht gestellt. Dazu gehören die Wälder in Nationalparken, Naturschutzgebieten, Waldschutzgebieten und Naturwaldreservaten.

Zusätzliche 2% betreffen Wälder in Biosphärenreservaten, die auf Teilflächen ebenfalls strengen Schutz vorsehen.

Auch auf die seit langem eingeleiteten speziellen Maßnahmen zur Erhaltung der forstgenetischen Ressourcen ist zu verweisen (*in situ*, d. h. im Wald, oder *ex situ*, d. h. in Samenplantagen oder in Genbanken). Ein Programm zum genetischen Langzeitmonitoring gem. Art. 7b des Übereinkommens über biologische Vielfalt ist geplant. Auf europäischer Ebene wird im Rahmen des seit 1995 bestehenden Europäischen Programms für forstgenetische Ressourcen (EUFORGEN) zusammengearbeitet.

Zur Sicherung der Biodiversität in Wäldern beschlossen die europäischen Forstminister soeben in Lissabon ein umfangreiches Arbeitsprogramm, das den Weg ebnen soll zu einem integrierten Gesamtkonzept. Es soll nachhaltige Nutzung und Gebietsschutz, aber auch Monitoring, Aufklärung und Weiterbildung, Forschung und – besonders wichtig – den immer noch notwendigen Schutz der Wälder gegen Belastungen von außen (z. B. gegen Luftschadstoff- und Nährstoffemissionen) behandeln. Um Doppelarbeit zu vermeiden, wurde das Arbeitsprogramm mit der europäischen Umweltministerkonferenz abgestimmt.

In Deutschland arbeiten Bund und Länder gemeinsam bereits an einem solchen integrierten Konzept. Auch die Verbände werden beteiligt werden. Speziell für die Forschung bleibt noch ein weites Feld. Ich denke, dazu wird dieses Forum einiges ausführen.

Ich benutze die heutige Gelegenheit, auch noch mehr Dialog zwischen Wissenschaft und Politik über prioritären Informationsbedarf anzuregen. Wir finanzieren in Deutschland z. B. ein Verbundprojekt „Auswirkung forstlicher Maßnahmen und anderer Einflussfaktoren auf die Biodiversität in Wäldern". Dafür wurde ein Simulationsmodell entwickelt, genannt Ökogen, das auch in anderen Ländern Beachtung findet. Wir würden es z. B. begrüßen, wenn Vergleichsstudien wie die eingangs erwähnte auch in anderen Waldgebieten durchgeführt würden.

Wir würden es noch mehr begrüßen, wenn solche Studien im Zusammenwirken über Ländergrenzen hinweg betrieben werden könnten. Vielleicht kann das Forum auch dazu Anstöße geben. IUFRO, CIFOR und das European Forest Institute bieten dazu alle Möglichkeiten der Netzwerkforschung.

In Europa und Nordamerika wachsen Waldfläche, Holzvorräte und Holzzuwachs. In anderen Regionen der Erde ist Forstpolitik darauf angelegt, aus einer stetig schrumpfenden Waldfläche immer mehr Bedürfnisse einer immer größeren Bevölkerung zu befriedigen und gleichzeitig die schlimmsten Angriffe auf die Wälder, die von außen kommen, abzuwehren. Deutschland versucht dabei zu helfen: 250 Mio. DM werden jedes Jahr allein für forstliche Projekte in der Welt bereitgestellt. Ländern, die die gewünschte wirtschaftliche, technische und industrielle Entwicklung erleben, soll geholfen werden, in ihre Entwicklungsstrategien frühzeitig den Schutz von Natur und Umwelt zu integrieren. Dies führt zu wechselseitigem Geben und Nehmen. Auch wir wollen daraus lernen.

Diese Politik der Bundesregierung zur Erhaltung der Tropenwälder dient auch nicht zum geringsten Teil der Erhaltung der biologischen Vielfalt. Die Tropenwälder zählen zu den vielfältigsten und artenreichsten Ökosystemen, die es auf der Erde gibt, und es war die Sorge um die Erhaltung dieser Wälder, die mit zum Abschluss des Übereinkommens geführt hat. Bei der Unterstützung von Tropenländern zur Erhaltung und nachhaltigen Bewirtschaftung ihrer Wälder verfolgt die Bundesregierung einen integrativen Ansatz. Es kann auch hier nicht einfach nur darum gehen, große Flächen unter Schutz zu stellen. Die ansässige Bevölkerung sollte nicht ausgeschlossen werden von der Nutzung des Waldes, der gerade in den Tropen meist nicht nur Holz, sondern eine Fülle weiterer Güter bietet. Die Integration von Walderhaltung und Waldschutz, nachhaltiger Nutzung und ergänzenden Maßnahmen zur Verbesserung der Lebensbedingungen der örtlichen Bevölkerung hat noch einen weiteren Vorteil. Wald erlangt über seinen Wert als Lebensraum hinaus einen wirtschaftlichen Wert als Einkommensquelle. Damit wächst die Bereitschaft der Menschen, sich für seinen Schutz einzusetzen.

Forstliche Projekte müssen ihrerseits integriert werden in geeignete Landnutzungskonzepte, die die Armut bekämpfen und Ernährung und Beschäftigung sichern. Die tieferen Ursachen der Waldvernichtung liegen nämlich außerhalb der Forstwirtschaft. Von großer Bedeutung ist auch die Lösung sozialer Probleme. Eine Politik zur Tropenwalderhaltung muss sich daher mit Bemühungen um faire Entwicklungschancen für die Menschen verbinden. Darüber hinaus strebt die Bundesregierung den Abschluss eines völkerrechtlich verbindlichen Übereinkommens über die Walderhaltung (Waldkonvention) an. Wir wissen, dass noch viele Details zu klären sind. Länder, die noch zögern, möchten einfach besser informiert sein über Inhalte, Optionen, Vorteile der verschiedenen Optionen etc.

Deshalb wird sich Deutschland weiterhin aktiv an den Arbeiten des zwischenstaatlichen Waldforums (Intergovernmental Forum on Forests, IFF) beteiligen, das bis zum Jahr 2000 den Beschluss über ein eventuelles Verhandlungsmandat für eine Waldkonvention vorbereiten soll. Das IFF wird Ende August zu seiner 2. Sitzung zusammentreten.

Deutschland war auch Gastgeber eines internationalen Experten-Workshops über nationale Forstprogramme, der gestern endete. Nationale Forstprogramme wurden, wie Sie sich erinnern werden, von der Vorläuferorganisation des IFF, dem Zwischenstaatlichen Waldausschuss (Intergovernmental Panel on Forests, IPF) besonders empfohlen als geeignetes Instrument zur Verwirklichung einer nachhaltigen Waldbewirtschaftung. Auch diese internationalen Aktivitäten gehören zum forstpolitischen Konzept von Bundesminister Borchert. Ich habe Ihnen daraus einige Gedanken vorgetragen, auch um das Interesse deutlich zu machen, das der Schirmherr dieser Veranstaltung beimisst. Aus den Ergebnissen des Forums wollen wir lernen. Es ist also durchaus Eigennutz im Spiel, wenn ich Ihnen den bestmöglichen Erfolg wünsche.

Die Aufzählung von Aktivitäten zur Walderhaltung und zur Integration der Erhaltung der biologischen Vielfalt in die nachhaltige Bewirtschaftung der Wälder war nicht erschöpfend. Zu einem vollständigen Bild gehören auch die zahlreichen Initiativen von nichtstaatlichen Organisationen sowie der Wissenschaft. Hier reiht sich Ihre Veranstaltung vorbildlich ein.

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Challenges of Implementing the Convention on Biological Diversity

Zakri A. Hamid

Abstract

Biodiversity supports society in many important and real ways. Food security, climatic stability, freshwater security and the health needs of humans around the world all depend directly upon maintaining and using the world's biodiversity. More than 40% of the world's economy and some 80% of the needs of the world's poor are derived from biodiversity. Loss of biological diversity threatens these services and hence society generally.

The Convention on Biological Diversity (CBD) is an international treaty with near universal membership (as of May 1998, 172 countries have ratified the Convention). It is conceived as an ambitious project to arrest the pace of biodiversity destruction. The principal objectives of the CBD are the conservation, sustainable use and equitable sharing of the benefits of the use of genetic resources. The CBD recognizes that the key to maintaining biological diversity depends upon using this diversity in a sustainable manner. A central purpose of the CBD is to promote the concept of sustainable development as envisaged in the instruments arising from the UNCED process with which the CBD was negotiated contemporaneously. The CBD is therefore not simply a conservation treaty: It assumes human use and benefit as the fundamental purpose for achieving its objectives.

The Convention translates its objectives in its normative provisions contained in Article 6 to 20. These articles contain key provisions on: measures for the conservation of biodiversity, both *in situ* and *ex situ*; incentives for the conservation and sustainable use of biodiversity; research; education; assessing the environmental impacts of projects; regulating access to genetic resources and the technology to use these resources; and, financial resources. The Convention also establishes the standard institutional elements of a modern treaty, namely a COP, a Secretariat, advisory bodies, a clearing-house mechanism and a financial mechanism.

Among the substantive elements of the Convention that have been deliberated by the Parties are programs of work on coastal and marine biodiversity, forest biodiversity and agricultural biodiversity; negotiations on a Biosafety Protocol; and an international initiative to further consider the rights of indigenous and local communities under the CBD.

The challenge for the process as it moves into its implementation phase is to develop an approach which will find a balance between pursuing a truly holistic and integrative approach demanded by the Convention whilst at the same time being focused enough to allow development of its provisions.

Transcript of the presentation by Prof. Dato' Zakri A. Hamid based on tapes

Responsible editors: Inge Stein, Jutta Poker

In a world of increasing globalization and environmental degradation, biological diversity is one of the outstanding issues which humankind has to address in order to survive. It is a common concern to all of us and therefore not surprising that biological diversity is along with climate change addressed by the international community not only in political but also in legal terms. The Convention on Biological Diversity (CBD) is an international treaty with near universal membership. It entered into force five years ago and now has established most of the elements required to be operational. Attention within the process is now moving towards implementation. By a way of context and in order to understand the issues at stake in this move towards implementation, I will briefly describe the importance of biodiversity and the history of the Convention and we will then try to elaborate under provision of the Convention its institutional structure and the processes on substantive elements which the parties have initiated to develop the substantive provision of the Convention.

Biological Diversity

The term is used to describe the number and variety of living organisms. It is defined in terms of genes, species and ecosystems which are the outcome of 3.000 million years of evolution. Although the concept is not fully understood in terms of numbers of species and genes or even what an ecosystem exactly is, it is widely accepted that globally biodiversity is being lost at all levels. For example, current rates of extinction of species are unprecedented which in turn directly diminishes genetic variability. Ecosystems around the world are under increasing pressure from human activities.

Biological diversity supports society in many important and real ways. Food security, climatic stability, fresh water security and the health needs of humans around the world all depend directly upon maintaining and using the world's biological diversity. More than 40% of the world's economy and some 80% of the needs of the world's poor are derived from biological diversity. Loss of biological diversity threatens these services and consequently society generally. Accordingly, the UN Conference on Human Environment in Stockholm in 1972 identified as a priority the need for the conservation of biological diversity. The number of international legal instruments related to biological diversity adopted during the 1970s reflect such a priority. The Ramsar Convention on Wetlands in 1971, the Convention for the Protection of the World Cultural and Natural Heritage in 1972, the Convention on International Trade in Endangered Species of Wild Fauna and Flora in 1973 and the Bern Convention on the Conservation of Migratory Species or Wild Animals in 1979 are a testimony to these efforts and the importance attached to the issues by the international community. However, these early initiatives emphasize conservation. It is only through the report 'Our Common Future', the 1978 report of the World Commission on Environment and Development, that strides the new challenge facing the conservation and sustainable use.

* Chairman, Subsidiary Body on Science, Technical & Technological Advice (SBSTTA), Convention on Biological Diversity

History of the CBD

The origin or the negotiation of the Convention lies in the 1987 Governing Council of UNEP which called upon UNEP to convene an ad hoc Working Group of Experts on biological diversity for the harmonization of the existing conventions related to biological diversity. At its first meeting the group of experts agreed on the need to elaborate an internationally binding instrument on biological diversity. This was followed in May 1989 by an ad hoc Working Group of Experts on biological diversity. In February 1990 the ad hoc Working Group was turned into the Intergovernmental Negotiating Committee which held seven working sessions, which combined, in adoption of the Nairobi Final Act of the conference, the agreed text of the CBD. The Convention was opened for signature in June 1992 during UNCED and entered into force on 29 December 1993. As of May 1998, that is at the fourth Conference of Parties in Bratislava, 172 countries and the European Union have ratified the Convention and further 18 countries have signed it.

There are some provisions which are important in the context of the treaty. The principle objectives, as we are fully aware, are three prongs, namely the conservation, sustainable use and equitable sharing of the benefits of the use of genetic resources. The Convention recognizes that the key to maintaining biological diversity depends upon using this diversity in a sustainable manner. A central purpose of the BCD is to promote the concept of sustainable development as envisaged in the instruments arising from the UNCED process with which the CBD was negotiated contemporaneously. Therefore, the CBD is not simply a conservation treaty. It assumes human use and benefit as the fundamental purpose for achieving its objectives. The Convention translates its guiding principles of conservation, sustainable use and equitable sharing of genetic resources into binding commitments in its normative provisions contained in article 6–20. These include key provision on:

- measures for the conservation of biological diversity, both *in situ* and *ex situ*
- incentives for conservation and sustainable use
- research
- education
- assessing the environmental impacts of projects
- regulating access to genetic resources and the technology to use these resources
- financial resources.

The Convention also establishes the standard institutional elements of a modern treaty, namely the Conference of the Parties (COP), a Secretariat, advisory bodies, a clearing house mechanism and a financial mechanism. Article 23 establishes a Conference of the Parties which is the supreme party of the Convention. The principle function of the COP is to regularly review the implementation of the Convention. Today, the COP has met four times, in the Bahamas in 1994, Jakarta in 1995, Buenos Aires in 1996 and recently in Bratislava in May 1998.

Some of the components of the Convention will be the Secretariat and also the SBSTTA, the Subsidiary Body on Scientific, Technical and Technological Advice, a mechanism of provision of financial resources, namely at this point the Global Environment Facility (GEF) which is deemed as an interim basis to operate the financial mechanism of the Convention, and also the establishment of the Clearing House Mechanism to promote and facilitate technical and scientific co-operation. In this last context the government of Germany has been very forthcoming in supporting the establishment and also the implementation of the Clearing House Mechanism.

The nature of the issues which the Convention seeks to address means that it is heavily dependent on the effectiveness of the actions of parties in other institutions. The need to develop institutional links with other international bodies, to develop co-operative relationships with such bodies and hands-mechanism for coordinating this relationship is fundamental to the implementation of the CBD. The importance of co-operation and co-ordination between the CBD and other conventions, institutions and processes of relevance has been affirmed at every meeting of the COP. Consequently, it is not accurate to simply think of the institutional structure of the Convention in terms of those institutions established by the process itself.

Some of the substantive elements of the Convention are the following:

- Bio-safety is an important issue. Despite the considerable benefits which biotechnology may bring, the technology does also have the potential to cause harm to the environment and human health. Mindful of these dangers, the COP established an ad hoc Working Group of Experts on bio-safety to develop an internationally legally binding Protocol, specifically focusing on the transboundary movement of any living modified organism that may have an adverse impact on the conservation and sustainable use of biodiversity. These negotiations have been conducted in earnest, and it is anticipated that it should complete its work early next year in 1999.
- Another issue that has been brought up by the Convention will be on the marine and coastal biodiversity. At the second meeting of the COP a program of work was initiated known as the Jakarta Mandate which proposes a framework for global actions to maintain marine and coastal biodiversity.
- An issue which is most pertinent to the scheduling in this turn will be on forests. As we are fully aware, forests provide the most diverse sets of habitats for plants, animals and micro-organisms, holding the vast majority of the world's terrestrial species. Consequently, the maintenance of forest ecosystems is crucial to the conservation of biological diversity and degradation of forests has a dramatic impact on biodiversity. The importance of forests for the purposes of the Convention and the mandate of the CBD in issues of forest biological diversity has been confirmed repeatedly by the COP. As for now, focus work program for forest biological diversity has been on the card, whereby some elements for such a work program include focus on research, co-operation and development of technologies necessary for the conservation and sustainable use of forest biological diversity. The program will also compliment existing national, regional or international criteria and indicators of frameworks for sustainable forest management and it would also incorporate traditional systems of forest biological diversity conservation. This will build upon the co-operation with other relevant fora that the CBD has already undertaken, e. g. the close linkage that we have with the Intergovernmental Forum on Forest.
- Another main issue dealt by the CBD will be agriculture and, as we know, promoting sustainable agriculture and rural development have been acknowledged within the CBD as central to achieving the

aims of the Convention. This is due to the importance of maintaining agricultural biological diversity for ensuring sustainable use of biological diversity and a dramatic impact that unsustainable agricultural practices have had on biodiversity generally. Since the third meeting of the COP, a multi-program of activities to arrest the decline of agricultural biodiversity has been implemented. The objectives of the work program include to promote the positive effects and mitigate the negative impacts of agricultural practices on biological diversity in agroecosystems and there interference with other ecosystems. Further, it seeks to promote the conservation and sustainable use of genetic resources of actual or potential value for food and agriculture and, last but not least, to promote the fair and equitable sharing of benefits arising out of the utilization of genetic resources. The COP of the Convention recognizes the central role that the FAO has to play in this area and has sought to work closely with their programs.

■ Another issue which is of significance to the Convention would be indigenous knowledge embodied in article 8(j) of the CBD. In this, the CBD recognizes the importance of indigenous and local communities to the conservation and sustainable use of biological diversity in several of its provisions which stresses the right for indigenous and local communities to share in the benefits derived from ideas and innovations they have developed that proved useful to others and calls upon parties to respect, protect and encourage customary use of biological resources. As of COP 4, an ad hoc Working Group has been established with direct reporting to the COP.

In terms of implementation it is evident that development so far within the CBD process had been focused on establishing the institutional structure and clarifying the scope of the Convention. It is expected that this process of establishment will be largely completed by or since May 1998 in Bratislava. The focus of the process thereafter is expected to shift to implementing the COP decisions and provisions of this Convention. In this light, the convention process can be characterized as moving from an establishment phase, the dominant feature of COP 1 to COP 4 period, into an implementation phase in the post COP 4 period.

Development of the Responsibilities of the Parties

The effectiveness of any international treaty is dependent upon the extent that it is respected and implemented by its parties. With over 95% of biodiversity located within existing national jurisdiction, this means that the Convention is dealing with the management of an essentially domestic resource. In contrast, international environmental instruments normally address the use or abuse of international or shared resources such as protection of the world's oceans, the ozone layer and the global climate. A consequence of this difference is that the role of parties is emphasized in that not only are they responsible for implementation but they also have an important role through domestic activities, as distinct from international activities to develop policy for the international level. The international policy of the domestic activities of parties is often overlooked due to the perception that as a Framework Convention the provision of the Convention are merely exhorted theory and require for elaboration before they can be implemented. It does also mean that much of the implementation work already undertaken by parties is overlooked in assessment of the effectiveness of the Convention. Although many of the provision of the Convention require considerable development before it can be described as having any normative consequence, many aspects of the Convention are currently being implemented by parties without further elaboration at the international level. This implementation provides important proceedings or key studies for other parties which, to the extend that they are relied upon by these other parties, develops detail of the provisions of the Convention.

Conclusion

In conclusion I might see that the challenge for the process as it moves into its implementation phase is to develop an approach which will find a balance between pursuing a truly holistic and integrative approach demanded by the Convention whilst at the same time being focus enough to allow development of its provisions. This will require close attention to the international institutional structure of the Convention, the responsibilities of the parties and a clear philosophical basis or intellectual *modus operandi* for the process ensuring that each one of these key elements properly reflects the needs of the process and is fully developed, which is crucial if the Convention is to be effective and achieve its aims.

This emerging focus on implementation reflects a wider trend throughout international communities. The general frustration and disappointment associated with many of international processes centers around the lack of implementation, the lack of commitment to turn the rhetoric of international diplomacy into concrete actions which will materially address the issues currently facing society. Many eminent commentators have begun to explore alternative ways and means of achieving the aims of sustainable development to the international conferencacy. Many have suggested that civil society turn to the courts and the legal system to break the empires which seems to emasculate the capacity of the international community to respond to issues in a timely fashion. The Convention as the legally binding instrument has a vital role to play in translating the well-meaning rhetoric of the international community into action, both in the traditional sense and the alternatives being explored. The success of the CBD process in making the transition towards an implementation phase will therefore not only be important for the Convention itself but will provide valuable lessons and experiences for other international processes. Indeed, if the CBD can rapidly move into this implementation phase then it would make a valuable contribution to a renewed credibility and revitalizing of the international order.

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Biodiversity – The Uneven Distribution of a Treasure*

Wilhelm Barthlott, Gerold Kier & Jens Mutke

Abstract

Biodiversity and its dramatic change play an increasingly important role in research and public discussions. Its protection and sustainable use require knowledge about its geographical distribution. One promising approach in this direction is the investigation of indicator groups, since substantial progress in the exploration of approximately 20 Mio species can hardly be expected in the near future. The well-investigated vascular plants, which comprise approximately 300,000 species, are comparatively well suited as an indicator group in terrestrial habitats. Several examples show the good correlation of their diversity with overall diversity. Despite the amount of accumulated data on vascular plants, only relatively few survey studies on continental and global scales have been carried out. Maps of biodiversity can be produced using either an approach based on data for the individual taxa (taxon based approach) or an approach based on summary data for whole geographical units (inventory based approach). The latter was used for mapping the global diversity of vascular plants. In the resulting map the six diversity maxima are all located in the humid tropics and subtropics. Additional centres can be found in Mediterranean-type regions, especially South Africa. Comparatively high species numbers can be found especially in non-arctic mountainous regions, showing that high geodiversity increases biodiversity. Apart from species richness, other criteria of quality play a role, especially when assessing the value of the biodiversity contained within a region. The proportion of allophytes, i.e. of introduced plants, is a criterion of quality which has increasingly been receiving attention. It is a manifestation of growing biological globalisation, which changes natural habitats and results in the displacement of indigenous species. If the foundations for the protection and sustainable use of biodiversity are to be laid, considerable and co-ordinated efforts in basic research will have to be made. The research potential that is needed for the task already exists to a high degree in industrialised countries. This situation gives rise to many chances but also charges us with considerable responsibility.

Keywords: Biodiversity, Biogeography, Mapping, Endemism, Invaders, Biological Globalisation

Introduction

Biodiversity is a special quality of life, the exploration of which has recently moved into the centre of both scientific and political interest. One important reason for the increased attention paid to biodiversity is the increasing recognition of its essential functions for the survival of mankind as well as of its immense direct and indirect economic significance.

The direct and vital significance of biodiversity predominates in the areas of nutrition and medical provision. Moreover, biological diversity forms an important, often the central basis of entire economic branches such as tourism and trade in ornamental plants. In order to clarify questions of legal rights in connection with the use of biodiversity and to combat the threats biological diversity faces, the international community of states agreed on the Convention on Biological Diversity (CBD) in Rio de Janeiro in 1992.

Despite its far reaching economic and political significance, only a small part of global biodiversity has been investigated. Alexander von Humboldt already reflected upon the discrepancy between the number of plant species known to mankind and the total number of species living on our planet. Humboldt (1850) stated that "three questions must be carefully distinguished from one another: 1. How many species of plants have been described in printed works? 2. How many of those discovered – that is to say included in Herbariums – still remain undescribed? 3. How many species probably exist on the surface of the earth?" He estimated a total of 213,000 vascular plant species, while also mentioning the poor knowledge of insects and their relation to plant species. He thereby readjusted his earlier estimation of 80,000 species (Humboldt 1806), which had already been quite remarkable, considering that Willdenow (1797-1807) had only listed 17,457 species of phanerogamic plants in his edition of *Species plantarum*. These reflections are just one example for Humboldt's modern way of thinking and his generalistic view, which led him to statements at the beginning of the 19th century on problems and questions that actually came into focus in the last decades, e.g., in the context of global environmental change.

Today our knowledge of vascular plants is much better: it is estimated that there are ca. 320,000 species of which about 80% are already known. In the early 1980s most taxonomists were convinced that animals, fungi and bacteria were also very well investigated. The extrapolations made by Erwin (1982) then suggested that more than 30 Mio species of insects remain to be discovered. Today estimates for insect species numbers are generally somewhat lower but it is now accepted that the 1,75 Mio species of animals, plants and micro-organisms described today represent less than 20%, maybe even less than 5% of the species living on earth.

It will doubtlessly be one of the major challenges to biodiversity research in the following decades to fill this gap of knowledge, particularly in research on systematics and taxonomy. However, already today, even before the greater part of still unknown species have been described and investigated in their geographical distribution, scientific curiosity and political decision processes in particular require substantial data on biological diversity as a whole. One of the most important ways to achieve substantial results is the investigation of indicator groups. Vascular plants are highly suited for this kind of investigation in terrestrial biomes for different reasons:

- As stated above, about 80% of their species are already known to science, making them an extremely well researched group. This is especially true when compared to the species-richest group of organisms, the arthropods, of which only

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6% are known as yet. Our knowledge about the geographical distribution of vascular plants is comparatively good, documented by an estimated 5,000 relevant inventories like floras, checklists and databases world-wide.

- The vascular plants as the most important producers in terrestrial ecosystems form the basis for total biological diversity. There is a lot of evidence that their diversity – at least with regard to species richness – is in fact relatively strongly correlated to total diversity (see below).
- Since vascular plants form the basis of human existence, in particular with regard to food, they are of especially great economic importance. This fact makes them good indicators for the economic significance of total diversity in terrestrial areas.

However, it is sometimes surprising in which geographical areas and in which taxonomic groups those new species are discovered that belong to the estimated 20% of vascular plants still to be described. It was only 1997, when Moroccan and French botanists discovered a population comprising thousands of trees of a new subspecies of *Dracaena drago* growing in the south of Morocco, only some 80 kilometres south of Agadir (Benabid & Cuzin 1997). Until then, the famous dragon tree, one of the most conspicuous and renowned plant species for centuries, was thought to be endemic to Macaronesia. And it was only 1998, when Marrero et al. described a new arboreal species of *Dracaena* found on the Island of Gran Canaria, one of the most visited summer resorts for European tourists. Those trees were always thought to belong to *Dracaena drago*, the long known dragon tree of the Canary Islands. Nevertheless, the new analyses showed them to be a quite distinctive new species closer related to the east African members of the dragon tree group.

State of research

Despite the good data situation for vascular plants mentioned above, only few works have dealt with the global distribution of species diversity. In particular, there is a lack of detailed maps of the spatial distribution of vascular plant diversity. This is all the more amazing as the distribution of biodiversity is of central significance with regard to the Convention on Biodiversity as well as with regard to the whole ecological context. For the latter, the definition of ecology by Krebs (1972) may serve as one example: "Ecology is the scientific study of the interactions that determine the distribution and abundance of organisms."

The most exact method for mapping biodiversity as well as for further analyses is the exact survey of the distribution ranges of all occurring species and the superimposition of the results into diversity maps under several different aspects. For Europe should be mentioned, apart from the works of e.g. Meusel et al. (1965, 1978, 1992), the various floristic grid mapping projects (e.g. Perring & Walters 1962, Jalas & Suominen 1972-94, Haeupler & Schönfelder 1989, Jalas et al. 1996). In these projects a great number of botanists have compiled extensive data on the distribution of the individual taxa over several decades. These data are immensely valuable for, among others, species and nature conservation purposes. Still, even in well investigated areas these very detailed and finely scaled surveys may create their own problems. Lahti & Lampinen (1997) estimate that by applying constant methods the project "Atlas Florae Europaeae" will need at least 150 years until its conclusion. Furthermore, in projects which already finished their first phase (e.g. Perring & Walters 1962, Haeupler & Schönfelder 1989), the natural diversity distribution patterns in the resulting maps are strongly superimposed by patterns of the different degrees of study of the area concerned (see Fig. 3).

In view of these problems different approaches exist to achieve a first analysis of diversity distribution in a short time by reduction of information. One of these is the analysis of the distribution of whole families or genera. For example, Williams et al. (1994) present a relatively rough map showing the numbers of vascular plant families on global scale (grid cell area of about 611,000 km²). Another strategy is to use summary data available for numerous regions from floras, checklists or vegetation surveys instead of using data for each individual taxon. Applying this approach, Lebrun (1960) compiled a map of the species richness of vascular plants in Africa with still relatively low spatial differentiation. The first world map of vascular plant diversity, also comparatively rough, was elaborated by Malyshev (1975) on the basis of about 400 records. The world map of vascular plants which is shown in Fig. 1 is based on a considerably larger database of about 1,400 records (see below).

A further approach which relies on another aspect besides numbers of taxa, namely the range sizes of the taxa involved, was described by Usher (1986). Maps based on this approach have been published e.g. by Williams et al. (1994). It is also implemented in the computer programme WORLDMAP (Williams 1997).

Apart from vascular plants, the subjects of surveys on continental up to global scale are often groups of particularly conspicuous organisms like butterflies or birds (compare e.g. Bibby et al. 1992). Geographical information systems (GIS) play an ever increasing role in all these analyses as well as in the elaboration of models of the spatial distribution of biodiversity (compare e.g. Skov & Borchsenius 1997; Miller 1994; Wohlgemut 1996). The at present probably most comprehensive overview on the current state of biodiversity mapping is given by Gaston (1998).

Apart from the above-mentioned concepts, emphasis should also be given to investigations which are aimed at identifying "hot spots" (endangered regions with high species diversity) or priority areas for conservation. Important studies were accomplished by, amongst others, Myers (1988, 1990), Bibby et al. (1992), Davis et al. (1994,1995,1997) or Olson & Dinerstein (1998).

However, it has to be concluded that in terms of exactness most survey studies only use a small fraction of the data already available. While taxonomists, florists and faunists as well as ecologists and geobotanists have compiled valuable data on many different groups and areas, the synoptic analysis of these data is still very much at the beginning. Blake & Atwood (1942) and Blake (1961) have already listed in the two editions of "Geographical Guide to the Floras of the World" almost 6,800 floras, checklists and floristic surveys with complete species lists for some regions. Many herbariums, natural history museums and other collections are recording their complete collections in data bases, making them accessible for a comprehensive evaluation under biogeographical and biodiversity-related aspects. The critical evaluation of this vast amount of data which has been published or gathered in collections could even now render fresh knowledge for an efficient protection of global biodiversity.

Methods of biodiversity mapping

The projects and concepts presented in the previous section can be allocated to two basic approaches which start either from the individual taxa or the observed units, i.e. geographical areas as their primary information.

In a taxon based approach data on the individual taxa is superimposed under consideration of different aspects into diversity maps. On the other hand, approaches based on summary data for geographical units (inventory based approaches) allow the direct processing of these summary data for different regions. Both strategies involve, to a different extent, a reduction of information.

In case of the taxon based approach, it is of course usually not possible for each individual specimen to be considered in the analyses. One way of reducing the data amount to be gathered and processed is to just record the occurrence of the taxon in whatever kind of greater spatial unit offers itself (grid cell, state, natural spatial unit, etc.). The other possibility is to assess a limited selection of exactly pinpointed and in their conditions recorded habitats, from which an idealised occurrence over the complete area is assessed or extrapolated by various procedures. A lot of classic distribution maps such as of Meusel et al. (1965, 1978, 1992) would fit into this group. Recently, several projects have been initiated in order to standardise this extrapolation in Geographical Information Systems, such as the ERIN project in Australia (compare Chapman & Busby 1994).

The second, inventory based approach of mapping species diversity, which often allows a faster overview even for less investigated regions (compare also Gaston 1998), is based on summary data for specified regions. Hence, it usually uses a stronger reduction of information compared to the taxon based approach. Here, data such as total species or family numbers in a region, but also taxon numbers of selected groups are recorded. These numbers may be estimated relatively reliably by specialists long before all involved taxa are exactly and systematically assessed. After standardisation of taxon numbers of regions of different sizes to a defined area size, preliminary diversity maps can be created in a rather short time and the centres of diversity can be delineated. Since the data structure is often strongly determined by political units, it is necessary to adjust the boundaries of diversity zones by superimposition with vegetation maps and data sets on physical geofactors (Fig. 2). This procedure is also applied to the diversity map in Fig. 1.

The standardisation of taxon numbers per standard unit area on the basis of taxon-area-models is a necessary step for the comparison of taxon numbers of different regions. However, since species are only very seldom equally distributed within an area, the result is no more than an approach to the natural conditions. In addition, different habitats and landscapes often show quite different taxon-area-relations. These are integrated in the renowned species-area-model of Arrhenius (1920, 1921) by a parameter indicating the floristic heterogeneity of the study areas. This parameter z, for vascular plants mostly on the level of 0.1–0.3

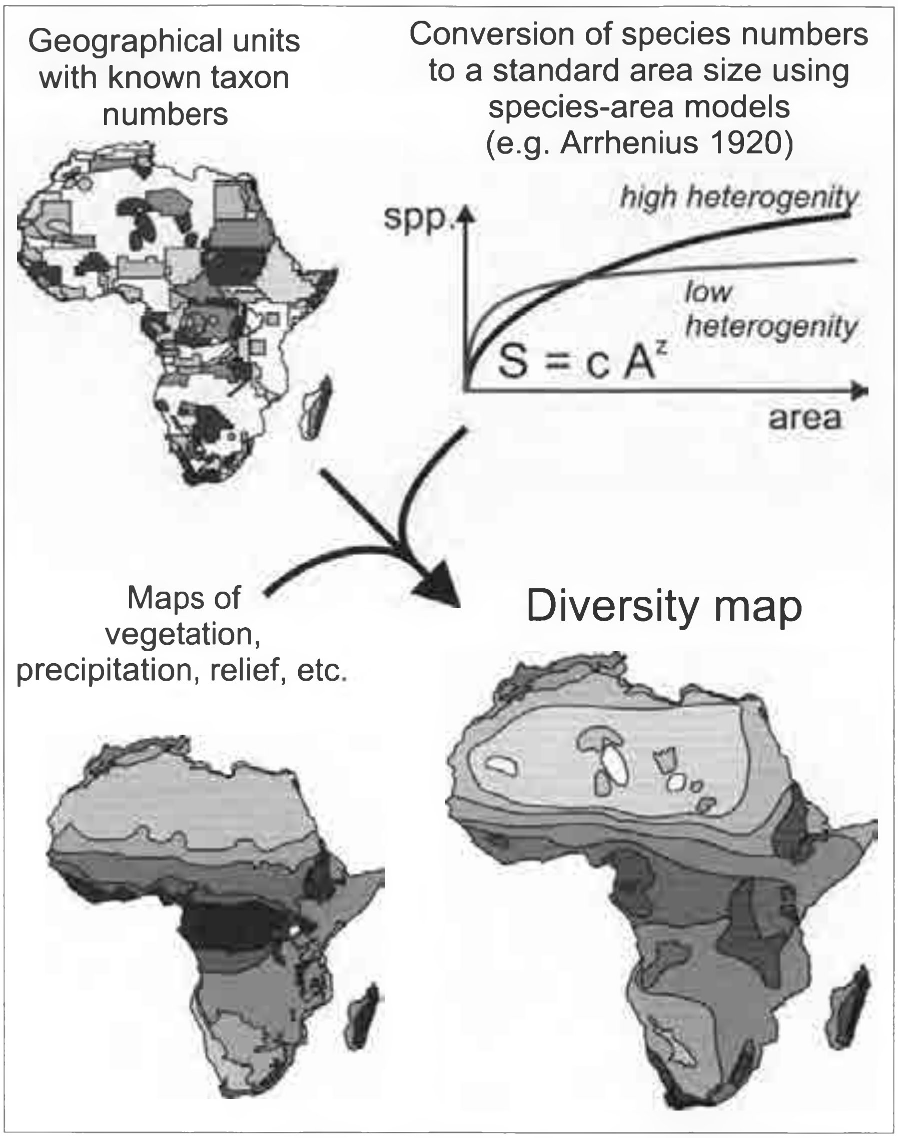


Fig. 2: Methods of producing diversity maps using an approach based on summary data for geographical units (inventory based approach). The taxon numbers for different geographical units are converted into numbers per standard area using taxon-area-models. Due to often politically rather than naturally defined regional units, the exact boundaries of diversity zones have to be adjusted by superimposition with vegetation maps and data sets on physical geofactors. The exemplary phytodiversity map of Africa demonstrates the result of the revision of the corresponding section in Fig. 1 with an improved method (Kier & Barthlott, unpubl. data).

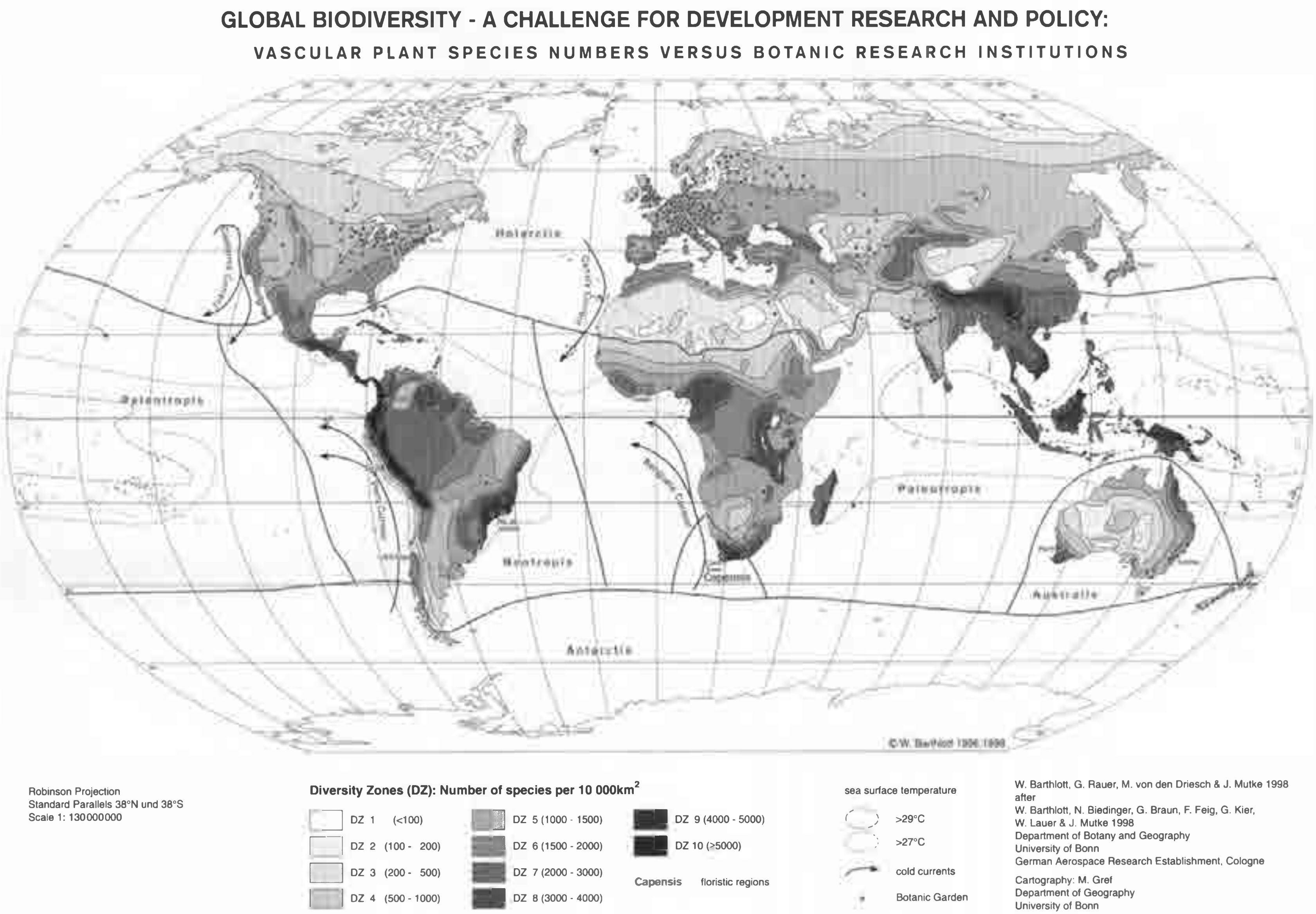


Fig. 1: Map of the distribution of species diversity of vascular plants, superimposed by the location of more than 500 important Botanical Gardens (Barthlott et al. 1999b).

(Malyshev 1991, 1993) can fluctuate between 0.01 in arctic areas (Malyshev 1991) up to 0.5, e.g. in the tropical Andes (Mutke & Barthlott, unpublished data). It can be determined from raw data by regression calculations.

The appropriate taxonomic level for diversity mapping according to this approach will be in most cases the species level because of the data availability. Under certain aspects in well investigated limited areas such as in Central Europe it may be sensible to include infraspecific taxa such as subspecies as well. However, these depend even more than species numbers on the assessment level of the flora in question (compare Fig. 3). The genus and family levels, by contrast, have the disadvantage, apart from less published data, that much less is known about the genus and family-area-relations than about species-area-relations.

Above all, a distinct emphasis must be put on the fact that there will not and cannot be a single correct diversity map, completely irrespective of the approach chosen and the data base available or the investigated organism group. The comparison of lowland rain forests of the western Amazonian region to the eastern slopes of the Andes is one example which shows that biodiversity is scale dependent. In an area of 100 x 100 m in the lowland rain forest of Cuyabeno in Ecuador, almost 500 tree species and probably more than 800 species of vascular plants can be found altogether (Valencia et al. 1994) – numbers which correspond in mountain rain forests to those of complete nature reserves of hundreds of ha. At the same time, 4,430 species of vascular plants (Jorgensen & Ulloa Ulloa 1994) have been recorded in the Ecuadorian Andes above 2400 m above sea-level in an area of about 45,000 km^2 so far – more than Balslev & Renner (1989) estimate for the whole Amazonian lowland area of Ecuador (Oriente) with more than 70,000 km^2, where about 3,000 species have been recorded until now (Renner et al. 1990). Similar examples can also be found in other regions. Thus, a cartographic depiction of alpha-diversity in some areas would show distinctly different patterns from a gamma-diversity map.

Centres of global biodiversity

The map shown in Fig. 1 (Barthlott et al. 1999a,b), based on about 1,400 records taken from literature, demonstrates the species diversity of vascular plants on a standard area of 10,000 km^2. This is a slightly altered version of the map of Barthlott et al. (1996). The species numbers have been extrapolated for the standard area using the equation of Evans et al. (1955) under the simplified assumption of an uniform species-area-relation world-wide. For a complete revision of the map which is already in process, the species-area-model of Arrhenius (1920, 1921) will be used since it offers the possibility of a differentiated extrapolation by including parameters for spatial heterogeneity (compare also Fig. 6).

The species numbers shown in the map correspond basically to the current eudiversity of vascular plants, although this aspect cannot be maintained throughout due to the heterogeneity of the data situation. Here we define eudiversity as the diversity of indigenous species (autophytes) plus the diversity of archaeophytes (see section 'Biological Globalisation').

In addition to some new patterns (compare Barthlott et al. 1996), trends already known are shown in the map: The diversity in general increases from the poles towards the equator (compare Fischer 1960, Gaston 1995). The poorest regions with respect to species richness (DZ1-3) are the Tundras and the boreal conifer forest biomes. All global diversity maxima with more than 5,000 spp. per 10,000 km^2 (DZ10) are located in the region of the humid tropics and subtropics. All in all, six species maxima can be distinguished: 1. Chocó-Costa Rica-Centre, 2. Tropical East Andes Centre, 3. Atlantic Brazil Centre, 4. East-Himalayan-Yunnan-Centre, 5. North Borneo-Centre, 6. New Guinea Centre.

Apart from these six maxima of diversity zone 10, there are also regional maxima of some significance in the area of diversity zone 7-9. In Europe this is the region surrounding the Mediterranean Sea and here particularly the Sierra Nevada, the Pyrenees, the Sea Alps, and the mountains of the Balkan as well as the mountains in South and Central Greece. On a global level as well, regions with a Mediterranean climate are of outstanding significance. The Capensis in southern Africa or the south-west of Australia belong to the most important centres of diversity with their species-rich flora and high degrees of endemism.

The general diversity-increasing role of mountains outside arctic climate regions is also significant. All of the six above-mentioned global species maxima are situated in orographically richly structured regions of the humid tropics and subtropics.

Biodiversity versus Geodiversity

As already stated in the previous section and demonstrated in the method section by the example of tropical high mountain ranges, the biodiversity of a region is, apart from historical factors, also particularly a result of its geodiversity (the diversity of abiotic factors). Geodiversity constitutes in addition to its mostly biodiversity-increasing effect a quality of an area in its own right of the same order as biodiversity (compare Barthlott et al. 1996). Both together we designate as the ecodiversity of an area in accordance with a landscape-ecological concept (compare Leser 1992) which subsumes and contrasts the biotope and the geotope under the term 'ecotope' (Tab. 1). The alternative geographical term of 'landscape diversity' should not be used as in biodiversity research it is generally defined as a synonym for the gamma-diversity in the system of Whittaker (1972, 1977).

The biodiversity raising effect of a higher geodiversity becomes also evident when comparing the taxon numbers of the floristic survey (following Haeupler 1997) or the species numbers of mosses in the federal states of Germany (Düll 1977) respectively with the boundaries of the highlands. (Fig. 3, 4). While in the North German plains taxon numbers of vascular plants of fewer than 1,300 per 3 x 3 Ordnance Survey Maps can be found almost throughout, those in the low mountain ranges, with only a few exceptions, may be as high as a little more than 2,000 taxa of vascular plants. The situation of species

Tab. 1: Schematic description of the terminological concept of bio-, geo- and ecodiversity by Barthlott et al. (1996).

Ecodiversity

Geodiversity	⇆	**Biodiversity**
Abiotic Factors:		Biotic Factors:
Climate / Water		Producers
Geology / Chemistry		Consumers
Morphology / Orography		Decomposers

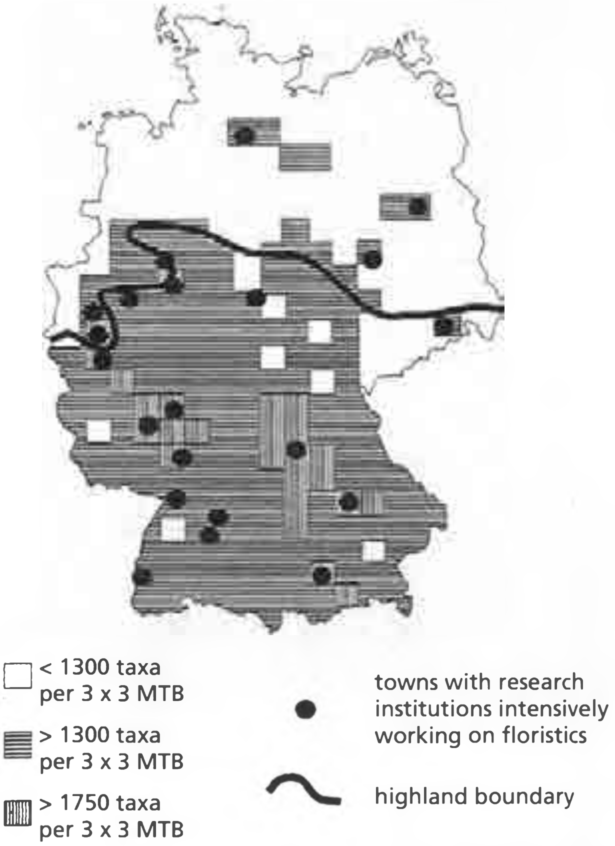


Fig. 3: Taxon numbers of the identified vascular plants in 3 x 3 ordinance survey maps (MTB) (Haeupler 1997) in comparison to the highland boundaries and the location of towns with research institutions intensively working on floristics.

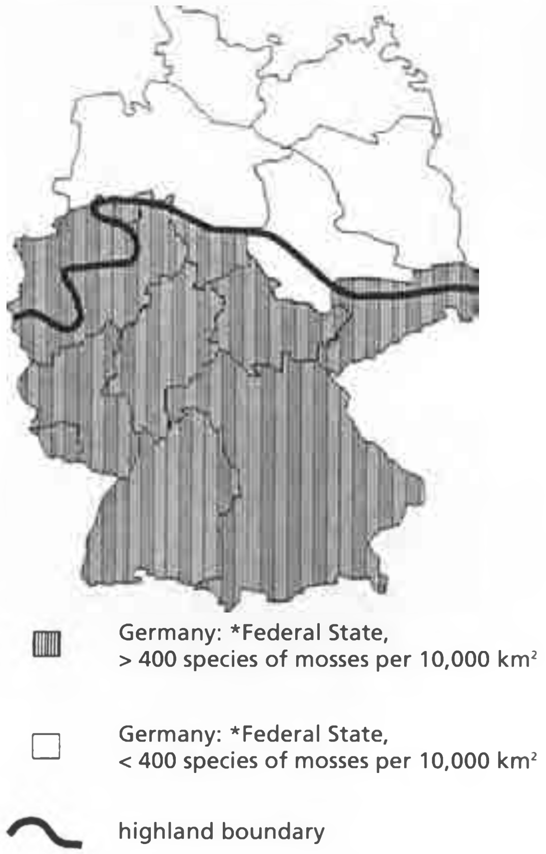


Fig. 4: Average species numbers of mosses per 10,000 km² in the individual states of Germany compared to the highlands boundaries. As is the case with vascular plants (Fig. 3), higher species numbers occur throughout the area of the highland. For the conversion of the species numbers (following D̦ll 1977) to the standard area, the species-area model by Arrhenius (1920) was used with a z-value of 0.24. The z-value was determined by regression calculation based on data for 43 European regions.
****for Lower Saxony D̦ll states different numbers for the highlands and the Lower Saxony plains incl. Bremen.***

numbers of mosses for a standard area of 10,000 km² in the individual states of Germany is similar.

The problem of scale which was mentioned in the section "Methods of biodiversity mapping" is to a large extent a result of the different geodiversity of the investigated areas.

Vascular plants as indicator group for the total diversity of terrestrial systems?

As already mentioned in the introduction, a mapping of the total global biodiversity based on other groups of organisms, like e.g. the arthropods is impossible at least in the near future due to the data situation. For terrestrial systems, the comparatively well known vascular plants are particularly suitable as indicator group because of their significance for the ecosystems. Apart from extreme habitats such as the arctic lichen tundra, they are the most important primary producers as well as important structural shapers of the habitats. The overwhelming diversity of animals in the highly structured canopies of tropical rain forests may serve here as only one example. Due to the numerous, often specialised plant animal interactions, a close linkage between animal and plant diversity seems to be exceedingly probable.

However, it must be emphasised that these statements only refer to terrestrial habitats. In marine habitats, where vascular plants generally play a minor role, the basic relationship between the species numbers of producers and consumers follows different rules than in terrestrial systems. The coral reefs, often compared to tropical rain forests because of their high diversity, are a case in point. Despite the high animal diversity and the producers' essential role for the system (compare Adey 1998), the species numbers of the producers, i.e. algae, appear to be comparatively low (Adey 1998, Rowan 1998).

The question whether this close, universal relationship between vascular plant diversity and total diversity in terrestrial systems exists, how strong it is and what its possible exceptions are cannot be answered here conclusively because of the data situation already mentioned. Nevertheless, the species numbers for vascular plants and major animal groups to be found in literature show high correlations on the country level (Fig. 5). The comparison between the diversity map of

South American birds (Fjeldsa & Rahbeck 1998) or the tiger beetles (*Coleoptera: Cicindelidae*) of India and Australia (Pearson & Cassola 1992) and the corresponding patterns in Fig. 1 also show basic conformities. However, other organism groups (e.g. aphidoidea, hemiptera or apidae, hymenoptera, compare Gaston & Williams 1996) evince significantly different distributions or even completely contrary trends. However, the problem with all these comparisons is that they are always only comparisons with a single other group, each with its own ecology and corresponding own distribution pattern but not with total diversities. After all, the question is not whether the diversity of vascular plants is a good indicator for the tiger beetle diversity – e.g. for North America this would in fact constitute a highly dubious statement.

Therefore it is at present not possible to ultimately prove the suitability of vascular plants as indicator group for the total diversity with numbers. Nevertheless, the principle considerations (see above) as well as the trends within larger groups (Fig. 5) strongly support this assumption – along with a simultaneous lack of significant evidence against it.

Quality of biodiversity

The terms 'biodiversity' and 'species numbers' are often used as synonyms. This simplification may have different reasons. Often the species number for an area is known, while other data, e.g. the systematic composition, are not available. The species number dominates the diversity concept, not least because it is easier to handle and more graphic than other aspects of diversity. In addition it plays traditionally an important role in the evaluation of areas, e.g., under conservation aspects.

In a more differentiated discussion, however, some other aspects of biodiversity apart from species numbers can be identified. This list is even more extensive when evaluating the biological diversity of an area by means of quality criteria. A great number of such criteria are mentioned in literature, some of them already playing an important role in nature conservation practice (Usher 1986). Seven quality criteria appear to be of basic significance for us:

1. Taxon richness. The majority of investigations here concentrates on the number of species. However, for different questions particularly in the area of biogeography and evolutionary research the genus or family number is also significant.
2. Abundance structure. The share of the number or biomass of individuals per species is discussed in various approaches. Regarding rarity with respect to local population size (Rabinowitz 1981, Gaston 1996) the abundance of a species is compared to the abundance of other species. By contrast, the evenness (Pielou 1975, Haeupler 1982) of the distribution of individuals over the species is a characteristic of the whole observed species community in the area of investigation. Evenness can be combined with species richness in diversity indices (e.g. Shannon-Index). As the abundance distribution of a systematic group for larger areas is available in just a few cases, it plays only a role in diversity investigations on small scale.
3. Taxonomic, phylogenetic and character diversity. These diversity conceptions, including the systematic, phenetic and cladistic diversity as well as the taxic diversity, are closely interrelated. They are discussed in detail by Williams & Humphries (1994, 1996) and Faith (1994). The term of taxonomic diversity is based on the idea that, in simple words, for instance a system of 2 species of different genera shows a higher diversity than a system of 2 species of the same genus. As a solid taxonomy aims at the reflection of the phylogeny, taxonomic diversity can be defined as an approximation of phylogenetic diversity. The conception of character diversity (or feature diversity), by contrast, is based on the concept that a system is the more diverse the more (genetic, phenetic, functional) features its species show. Feature diversity can be approximated by taxonomic and phylogenetic diversity and is a possible indicator for the potential use of biological diversity (Faith 1994).

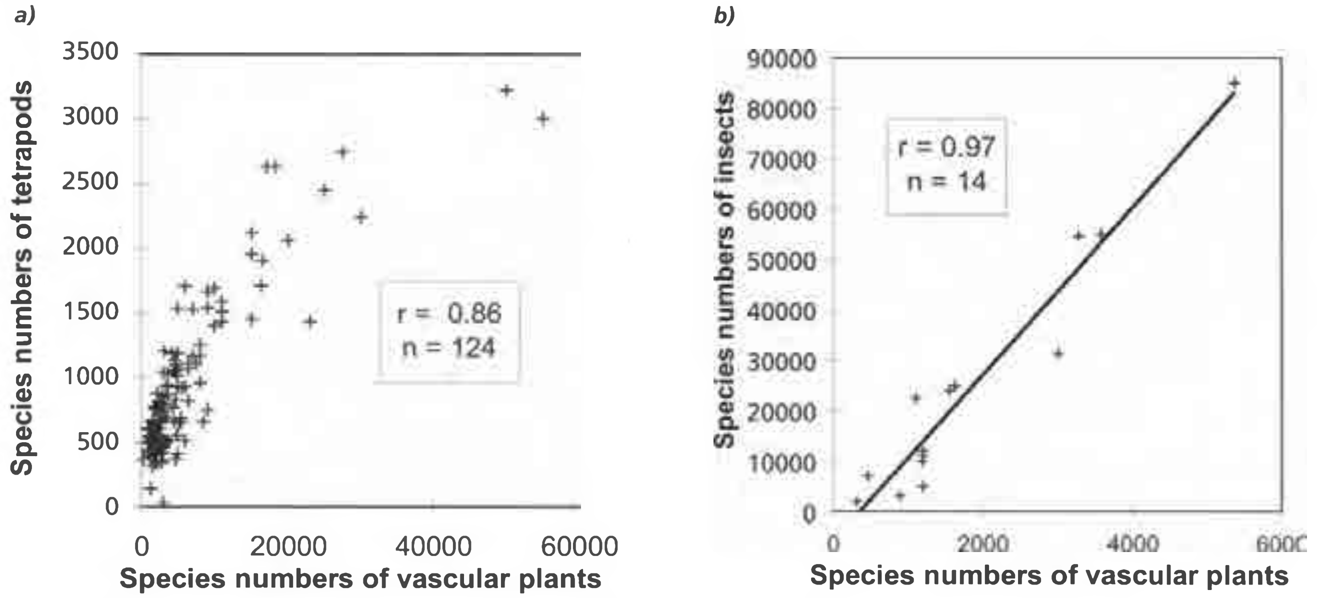


Fig. 5: Comparison of species numbers of vascular plants (following WRI 1996) to a) the sum of species numbers of land vertebrates (birds, mammals, reptiles and amphibious animals) on the country level (data taken from WRI 1997), b) estimated species numbers of insects for different regions (countries, archipelagos) world-wide (following Table 4.5 in Gaston 1996).

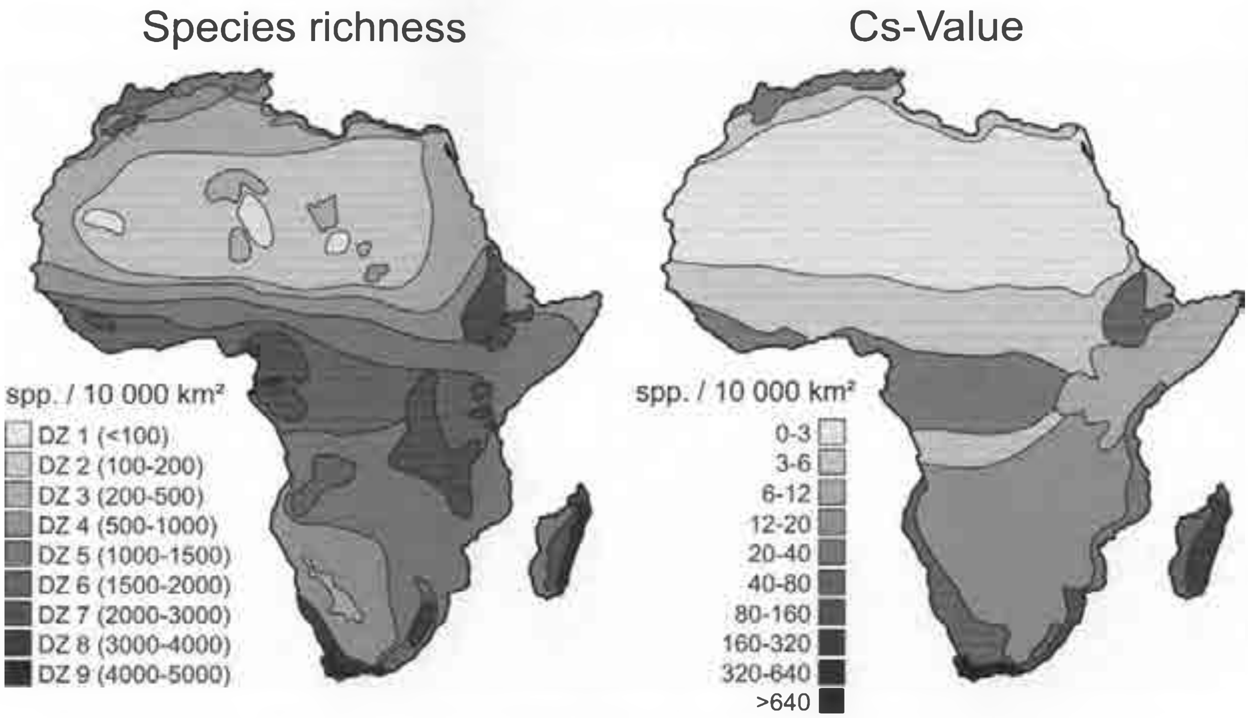


Fig. 6: Diversity of vascular plants in Africa. The species richness is shown on the left, a combined index which comprises species richness and endemism (Cs-value) on the right. Both maps show some significant differences, such as in West Madagascar, where a medium value for species richness coincides with a relatively high Cs-value because of the high degree of endemism. The Capensis, already striking at first sight because of its species richness, shows by far the highest Cs-value. However, comparison is difficult since the Cs-values for the 19 regions represent averages which are not further differentiated. Further explanations in the text. (Kier & Barthlott, unpubl. data).

4. Range sizes and degree of endemism. The range sizes of occurring species in a region are an important criterion for qualitative studies: the occurrence of species with small distribution ranges raises the value of a region. One assessment procedure, which is in many respects imprecise, is the determination of the percentage of endemic species, i. e. of species which occur only in the area of investigation. Several disadvantages of this index, particularly with respect to its mapping, are eliminated by newer calculation methods (Usher 1986, Williams et al. 1994). They are based on the range sizes of all occurring taxa and thus enable a continuous and area-related calculation of the degree of endemism (see below).
5. Share of allodiversity. An important characteristic and quality criterion of the biodiversity within a region is the share of allodiversity, i.e. the organisms introduced by man. It has a significant medium- to long-term influence on total diversity as indigenous species are often replaced or extinguished by alien species (see below).
6. Relevance within ecosystems. An aspect, above all recognised in the research of global change, is the relevance of species for the functioning of ecosystems, particularly with respect to global biogeochemical cycles. The ecosystematic relevance as a quality criterion of biodiversity designates in this sense the function of a species or a species community for the ecological integrity of a larger spatial unit.
7. Actual and potential economic value. This aspect represents a central quality criterion from an anthropocentric point of view.

The four last-mentioned criteria can, strictly speaking, not be considered aspects of diversity. It is hardly correct to say that two regions show a different degree of biodiversity because its species differ in the degree of endemism (Williams & Humphries 1994). Nevertheless, they are important quality criteria in the comparative evaluation of the biodiversity of regions.

For all seven quality criteria, indices have been either defined or are at least conceivable. Often, a combination of two criteria in one index is possible. In case of grid related data, for instance, the reciprocal value of the range sizes of all the occurring species may be defined for each grid cell and the sum of these reciprocal values may be calculated. The resulting index (Usher 1986) is a combination of two quality criteria: it reflects the degree of endemism as well as the species richness. It can be calculated and cartographically depicted for instance with the computer program WORLDMAP (Williams 1997) on the basis of grid data (i.e. following a taxon based approach, see above). It is also possible to calculate the index with an approach based on summary data for geographical units. For this method the number of species for each region as well as their classification in chorological groups are taken as basis. The map on the right in Fig. 6 presents the calculated values according to this method (here called Cs-Values) for the 19 regions of Africa defined by White (1983) (Kier & Barthlott in preparation, see also for a discussion of the relevance for setting priorities in the protection and conservation of biodiversity). The subtropics and the mountains of Africa as well as Madagascar show particular high values. The Capensis for instance has a Cs-value about 15 times higher than an area of the same size in the equatorial rain forest. Yet we must note that at this first stage of surveying only mean values have been calculated for the regions. A more differentiated study would presumably lead to higher results in some regions, e.g. in Cameroon and Gabon.

Biological globalisation

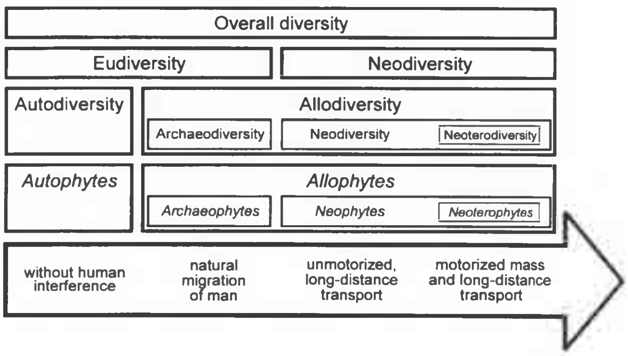
The fundamental change in global biodiversity caused by the activities of mankind is a well-known problem. Discussion in the past covered mainly the issues of fragmentation and destruction of habitats. These are still the main problems regarding the loss of biological diversity. Only 1999, Nepstad et al. found the deforestation rate of amazon forest to be twice as high as been calculated from remote sensing data. Nevertheless, another phenomenon of anthropogenic change of biodiversity has generally been acknowledged for a long time, but has been developed only recently into a central topic of the scientific debate about the threat to global species richness: the displacement of indigenous by introduced species. This "biological globalisation" leads to far-reaching consequences for biodiversity research.

An indispensable basis for its description is a suitable terminology. Indeed, there are plenty of terms like "neophytes", "neozoa", etc. However, terms for the corresponding diversities such as the diversity of neophytes have been missing so far. In order to fill this gap a terminology system – based on existing terms – is suggested (compare Tab. 2, for a detailed presentation compare Barthlott et al. 1999a). The following statements should also be valid also for zoology, though here terms of botany are used.

At last since the beginning of the motorised mass- and long-distance transports, people have transported and carried off species over long distances to an increasing extent – intentionally or unintentionally. At the same time humans foster the settlement of species in areas altered by their activities. This happens, above all, by increasing structure diversity and thereby geodiversity, i. e. the diversity of abiotic factors. For example, road construction in a formerly closed forest area creates a suitable habitat for many ruderal plants. Thus, neodiversity is increased to a substantial extent, since the organisms settling in the newly constructed habitats are often neophytes and neozoa. The species introduced by man settle preferably in habitats like this. However, in many cases neophytes also spread in natural habitats and displace indigenous plants. A South African study of 200 endangered or already extinct fynbos plant species revealed that in 54% of the cases introduced species caused endangerment or extinction (cited after Kidd 1996). In 39% of the cases of animals becoming extinct the reasons for extinction being known since the year 1600, organisms introduced by humankind are said to be responsible (Groombridge 1992). These effects occur particularly in the first phase after the arrival of humankind. In Central Europe today, millennia after the first settlement and centuries after the establishment of intercontinental connections, they are noticeable only in a diminished way.

However, another effect results in the frequent difficulties for biodiversity research and nature conservation practice to demonstrate the negative impact of neophytes. Settlement of foreign plants leads to a net increase of local species richness – at least in the short to medium run. Global biodiversity, by contrast, decreases due to the often resulting extinction of indigenous species (see above). Thus the total diversity of vascular plants in Germany – measured by taxa richness – has increased by about 10% (Korneck et al. 1996). Their eudiversity, however, has decreased due to the extinction of some species.

Tab. 2: Classification of plants and their diversities according to their mode of introduction. The description here refers to plants. An analogous classification e.g. for the fauna or for all organisms taken together is easily conceivable, corresponding terms have partly been introduced already (e.g. neozoa). Whether the classification into eu- and neo-diversity or alternatively into auto- and allo-diversity is chosen for the rough classification depends on the data situation and the purpose of the investigation. (after Barthlott et al. 1999a)



Research potential and responsibility

Biodiversity research contributes considerably in many respects:

- To a large extent it is basic research. Thus, it has also the potential for economic uses which are not yet foreseen at the time of research.
- It forms a central basis for the sustainable use of biological resources, e.g. by bioprospection.
- It supplies the necessary data and knowledge needed for the protection and conservation of biodiversity.

The relevant potential for biodiversity research exists to a considerable extent in the industrialised nations. Besides a large number of research institutions, a considerable rate of *ex-situ* diversity is available: collections and gardens contain about 80,000 species or 33% of all described species and 85% of the families of vascular plants (Barthlott et al. 1999b). Moreover, an enormous potential is at the individual nations' disposal with respect to herbariums and zoological collections. The *in-situ* diversity by contrast is largely located in the tropics, i.e. above all in the developing countries. This discrepancy is shown in Fig. 1, where the distribution of more than 500 significant botanical gardens is indicated in comparison to the species richness of vascular plants (Barthlott et al. 1999b). This situation results not only in great chances but also in considerable responsibilities.

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Supporting Biodiversity: Taking the Benefit of Tourism into Account

Wolf Michael Iwand

1. The WWF has given itself an admirable mandate: "In the interest of nature". A company like TUI puts it more pragmatically: "In the interest of our customers!" But without any doubt we do have something in common: our customers put intact nature at the centre of their dreams. What do holidaymakers expect of nature? They certainly have no dream about biodiversity! That is a completely unknown political slogan, or – at best – a media buzzword. Dreams about "Paradise", on the other hand, is a pretty precise (!) definition of our customers' desires.

Today, international tourism is one of the fastest growing sectors of the world economy. According to various forecasts, tourism already is or will become the world's most significant economic activity within the very next years. It is by this dynamics that mass tourism is hold responsible for world-wide environmental pollution, for nature degradation, for the loss of species and landscape diversity, especially in sensitive coastal and alpine areas.

In 1990, TUI, the European market leader in organized package holidays, created voluntarily as the world's first tour operator a Corporate Department of Environment in order to establish a feasible management system to reduce the impact of some million TUI clients per year on the environment in holiday regions. Since seven years, we force our contracting partners – destination authorities, tourism boards, hoteliers, transport companies – around the world to implement procedures to reduce or avoid waste and sewage, over-consumption of water, energy, land, beaches, nature. We did not decide for so-called "ecotourism" for the politically correct happy few. We decided for an integrated systematic approach of environmental care within the business processes such as monitoring, product planning, product development, purchasing, education, training, information to reduce the environmental impact of tourism. The common denominator in our company today is: "Quality Management" – and this definitely includes environmental quality standards, quality controls and quality assurance.

We started by concentrating on more or less technological eco-aspects such as sewage treatment and disposal, waste deposits, renewable energies. But then we found the real issue: the capital asset of tourism which is the beauty, the uniqueness and attraction of nature, the diversity of fauna, flora, habitat, landscape, scenery.

This is exactly what I am going to be talking about: the capital which nature, landscape, biodiversity constitute for tourism. This is not the trivial platitude about the branch we are perched on which nobody is about to saw off, it is the insight that we must handle our capital investment, capital wealth, our natural treasures, values, assets more economically and more profitably. This kind of tourism does not need just green managers, but – so to say – eco-investment trustees who secure this capital and make more of it and prevent losses at all costs. Therefore, it is very much to the tourism industry's own vital interest to support the aims of a global, not only regional nature conservation strategy!

2. Question: What do Cologne Cathedral and the Galapagos Islands have in common? Both are examples of the "World Heritage of Mankind". In 1972, UNESCO adopted the World Heritage Convention for the protection of unique cultural and natural treasures.

Question: When was the last time you used the words unique, outstanding, exceptional – and you really meant it? These are the very criteria for the superlatives, the crown jewels of the World Heritage of Mankind! Today, 552 sites are included in this world heritage. Of those, 134 are counted to the "World Natural Heritage": unique natural treasures. The Grand Canyon, the Great Barrier Reef, the Serengeti with Kilimanjaro and Ngorongoro, and the Danube Delta are some of them. The Ayers Rock National Park in Australia, the Coto Doñana in Andalusia, the Everglades in Florida, Yosemite National Park. Examples of extraordinary natural beauty!

The World Heritage Convention puts the focus on the protection and preservation of these unique natural sites. So should we promote them touristically? Wouldn't we then be the cause of additional pressure from holiday-makers and visitors?

Question: Do you regard "man and the biosphere" as a contradiction? Since the UNESCO "Man and the Biosphere" program's founding in 1976, 337 biosphere reserves (April 1996) have been established in 85 countries, with the goal of preserving biodiversity while at the same time promoting the economic development of the local population. Nature conservation and economic development while preserving the specific cultural values of the region. Man and nature together, on a fair and balanced footing. Compatibility is achieved by zoning the area into a main zone, a buffer zone and a development area. This concept implies what is where to be protected, and where economic operations may take place. Not only protection against people, but, just as important, development of these areas for people.

One result of such zoning regulations is the setting aside of nature conservation areas in varying categories of protection. For TUI, designated protected areas are highly significant touristic indicators for assessing the quality of nature, landscape and biodiversity in holiday regions. For example, the 40.4% protected areas on the Canary Islands or the 39.7% on the Balearic Islands. Compare these to 8.4% in total Spain, 2.7% in Switzerland and 11.9% in Germany (according to OECD statistics)!

Surprisingly, there are also 40 biosphere reserves on the list of the world heritage treasures of mankind. Here, the preservation of the beauty and the development of diversity by man converge. From the standpoint of tourism, some striking examples are the Everglades and Yellowstone, Coto Doñana and the Serengeti. So you see, we are circling in on this kind of area where nature conservation interests and those of touristic development overlap. Model regions!

3. Astonishingly, Yellowstone National Park and the Florida Everglades are among the most endangered ones. The Everglades are dying. Not from tourism. Because of enormous population pressure and the density of population and traffic in South Florida and enormous water consumption of the population and agriculture.

It is urgent that we must quickly find economic ways of securing the natural capital of tourism. For example by a consistently and continuously funded "valuation strategy" by the tourism industry.

At a WTO Asian-Pacific Minister Conference at Malé in February 1997 the President of the Maldives Islands presented a calculation which gives much food for thought. At the fishmarket on the Maldives, a fisherman gets about 32 U.S. dollars for a shark; as an attraction for scuba-diving tourists – in the underwater area of Ari Atoll, under protection since 1995 – a shark brings about 33.500 U.S. dollars in revenue per year to the Maldives. A thousand times as much in one year! One shark! A group of sharks living there thus can be calculated to amount to about three quarters of a million U.S. dollars per year to the Maldives coffers.

And this kind of sustainable funding is precisely what I am driving at! The concept behind is "valuation", finding the equivalent, in financial terms, of natural beauty and uniqueness, upgrading nature, putting-on-stage and marketing its value, putting a benefit tag on it. Why do consumer goods always have a monetary value? What about their natural value, if this yields more profits?

For example: if whale-watching by tourists already generates more income today than whaling, this tourist attraction is profitable. What is true for whales also goes for the African elephant or the Sequoia tree.

So the "valuation strategy" is about the conception, management and control of sustainable plans for using resources in order to generate steady income, quality of life and to avoid long-term economic or ecological losses.

To enable this valuation of nature, landscape and biodiversity to take place, adequate funds for conservation projects must be set aside from the foreign-currency revenues of tourism countries on a stable, reliable, long-term basis. For nature, not for gigantic, often downright absurd road-construction projects in idyllic landscapes.

TUI respects very much that many tourism countries are increasingly implementing conservation projects. The indigenous population in these countries is taking an ever more active role in finding sustainable forms of dealing with nature.

So many tourism countries discovered a new kind of tourism, ecotourism. Ecotourism includes a wide variety of highly creative tourism alternatives which feature closeness to nature while sparing it at the same time as far as possible. There is no stringent definition, neither in the newcomers amongst the tourism countries, particularly the developing countries, nor in the traditional tourism countries of Europe, America or the Pacific region. UNEP has calculated the market volume of ecotourism to be millions of holiday-makers and thousands of million dollar. TUI regards ecotourism to date as a niche market for creative minorities, always for small to very small groups of people. So beware of false prophets who preach this as a futuristic picture for tourism as a whole. It cannot work for the 600 million holiday-makers today and approximately 1 thousand million of them by the year 2010. On the contrary: that would be a disaster! At best, ecotourism is an additional option, as a rule in particularly sensitive zones with respect to ecology and also frequently in the hitherto untouched hinterland. So be careful! Ecotourism requires far stricter regulations and controls than tourism in the traditional urban zones, or else it will become a "Pandora's box".

4. In the past we did not take much notice of the IUCN – until recently. We are learning! But this Internationale of conservationists is also learning. The Director-General of the IUCN, David McDowell, energetically demanded: "Let's talk economics! We conservationists must learn to think economically! We have to learn the language and argumentation of business!" And he hired a chief economist who is carrying out cost-benefit calculations for nature, landscape and biodiversity. Highly remarkable and futuristic.

A similar invaluable influence is exerted by the WWF and its "in situ" conservation work as well as its international campaigns – such as the current "The Living Planet" with the issues forestry, fishery, climate. The Forest Stewardship Council for sustainable forestry and the Marine Stewardship Council for sustainable fishery point to the future as models for the development of industries under strong environmental stress.

Moreover, within this context we are approaching UNEP and UNDP. Here in Germany, we are in close contact with the Federal Agency for Nature Conservation and – when it comes to developing countries – with the GTZ.

Taken only these examples it is a global network of impressive competence! The common denominator with tourism now actually becomes possible. Through the economic insight of "Protection by use"! Protection of biological diversity by sustainable use! In my view a highly significant concept of the tourism industry and conservationists. Now, beyond the stage of dialogue, networking by co-operation can be realized: with the "right" experts and the "right" selection of steps for sustainable use.

5. Remember for a moment "El Niño". The Christmas aquatic phenomenon of Peruvian fishermen has grown into a "Satan" for people world-wide. In Southeast Asia alone, more than 20 million people were affected by smog and haze of burning rainforests. More than 20 million! And many more millions of hectares of tropical rainforests, containing an abundant diversity of life which was incinerated.

Because of the smog impacts on tourism in Southeast Asia we had to start at TUI with "crisis management" to avoid health risks for our customers. We quickly became familiar with API and PSI – Air Pollution Index and Pollution Standard Index. But not with the question how to evaluate the immense loss of biodiversity or to understand the word "irreversibility".

In the "Asia Disaster Preparedness Center" in Bangkok, experts from 17 Asian countries discussed the connection between fire disasters and El Niño, the greenhouse effect and climate change. That is the core of the matter: the effects of unscrupulous economic activities on nature, on biodiversity, on climate, on people and on their interaction with each other by way of total deforestation, fire clearances, energy consumption and emissions.

Vast forest fires around the globe: in Indonesia, Malaysia, Australia, Brazil, Mexico, all of them are megadiversity countries. The consequence is loss of rainforests, genetic resources, ecosystems – and loss of tourism revenues as in Florida just now. They call it "wildfire of the century" and "a glimpse of hell". The El Niño caused fire blaze destroyed more than 200.000 hectares of forests, bushes and scrub until now. The consequence again is habitat destruction and tourism loss.

6. Two months ago I have been invited by the German Government to attend the Bratislava Fourth Conference of the Parties (COP) and to present to the participants our company's considerations on the incorporation of the Convention on Biological Diversity by tourism. At the final day, a plenary decision was adopted to initiate a process of exchange of experiences, knowledge and best practices on sustainable forms of tourism and the further implementation of the Convention.

For myself, it was interesting to learn that the German delegation's initiative for a proposal of establishing a working group on global guidelines for sustainable tourism and biological diversity was by far not welcomed by a large number of developing countries because they seemed to fear to lose their own right to establish economic activities unrestrictedly. Those countries have to be convinced by a broad bottom-up-approach that they will gain with sustainable tourism and not lose. As far as I understand, the United Nations Commission on Sustainable Development (CSD) is preparing an international action programme on sustainable tourism until April next year. CSD will do this with the support of the German Government (and the German tourism industry) which understand their role as Germany being the "lead country" in terms of sustainable tourism development guidelines. For the Fifth Conference of the Parties in May 2000 in Nairobi one of the three key issues will be "sustainable use, including tourism".

7. What about funding for supporting biodiversity? So far, we do not have experienced yet financial instruments such as eco-pricing, eco-taxes, certificates or dept-for-nature-swaps. There is a brutal price battle on the tourism market. The profit margin averages in Germany around only 1 %. Eco-sponsoring of TUI is done only for rather small scale projects such as afforestation or protection of endangered species. Our customers participate in these projects – and they do learn in the process: commitment! And so do we: for example the interrelationship of cultural and biological diversity, the interconnection with ecosystems, such as was recently the case with mangrove forests. But even more we learn about the causes and consequences of water shortage, soil erosion, forest fires, deforestation and desertification.

TUI's real "funding" is by investing year after year into a persistent process of growing eco-efficiency to reduce environmental impact and to avoid the loss of biodiversity. At the same time all our diverse and numerous environmental activities contribute by raising the customer's awareness and aiming on the customer's willingness to pay for the value of nature! Because this is the real gate-keeper of funding biodiversity.

8. Notwithstanding all the capitalization strategies for protecting nature and biodiversity by means of planned use, there is one aspect which should not be overlooked. There is – like nearly everywhere else – competition! A very active, innovative and successful competition, at a specific sector. I am not talking about other industries, I am talking about the modern leisure entertainment factories, including artificial worlds to be experienced under a glass roof. Subtropical beach paradises which copy nature so well that you can hardly tell the difference.

Nature and super-sophisticated technology are aesthetically and emotionally melted into one. These are no surrogates of nature, they are modern lifestyle, nature fairy tales. It may even be that holiday-makers find these are better than the real thing. They are not dangerous, uncluttered, clean, hygienic, accessible. There, nature can be touched. Entry desired – not prohibited! The question is: Which nature experience is more intense, more satisfying to the senses, enjoyable, entertaining? The original or the copy?

So you see: the competition with upgraded nature, be it artificial or artistic, wild or uncluttered, is already in full swing. The more ideological dispute as to whether nature-protection areas or national parks should be run by private companies, with the danger of commercialization, can in my opinion only end up to nature's disadvantage: "no dough – no go"! This is where the chief economist of the IUCN comes in! Let us make one thing clear: if the public till is empty, private funding must ensure nature conservation – or nature will be lost!

But the eco-competition in upgraded nature has its good sides, too:

1. It shows successful strategies of the private sector which can be imitated.
2. It increases the interest of holidaymakers and visitors in nature.
3. It achieves ecological relief of such valuable natural areas which must definitely remain protected.

9. Some time ago we posed the provocative question: "Can tourists save nature?" And our answer was: "Yes, by establishing and marketing the value of nature!" Protection by utilization, or better: protection by better utilization! That found consensus: acknowledged experts on nature conservation and leading international ecologists now describe tourism as their ally. In the German news magazine DER SPIEGEL (32/1997), the "appeal for mass tourism" was summed up: "The travel industry has the power to become a worldwide nature conservation agent." DER SPIEGEL drew the conclusion that "the ecological balance sheet for tourism is positive".

My belief is that by tourism development there are "sustainable" perspectives for prosperity, growth and nature conservation, proved in some different ways and increasingly accepted by the holiday destinations.

Is this also one-sided, blue-eyed, opportunistic optimism towards future?

Indeed! Can we achieve sustainability if an indigenous community chief in a third world country says to me: "But we have hunger! We have to survive!"? Can sustainability succeed with a world population which keeps on growing, with global poverty, with terrorism and belligerent conflicts, with millions of people, children, fighting for survival? Can sustainability succeed with the wish – and right! – of billions of people for an economic catching up-development which rectifies the present unbalance?

Who is to give the answers? Global governance? Corporate governance? Or communitarism?

10. There is one final recommendation: Take the ecological and the economic benefit potential of tourism into account! Nature conservationists should join forces with tourism organisations.

From my point of view, there is no other economic sector which depends so much on the value and diversity of nature. My experiences show that organised responsible tourism might be the vanguard of sustainable development in many countries. And that in a cost-benefit-comparison to other industries (agriculture, forestry and timber industry, raw material, oil, chemistry, manufacturing, energy and transport) sustainable tourism development creates necessary economic development whilst safeguarding nature, landscape and biodiversity.

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Conservation of Biological Diversity, with Special Reference to the Conservation of Forest Genetic Resources

Christel Palmberg-Lerche

Introduction

Most organisms in nature are, inherently, variable. Conservation of biological diversity and genetic resources, in essence, means ensuring that variation will be kept available and allowed to develop and evolve through both natural processes and through the direct or indirect intervention or influence by man.

It is acknowledged, at technical and scientific levels, that the values derived from diversity are associated with the different levels of organization of diversity in plants and animals that exist. These levels include the main components of ecosystems, species, populations, individuals and genes. It is also acknowledged that varying and complex interactions exist between these levels.

As managers, technicians and scientists we know that, in considering action in any field, the first step is always to clearly specify objectives aimed at. In the case of genetic conservation, the levels of diversity targeted for conservation must be clearly specified. This is of utmost importance, since it is possible to conserve an ecosystem and still lose specific species; and as it is possible to conserve a species and still lose genetically distinct populations, or genes which may be of value in adaptation and future survival of a species, or which will facilitate the genetic improvement of the species in breeding programs benefiting mankind. Similarly, conservation efforts must be placed into the context of specified aims and accompanied by regular monitoring to ensure that progress is being achieved, through management or through non-intervention, towards reaching these aims. In this regard it should be noted that there may be no single objective measure of biodiversity, only measures appropriate for specified and, by necessity, restricted purposes (Williams et al. 1994).

Debate on conservation at both policy and popular levels has been greatly intensified over recent years in the light of actual and perceived losses of diversity. In the current discussions, it is often incorrectly assumed that diversity in plant and animal communities, by definition, confers resilience (Holdgate 1996); that strong functional relationships exist among all organisms and among all levels of diversity; and that there are relatively few ultimate causes of threat to diversity. It is also frequently thought that any intervention by man will, without fail, cause unwelcome influences and destructive, or at least highly disruptive and negative, effects. If this were true, then managers and policy makers would not need to know much about the structure and dynamics of diversity, since single actions would have largely predictable effects. With the perception of a broad, common threat with largely predictable overall effects, there is a natural hope and belief that simple solutions, such as withdrawing all human intervention, or segregating land uses into strict, separable compartments, will solve the problem (Namkoong 1996).

Unfortunately, the fact is that a simple, uniform answer and a single strategy for genetic conservation is not available.

Especially when the popular term, "biodiversity", is used in calls for action, it is frequently not specified which level of diversity is discussed, nor what the ultimate aim or aims of conservation of intrinsically dynamic natural systems will be. This will make it difficult, if not impossible, to respond in a scientifically and technically sound manner.

It can be concluded that, from a technical and scientific point of view, there is an urgent need to gain more information on ecosystem dynamics, on genetic variation available in species, and on the way diversity is spatially and temporally organized within and among populations. Such information should form the basis for decisions on how to conserve, manage, sustainably utilize and enhance existing diversity. More generally, there is an urgent need to inform politicians, decision-makers and the public at large of the strategies and methodologies available to respond to the challenge, and of the steps needed to carry out well-targeted and efficient conservation programs. The message must be clear, convincing, informative and technically sound. Its aim must be to help dispel the misinformation prevailing in much of the public debate of today, which is a source of pressures and hasty policy decisions which are not always based on facts, and which may be damaging rather than constructive. Among the myths to be dispelled soonest are those related to the belief that nature is static and that lack of human intervention or management will ensure a status quo in ecosystems; that the present state of diversity is the ideal one; and that human action can only diminish, never help maintain, or enhance, genetic diversity (Eriksson et al.; Palmberg-Lerche 1993b).

The present paper reviews available strategies for the conservation, management, enhancement and sustainable use of forest genetic resources, and the linkages of genetic conservation with the management of forests on the one hand, and with tree improvement and breeding, on the other. It is mainly focused on the conservation of genetic resources of trees and shrubs found in forest ecosystems. Such ecosystems also house a range of other plant and animal species, and great numbers of insects, microbes and other organisms. This complexity adds to their overall value and importance, which need to be maintained and enhanced for the benefit of present-day and future generations. International co-operation, co-ordination of efforts and possible future strategies of action are briefly touched upon in concluding the overall review.

In the present paper, the concept of genetic resources refers to the environmental, social, economic and scientific values of the heritable materials contained within and among species. Conservation is defined as the actions and policies that assure the continued availability and existence of these resources (FAO 1989).

Basic considerations in the conservation of forest genetic resources

Forest trees are long-lived, outbreeding and generally highly heterozygous organisms, which have developed a number of natural mechanisms to maintain intra-specific variation. These mechanisms, combined with the often variable environment (in time and space) in which forest trees occur, have contributed to the fact that, with a few exceptions, forest trees are among the most genetically variable of all living organisms studied to date (Libby 1987).

A large number of genera and species can provide the goods and services generally sought from forests and trees, such as timber, wood, food, fodder, shade, shelter, environmental stabilization, and amenity, cultural and spiritual values. Although it is true that less than 500 tree species have been systematically tested for their present-day utility for man, and less than 40 are being actively bred (Anon 1991; FAO 1990), it is also true to say that a range of different species are used in different countries and regions to provide the same goods and services, even in the case of programs focused on intensive forestry production. In contrast to crop breeders (see e.g. Frankel 1976; Holden and Williams 1984), foresters do not generally attempt to change the environment to suit a specific species or variety, but will aim at identifying species and provenances which can provide some levels of the goods and services required also without major selection and improvement; and which, intrinsically, are buffered against variations in soil, aspect and microclimate at the site on which they are used (Ouedraogo 1997; Palmberg-Lerche 1993a). This gives some assurances of the conscious, or at time unconscious, diversification at species and intra-specific levels in the use of forest genetic resources in national and regional programs.

However, such assurances alone are not enough. The conservation of forest genetic resources is today rightly a subject of greatest concern, mainly due to habitat destruction and alteration, and to undocumented and uncontrolled movement of germplasm, oblivious of problems of potential loss of genetic identity of diversified, local populations (Palmberg-Lerche 1987, 1994a, 1997).

Strategies for the conservation of forest genetic resources

While some losses in present-day biological diversity over time are inevitable due both to natural and man-made causes, diversity can be managed through a wide range of human activity, from the establishment of nature reserves and managed resource areas, to the inclusion of conservation considerations in improvement and breeding strategies of species under intensive, human use (see e.g. Namkoong 1986; Namkoong, Barnes and Burley 1980; Kemp 1992; Kemp and Palmberg-Lerche 1994a; Palmberg-Lerche 1993b; Wilcox 1990, 1995).

The strategy of conservation and exact methodologies applied will depend on the nature of the material, the time-scale of concern, and the specific objectives and scope of the program. The two main strategies for the conservation of genetic resources, are conservation *in situ* and conservation *ex situ*; these two strategies are complementary, and should be used in parallel, whenever possible.

In situ conservation implies "the continuing maintenance of a population within the community of which it forms a part, in the environment to which it is adapted" (Frankel 1976). It is most frequently applied to wild populations regenerated naturally in protected areas or managed forests, but can include artificial regeneration whenever planting or sowing is carried out, without conscious selection, in the same area in which the seed was collected (FAO 1989). *Ex situ* conservation includes conservation in seed banks; in live collections such as arboreta and clone banks; in specially established *ex situ* conservation stands; and as pollen or tissue. The two strategies of *in situ* and *ex situ* conservation, methodologies in their implementation, and their comparative advantages and complementarity, have been amply covered in recent literature (see e.g. FAO 1975, 1989, 1990, 1993a,b; Holden and Williams 1984; Ledig 1986; Ouedraogo 1997; Palmberg 1987, 1993b).

Definition of the amounts and proportion of extant genetic variation which needs to be retained, in the long term, to ensure that species and populations are able to adapt to future changes in environmental conditions (including changes in climate, and occurrence and pathogenity of pests and diseases), is central to the question of conservation. A similar question in tree improvement relates to concerns to meet shifting needs and demands of users over time, in addition to ensuring adequate buffering of breeding and production populations to environmental change.

In relation to *in situ* conservation in protected (nature) reserves and in gene management areas, the concept of "adequate size" has caused over the years a lot of confusion, having been used frequently in an unspecified manner to relate to ecosystems, species, intra-specific variation and/or genes, at times even to landscapes. When the focus is on the conservation of genetic resources, consideration must be given to the number of unrelated, inter-breeding individuals needed to constitute a viable genepool of species targeted for conservation, rather than to the physical size of the area in which they are contained. The minimum number of individuals, in turn, is in the case of forest trees related to basic issues such as flowering phenology, breeding system, and pollen and seed dispersal mechanisms.

Further to size, correlated with the number of inter-breeding individuals in the gene pool targeted for conservation, the number and siting of conservation areas (or of populations which will be used in sampling for *ex situ* conservation), is of crucial importance. In addition to the fact that individual species possess varying, total levels of genetic variation and that the intra-specific distribution of such variation differs between them, differing variation patterns seem to exist even within any one species: morphological characteristics tend to be more evident at the provenance, and less at the individual stand levels; isozymes tend to concentrate more than 90% of their variability in the within-stand component; while variation in components of growth, survival and susceptibility to various physical and biotic events, is important in all of these categories (Libby 1987, 1995).

In this kind of situation it is clear that conservation of diversity can only be achieved to any degree of satisfaction through systematically including conservation considerations in overall landuse plans, and through managing genetic variability of target species within a mosaic of economically and socially acceptable land use options, ranging from protected areas to managed forests and agro-ecosystems (Kemp and Palmberg-Lerche 1994; Wilcox 1990, 1995). Conservation action can be further enhanced through developing and managing, in parallel, an array of multiple populations of species and provenances included in tree improvement and breeding programs (Burdon and Namkoong 1983; Namkoong 1989).

In presently little-used forest tree species, a network of *in situ* conservation areas and protected reserves, which are placed under varying intensities of management intervention, should be demarcated or established. Such genetic conservation areas should cover central as well as outlying populations. For species and provenances under intensive domestication and use, managed conservation areas should be complemented by *ex situ* conservation stands and/or a range of breeding populations subjected to divergent and varying selection pressures (Namkoong 1986, 1989; Palmberg-Lerche 1989).

Conservation of forest genetic resources and forest management

Especially in the case of forest trees, it is evident that large-scale and lasting conservation can only be achieved if the resources – in this case the forests and woodlands targeted for conservation – have a value in the present time. This implies the application of forest management methods which will allow the resources to be sustainably utilized for the development of nations, as well as for the direct benefit of human communities living in or close to the forests. Fortunately, genetic resources and the forests which provide these resources are renewable, if adequately managed: they can be used without ever being used up (Ledig 1986).

Over the past years FAO, as well as a number of other organizations and agencies, in line with the above, have stressed that management for the production of goods and services from the forest is generally compatible with the conservation of genetic resources of the species being utilized, provided that some basic, genetic and silvicultural principles are applied (see e.g. FAO 1989, 1993a; Kemp 1992; Kemp and Palmberg-Lerche 1994; Wilcox 1995). In practice, this means that prevailing forest management prescriptions must be examined in the light of guidelines available for the conservation of genetic resources of the species being utilized; and that management interventions are adjusted so that both forest management and genetic conservation aspects are considered in a balanced manner. Needless to say, monitoring and control of forest management operations must be in place to ensure that recommended practices are followed. Similarly, monitoring of effects of implementing given forest management prescriptions will be necessary to ensure that observed changes in species composition and genetic variation in component species are within acceptable limits from a conservation point of view.

Conservation of forest genetic resources and tree breeding

As already stressed, the definition of priorities and strategies for the conservation and management of forest genetic resources, requires an understanding of the degree and patterns of genetic diversity among and between species and specific populations (provenances). Within improvement and breeding programs, the search for populations and individuals useful as sources of desired characteristics and genes, is similarly based on locating genetic variation and understanding variation patterns in the species and populations concerned. In either case, provenance and progeny testing are the scientific methods and practical working tools used to distinguish levels of variation (Anon 1991). As both basic needs and methodologies, in principle, are the same whether the focus of action is on conservation or on breeding, it is clear that pooling of resources and joining efforts in programs aimed at genetic conservation and those aimed at tree improvement, will make best use of resources and will more quickly help fill the considerable gaps in information prevailing in the forestry field.

A common, early approach will also help ensure that the continued flow of genetic materials from conserved status into breeding populations, and vice versa, is feasible and practicable, and that it forms an integral part of the dynamic development of both conservation and breeding strategies over time.

Selection and intensive breeding without due concern to conservation is likely to lead to allelic losses and to loss of the ability of populations to respond to future shifts in selection objectives. On the other hand, a sound breeding strategy can help create greater diversity among populations and can, furthermore, enhance the utility of available genetic resources by careful management of an array of breeding populations (Anon 1991; Burdon and Namkoong 1983; Namkoong et al. 1980). From the point of view of continued improvement and breeding to enhance utilitarian values of forest genetic resources, integration of genetic conservation concerns into tree improvement and breeding strategies is thus an absolute and obligate must.

Conservation of forest genetic resources and seed procurement

With growing attention being paid to tree planting and the development of forest plantations to meet present-day needs for goods and services available from the forest, national and international movement of forest reproductive materials has greatly increased over the years. Movement of germplasm must be carried out using only well-documented seedlots, and must at all times be based on conscious decisions taken with a full understanding of actual or potential genetic consequences of such action.

In view of the basic need to be informed of the genetic characteristics and value of the reproductive materials used, it is evident that any seedlot moving within or outside of national boarders without documentation on origin, provenance and genetic quality (including information on number of mother trees from which the seed or scions have been collected), must be disqualified from use and discarded. This basic principle is not negotiable, ever.

In addition to general risks implied by the use of unknown, possibly sub-standard genetic materials in tree planting and, at times, even as a starting point for selection and improvement programs, a more subtle, but no less real, danger in the movement of forest germplasm relates to the risks of pollution of local genepools by pollen from introduced populations of hybridizing species or provenances. Decades of provenance research has shown that most forest tree species exhibit considerable population divergence in genetically based traits. This inter-population differentiation (provenance variation) means that certain alleles, or combinations of alleles, are more common in some populations than in others. Losing local populations, or losing their genetic identity through pollen contamination, will influence evolution based on specific alleles or allelic combinations, and is likely to diminish the possibilities of adaptation of populations to continuing environmental changes. It will also decisively increase the amount of effort needed to breed for enhancement of such alleles for their immediate use.

In view of the above, the introduction of genetic materials from elsewhere must always be based on a conscious an well-informed choice. Reproductive materials must not be introduced on a large scale until they have proven to be of more value, in all aspects tested, than local provenances. Should introductions prove necessary or desirable to meet present-day needs, the genetic identity of local provenances must be, in all instances, safeguarded through parallel, active conservation measures. Such measures may, at times, imply the establishment of *ex situ* conservation stands outside of the range of polluting pollen sources.

In relation to movement and exchange of "genetically improved" germplasm, it is important to remember that "improvement" means, in essence, that the genetic base of the material thus named has been artificially and purposely narrowed to meet specific end use requirements, when used in given environmental conditions and under specified management regimes. "Improved" reproductive materials brought in from different conditions within the country, or from another country, will therefore seldom, if ever, provide a suitable starting point for local improvement and breeding. Such material can, however, at times, be used to enrich a locally generated breeding population of the same species and provenance, provided that it has proved its value in local field trials, and provided that its genetic base, selection criteria, selection intensity and other parameters related to its development, are known, recorded and considered acceptable by the receiver.

Movement of clonal material can, at times, be of scientific interest for experimental purposes. Introduction of clones has, in some limited cases, also been used to underpin tree planting programs on an operational scale (e.g. in the case of poplars, which are usually grown in intensively managed plantations on better-than-average sites, on relatively short rotations thus reducing the calculated risks associated with the employment of genetically narrowly based materials). Importation of foreign clones must, as in the case of import of other, genetically narrowed-down materials, be supplemented by locally made selections from wider genepools. It is important to note that such selection work, related to seed, seedling as well as clonal material, is never a one-time effort, but a continuing one, which must be carried out within the framework of a sound, local breeding program.

The above considerations on seed procurement and the movement of forest reproductive materials, are today of considerable significance in regions such Europe, where economic and market-related pressures and subsequently passed laws and regulations governing national or provincial land use polices, have lead to increased reforestation efforts, including afforestation of areas earlier used for agricultural production. Such subsidized or mandated changes in land use may occur at too short a notice for the national Forest Services, or competent provincial level entities, to be able to respond through the provision of adequate quantities of well-adapted, certified or source-identified planting materials. This can lead, and has led, to the uncontrolled and unsupervised importation and use of exotic seeds, seedlings and clonal material, frequently without knowledge of their origin or their genetic worth. Not only may these reproductive materials be badly adapted for the areas of intended use, but their use may also lead to genetic pollution and potential loss of local gene pools once the trees start flowering and widely disseminating large amounts of pollen.

The frequently expressed opinion, "any seed is better than no seed at all", could not be more misguided, outright wrong, and potentially of great and non-reversible harm to our genetic patrimony.

At the present time, the development of prescriptions and rules governing the movement and use of genetically engineered plants is receiving considerable policy level attention, world-wide. In fact, also the movement of non-engineered, but non-native, reproductive materials could with advantage be included within the framework of emerging national legislation on "biosafety" in forestry, as this issue relates directly to frequent, manifested offences against sound, genetic principles, and poses obvious and known dangers in this regard.

Future co-ordinated action

As evidenced above, international discussion on the conservation of plant genetic resources has been pursued at national, regional and international levels for more than thirty years (see e.g. Anon 1991; Palmberg-Lerche 1994b). The FAO Panel of Experts on Forest Gene Resources, established in 1968, provides advice to FAO and, indirectly, to the international community, on country-based programs and priorities in the field of forest genetic resources (FAO 1997). The FAO Commission on Genetic Resources for Food and Agriculture and the International Undertaking it oversees, explicitly includes consideration of forest genetic resources in its mandate. Within the Convention on Biological Diversity, with which FAO has entered into a formal agreement of collaboration, forest biological diversity is included in discussions on "Terrestrial Ecosystems". A number of regional and species specific networks have been established over the past years, such as the European Forest Genetic Resources Network, EUFORGEN, co-ordinated by IPGRI[1] in collaboration with FAO; and the Dry-Zone Acacia and Prosopis Network, the International Neem Network and the incipient Mahogany Network, co-ordinated by FAO, in collaboration with a range of national and international partners[2].

The Fourth International Technical Conference on Plant Genetic Resources, held in Leipzig, Germany in June 1996, adopted a Global Plan of Action for the Conservation and Sustainable Utilization of Plant Genetic Resources for Food and Agriculture which stated that forest genetic resources would not be included in the plan, but that the need for action in this field should be reviewed in the light of the outcome of the work of the Inter-Governmental Panel on Forests (IPF)[3]. The IPF, which held its fourth and final session in February 1997, did not address the issue of forest genetic resources.

In view of the urgency of the matter, FAO raised the issue of forest genetic resources for substantial discussion at the Thirteenth Session of the Committee of Forestry (COFO) held in Rome in March 1997. In line with the recommendations of COFO, subsequently supported and further elaborated upon by the Tenth Session of the FAO Panel of Experts on Forest Gene Resources, FAO has initiated action to help plan and co-ordinate a series of regional and sub-regional forest genetic resources workshops, to be carried out in close consultation and collaboration with national and international partners.

The overall goal of the planned regional and sub-regional workshops on the conservation, management, sustainable utilization and enhancement of forest genetic resources, is the development of dynamic, country-driven and action-oriented regional and sub-regional plans, to be used in countries concerned to help ensure that forest genetic resources are conserved and sustainably utilized as a basis for local and national development, including food security, poverty alleviation, environmental conservation, economic and social advancement, and the maintenance of cultural and spiritual values. These action plans should, without fail, be compatible with national and regional strategies in other fields, contributing together with these to dynamic, multi-disciplinary plans aimed at overall sustainable development.

National forest genetic conservation programs will constitute the building blocks of regional and sub-regional action plans. In this regard, it is acknowledged that national plans and programs will vary according to local biological, social and economic environments and according to national needs and priorities. The purpose of the planned workshops is to help streamline concerted action at regional level; the aim is not the development of one, single model for conservation, but the elaboration of a framework for co-ordinated action, valid at sub-regional and regional levels.

While national plans are at the bases of regional and sub-regional action plans these latter ones can, in turn, provide a point of reference for national activities in the exploration, collection, evaluation, conservation *in* and *ex situ* and improvement and breeding of forest genetic resources. Common agreement on principles and mechanisms for the determination of priorities for species and specific, conservation-related activities, and on optional strategies for action, will help justify such work and will help strengthen the impact of national activities also at regional level.

Co-ordination of action at regional level will, furthermore, help make best use of scarce resources by avoiding duplication and overlap of effort, and by facilitating the sharing of technologies, information, know-how and genetic materials, on mutually agreed terms.

The sub-regional and regional action plans on forest genetic resources which will be developed in the planned workshops and which will serve as dynamic tools underpinning action by countries concerned could later, if countries so wish, be placed within a larger context, contributing to a comprehensive, international framework. A coherent global framework for action on forest genetic resources could decisively help promote overall co-ordination of action and help further co-operation between and among geographical regions and, above all, between and among countries in ecological regions of the world in which environmental conditions and social and economic aims and aspirations are similar, and in which such collaboration could therefore bring tangible benefits to all concerned.

In line with priorities expressed by countries in international fora in which the issue has been discussed, IPGRI, ICRAF and FAO have joined forces and plan to help organize, in September 1998, a Workshop on the Conservation, Management, Sustainable Utilization and Enhancement of Forest Genetic Resources in Sub-Saharan Dry-Zone Africa. This country-driven workshop and its follow-up will be carried out in close collaboration with the Secretariat of CILSS, and with the support of other concerned international and bilateral organizations with an interest and know-how in the subject.

Experience and information from the Sub-Sahelian workshop will help facilitate planning of a second, similar workshop in Eastern and Southern Africa, in collaboration with the SADC Secretariat and, pending identification of necessary resources for this purpose, further workshop in countries and regions which have requested support in this regard (initially, tentatively, the Pacific, Central America).

Concluding remarks

Genetic erosion is today occurring at an increasing pace, mainly due to changes in land use leading to habitat loss and degradation, and to selection and breeding carried out without including in the breeding strategies necessary elements of genetic conservation. Large-scale, uncontrolled movement of germplasm and consequent genetic contamination and potential loss of local genepools aggravate this problem in the forestry field.

Active and vigorous measures are needed to reverse this trend. These must

1) List of Acronyms is given at the end of the paper.

2) Information on these and other FAO coordinated programs in the field of forest genetic resources can be found on the FAO Forest Genetic Resources Homepage: http://www.fao.org/waicent/faoinfo/forestry/fpgemres/homepage/content.htm
or from the author of this paper.

3) The IPF was established by the Economic and Social Council of the United Nations (ECOSOC) in June 1995, following a recommendation of the Third Session of the UN Commission on Sustainable Development in June the same year. The IPF held a total of four sessions. It has been recently succeeded by the Inter-Governmental Forum on Forests (IFF).

be based on improved technical and scientific understanding of ecosystem functions, and of the extent, distribution and dynamics of biological diversity and genetic resources directly and indirectly used by man. Strong and continuing policy level support is needed to carry out related activities. In this regard, there is an urgent need to better inform decision makers and the public at large of facts and available alternatives for action.

Neither natural ecosystems nor breeding programs are static. Genetic conservation must not be aimed at freezing a given state, which would imply an arbitrary fixation, or a haphazard snapshot in time, of a dynamically evolving, living system. Similarly, it should be recognized that since economic, social and environmental requirements continually shift, objectives and aims of breeding for utilitarian purposes will continuously change in time and space.

Efforts to conserve and enhance forest genetic resources for present-day and future use, will involve action related to the management of protected areas, the management of productive forests, and the management of breeding populations. This "tripod" of action offers the only lasting solution to the challenge of conservation. The key to success will thus lie in the development of programs harmonizing conservation and sustainable utilization of forest genetic resources within a mosaic of land use options; and including in such programs a strong element of active gene management.

As stressed by a number of countries at the Thirteenth Session of COFO and a number of other international fora, including the XI World Forestry Congress held in Turkey in October 1977, action to safeguard and sustainably utilize forest genetic resources is an urgent priority. Delays in the conservation of forest ecosystems, species and genetic resources of trees and shrubs will be costly, implying environmental, economic and social risks, needs for expensive and at times difficult remedial action, and foregone opportunities in management and sustainable resource utilization in support of overall national development

The regional and sub-regional, country-driven and action-oriented workshops on the conservation, management, sustained utilization and enhancement of forest genetic resources which FAO plans to help co-ordinate and organize in collaboration with relevant CGIAR Centres, IUFRO and other international players, is a first step towards concerted action in response to these urgent needs (Palmberg-Lerche 1997).

Manifestation of the above needs by countries concerned, and requests for support received in this regard, is a clear indication of a growing acknowledgement of the fact that conservation is not a limiting factor for development, but a precondition for lasting well-being.

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Acronyms

CGIAR	Consultative Group on International Agricultural Research (Washington D.C., USA)
CIFOR	Centre for International Forestry Research of the CGIAR (Jakarta, Indonesia)
FAO	Food and Agriculture Organization of the UN (Rome, Italy)
IPGRI	International Plant Genetic Resources Institute of the CGIAR (Rome, Italy)
ICRAF	International Centre for Research in Agroforestry of the CGIAR (Nairobi, Kenya)
IUFRO	International Union of Forestry Research Organizations (Vienna, Austria)
UNEP	United Nations Environment Programme (Nairobi, Kenya)

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Regional Collaboration on Forest Genetic Resources: Conserving a Common Heritage

Jozef Turok

Abstract

The biodiversity debate usually takes an ecosystem or a species conservation approach. However, preserving an ecosystem is sometimes ineffective in saving certain species it contains. Saving species may similarly not conserve their genetic resources, defined as the useful genes/alleles of actual or potential value. The high levels of natural genetic variation existing in forest trees result from adaptations to changing conditions of the environment. This variation is often threatened, for example when populations are decreasing or are exposed to air pollution. It is argued that the genetic diversity within individual species, and the processes that maintain it, are essential for the future evolution of forest ecosystems. The conservation and proper management of genetic resources can also contribute to meeting human needs for timber and other forest products and benefits.

International collaboration is needed in managing genetic resources. Forest trees are distributed over areas which are larger than countries. Similar tasks and common problems faced require that information and experience be exchanged. To ensure good conditions for future evolution, the genetic variation of tree species needs to be conserved in their entire distribution ranges. Although countries are not dependent on each other for the availability of genetic material, the exchange of germplasm may result in ecological benefits or better economic use.

Although the actual knowledge of genetic variation is still very scarce, an increasing attention has been paid to forest genetic resources at both scientific and political levels during recent years. International agreements were adopted which provide a necessary basis for developing joint, practically oriented activities. Criteria and indicators of the genetic variation in forests become important for characterizing sustainable forest management.

Networking is a tool which brings together partners from different backgrounds, facilitates exchange of information, helps to analyze common needs and priorities, stimulates the development and coordination of projects and activities. The main goal of networking must be to strengthen national programmes.

Examples from networks on forest genetic resources established in Europe, Africa and Asia are presented. They illustrate the development of long-term gene conservation strategies for individual species and for the ecosystems to which these species belong. The strategies, for example those focusing on Noble Hardwoods in Europe, try to integrate efforts undertaken at a national level and suggest realistic ways of implementation. The international networks also developed minimum common standards that were agreed by all countries. The technical guidelines help forest officers to manage stands with consideration given to genetic concerns. Information platforms linking national databases have been established. Research projects specifically targeting on genetic variation were initiated, including a field experiment for cork oak provenances in the Mediterranean. Public awareness about forest genetic resources has been promoted by various means.

Considering the importance of genetic resources – a common heritage – and the growing concern for their conservation and sustainable use worldwide, a practical collaborative response is urgent.

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The Global 200: A Representation Approach to Conserving the Earth's Most Biologically Valuable Ecoregions*

David M. Olson and Eric Dinerstein, presented by James Martin-Jones

The current extinction crisis requires dramatic action to save the variety of life on Earth. Because funding for conservation action is limited, governments, donors, and conservation groups must be strategic and earmark the greatest amount of resources for protecting the areas richest in biodiversity. Most conservation biologists recognize that, although we cannot save everything, we should at least ensure that all ecosystem and habitat types are represented within regional conservation strategies.

The "representation" approach has been applied at a number of geographical scales, from single watersheds to entire continents. Here we introduce the Global 200, the first attempt to achieve representation of habitat types on a global scale. Our primary objective is to promote the conservation of terrestrial, freshwater, and marine ecosystems harboring globally important biodiversity and ecological processes. The Global 200 addresses this goal by identifying the world's most outstanding examples within each major habitat type (e.g., tropical dry forests, large lakes, coral reefs).

The representation approach, accepted by a growing number of conservationists, is soundly based in conservation biology. It integrates the goal of maintaining species diversity – the traditional focus of biodiversity conservation – with another level of conservation action, the preservation of distinct ecosystems and ecological processes. Although more than half of all species are likely to occur in the world's tropical moist forests, the other 50 % of all species are found elsewhere. To conserve that half, a full representation of the world's diverse ecosystems must be the goal.

Tundra, tropical lakes, mangroves, and temperate broadleaf forests are all unique expressions of biodiversity. Although they may not support the rich communities seen in tropical rainforests or coral reefs, they contain species assemblages adapted to distinct environmental conditions and reflect different evolutionary histories. To lose examples of these assemblages, and the ecological processes and evolutionary phenomena they contain, would represent an enormous loss of biodiversity.

Although conservation action typically takes place at the country level, patterns of biodiversity and ecological processes (e.g., migration) do not conform to political boundaries. Thus, we used the ecoregion as the unit of analysis in creating the Global 200. We define an ecoregion as a relatively large unit of land or water containing a characteristic set of natural communities that share a large majority of their species, dynamics, and environmental conditions. Ecoregions function effectively as conservation units at regional scales because they encompass similar biological communities and because their boundaries roughly coincide with the area over which key ecological processes most strongly interact.

To maintain representation of biodiversity at a global scale, we first stratified ecoregions by realm (terrestrial, freshwater, and marine) and then further divided realms by major habitat types (MHTs), which describe different areas of the world that share similar environmental conditions, habitat structure, and patterns of biological complexity (e.g., beta diversity) and that contain communities with similar guild structures and species adaptions. The MHT classifications are roughly equivalent to biomes. We identified 12 MHTs in the terrestrial realm, 3 in the freshwater realm, and 4 in the marine realm (Table 1). Each MHT was further subdivided by biogeographic realm (e.g., Nearctic, Indian Ocean) in order to represent unique faunas and floras of different continents or ocean basins. Finally, we identified ecoregions within each biogeographic realm that represent the most distinctive examples of biodiversity for a given MHT (Table 1).

The boundaries of terrestrial ecoregions for the Global 200 are taken from intensive regional analyses of biodiversity patterns across five continents undertaken by the World Wildlife Fund (WWF) Conservation Science Program and others. These assessments were conducted in collaboration with hundreds of regional experts and included extensive literature reviews.

Freshwater ecoregions were based on several regional analyses and consultations with regional experts. Marine ecoregions delineated by the Global 200 are nested within a large marine ecosystem framework, derived from several global and regional analyses.

Within each MHT and biogeographic realm, ecoregions are classified by their biological distinctiveness at one of four levels: globally outstanding, regionally outstanding (e.g., Nearctic), bioregionally outstanding (e.g., Caribbean), or locally important. Biological distinctiveness, as a discriminator, evaluates the relative importance and rarity of different units of biodiversity. It can be used to estimate the urgency of action based on the opportunities for conserving distinct units around the world. On a global scale, and within each biogeographic realm, we chose the set of ecoregions with the greatest biological distinctiveness based on the following parameters: species richness, endemism, taxonomic uniqueness (e.g., unique genera or families, relict taxa or communities, primitive lineages), unusual ecological or evolutionary phenomena (e.g., intact large vertebrate faunas or migrations, extraordinary adaptive radiations), and global rarity of MHT. We compared only the biodiversity value of ecoregions sharing the same MHT because the relative magnitude of parameters such as richness and endemism varies widely among MHTs. For ecoregions of equal biological distinctiveness in the same MHT and biogeographic realm, we selected the ecoregions that had more intact habitats and biotas based on assessments of their conservation status.

We identified 233 ecoregions whose biodiversity and representation values are outstanding on a global scale (Table 1, Figs 1 & 2). They represent the terrestrial, freshwater, and marine realms, and the 19 MHTs nested within these realms. Among the 3 realms, 136 (58 %) are ter-

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restrial, 36 (16 %) are freshwater ecoregions, and 61 (26 %) are marine. Terrestrial ecoregions outnumber those of the other realms largely because there is more localized endemism in terrestrial than in marine biotas. Gaps in biogeographic information for freshwater and marine biodiversity also account for some of the variation.

The results of the analysis target a number of well-known biodiversity priorities. For example, The Western Arc forests of the Amazon Basin, The Atlantic Forest ecoregion of Brazil, the Choco-Daríen ecoregion of north-western South America, Peninsular Malaysia, and the northern Borneo forest ecoregions are among the richest tropical moist forests on Earth. Similarly, the forests of Madagascar and New Caledonia were also recognized as highly distinctive at global scales, partly because of the number of endemic higher taxa (e.g., families and genera). Other results highlight less well-known areas. For example, Mexico harbors both the world's richest and most complex subtropical conifer forests and the most diverse dry forests in the world; the moist forests of Sulawesi display some of the highest levels of mammal endemism in the Indo-Pacific region, and the Congolian Coastal forests are Africa's richest moist forests and exhibit pronounced narrow endemism. Results for marine and freshwater ecoregions also confirmed documented patterns and highlighted many less recognized priorities, such as the extraordinary temperate freshwater biotas of the streams of south-eastern North America and the Yangtze River headwaters in central China, and the unusually high levels of endemism of temperate marine invertebrates in the South Australian coastal ecoregion.

Ecoregions vary greatly not only in their biological distinctiveness but also in their conservation status. Conservation status represents an estimate of the current and future ability of an ecoregion to maintain viable species populations, to sustain ecological processes, and to be responsive to short-and long-term environmental changes. We conducted conservation status assessments for the terrestrial Global 200 ecoregions based on landscape-level features, such as total habitat loss and the degree of fragmentation, and estimates of future threats and degree of protection. We drew heavily from regional conservation assessments to estimate conservation status. Terrestrial ecoregions were classified into one of three broad conservation status categories: critical/endangered, vulnerable, or relatively stable/relatively intact.

Among terrestrial Global 200 ecoregions, 47% are considered critical or endangered, 29% vulnerable, and 24% relatively stable or intact (Table 1). Terrestrial ecoregion boundaries approximate original extent, showing extensive habitat loss, fragmentation, and degradation within. In ecoregions that have been dramatically altered, characteristic species and communities survive in only a few remaining small blocks of habitat. Among the terrestrial MHTs, ecoregions falling within the tropical dry forests, temperate grasslands, Mediterranean shrublands, and temperate broadleaf forests are the most threatened. Island ecoregions are projected to experience a wave of extinctions over the next two decades because of the fragility of island ecosystems, the sensitivity and endemicity of island species, and the severe threats native island biotas face worldwide from introduced species and habitat loss.

We have not completed an assessment of the status of freshwater and marine ecoregions, but preliminary analyses show that freshwater ecosystems, particularly seasonally flooded forests, cataracts, and freshwater communities in xeric areas, are endangered worldwide. Moreover, most temperate freshwater biotas are threatened by invasion of exotics, pollution, dams, and habitat degradation. In marine MHTs, upwelling areas are heavily overfished, enclosed seas are degraded, and coral reefs and mangroves are severely affected by habitat destruction, degradation, and overfishing around the world.

The Global 200 is an effective tool for (1) targeting distinctive biogeographic units of biodiversity and (2) promoting ecosystem-level representation at global scales. The Global 200 broadens the goals of conservation from a primary focus on preserving species diversity to an encompassing view of habitat diversity, ecological processes, evolutionary phenomena, and adaptions of species to different environmental conditions around the world. In some cases, it also distinguishes representative ecoregions that are more intact than others, highlighting the best opportunities for long-term conservation.

Like any effort to set priorities, the Global 200 cannot address all aspects of biodiversity conservation. The Global 200 does not explicitly target hemisperic-scale ecological phenomena such as migrations of marine mammals, sea turtles, birds, or fish; intratropical migrations of bats, birds, and insects; widespread and dynamic pelagic ecosystems; hydrothermal vent communities; abyssal ecosystems; cave and groundwater ecosystems; or global ecosystem dynamics such as carbon sequestration. More-detailed, fine-scale analyses are essential to identify important targets within ecoregions.

One tactical concern about the Global 200 is that it is too ambitious; that is, by focusing on 233 ecoregions rather than on a handful of conservation units we run the risk of placing less emphasis on the most diverse and distinct ecoregions. We argue that the broad geographic reach of the Global 200 makes almost every nation on Earth a stake-holder in a global conservation strategy. From the global scale to regional and national conservation strategies, the Global 200 lends weight to shared priorities and provides a global perspective for lobbying efforts by local conservation groups. The Global 200 also can help major development agencies to better recognize and mitigate the effects of projects that result in land-use change or to forego development activities in particularly sensitive ecoregions. For these reasons we see the Global 200 as a map guiding conservation investments so that a comprehensive plan eventually can be achieved by the global conservation community and the nations of the world.

The widespread destruction of the Earth's biodiversity occurring today must be matched by a response an order of magnitude greater than currently exists. The Global 200 provides a necessarily ambitious template for a global conservation strategy.

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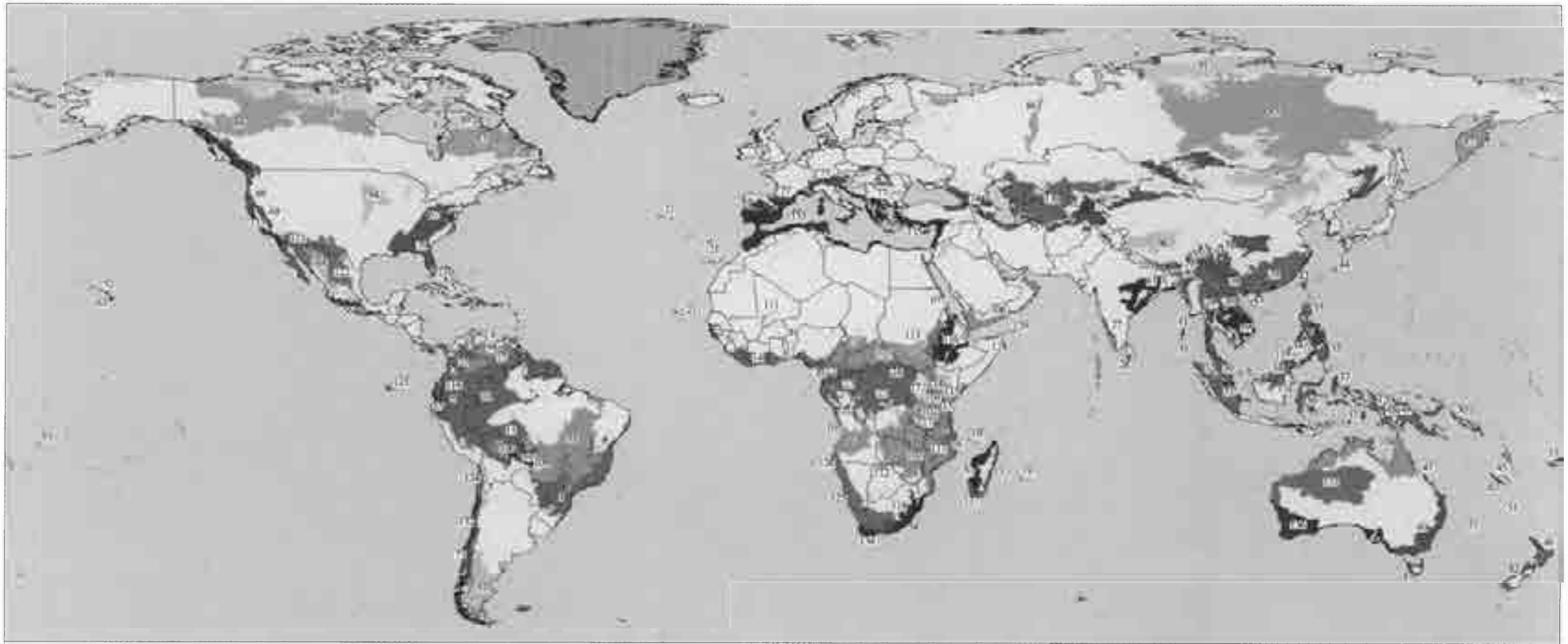

- Tropical & Subtropical Moist Broadleaf Forests
- Tropical & Subtropical Dry & Monsoon Broadleaf Forests
- Tropical & Subtropical Conifer Forests
- Temperate Conifer & Broadleaf Forests
- Boreal Forests & Taiga
- Arctic Tundra
- Temperate Grasslands, Savannas & Shrublands
- Tropical & Subtropical Grasslands, Savannas, & Shrublands
- Flooded Grasslands & Savannas
- Tropical Montane Grasslands & Savannas
- Deserts & Xeric Shrublands
- Mediterranean Shrublands & Woodlands
- Mangroves

Fig. 1: Terrestrial realms of The Global 200 ecoregions.

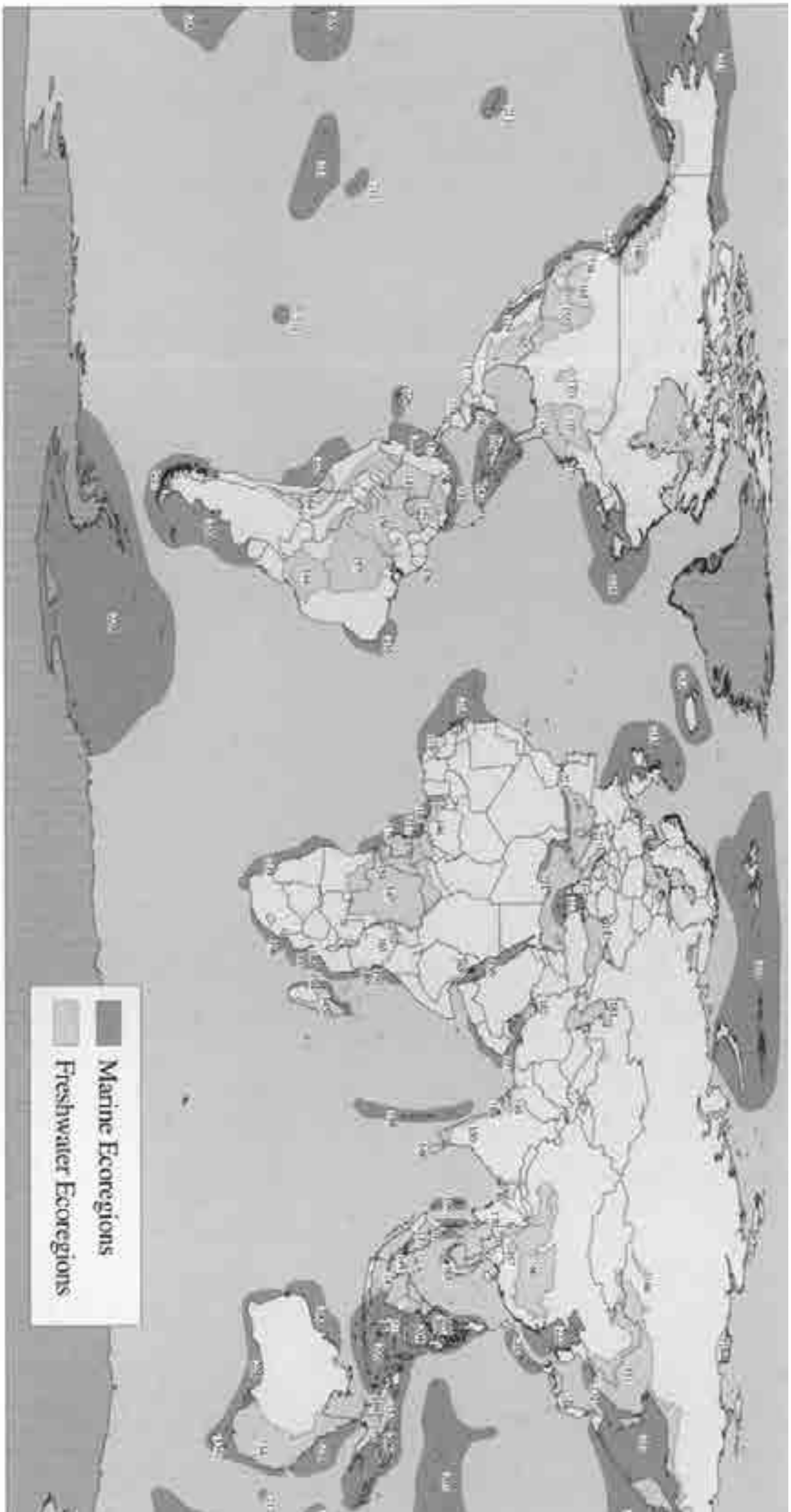

Fig. 2: Marine and freshwater realms of The Global 200 ecoregions.

Table 1. The Global 200 ecoregions organized by terrestrial, freshwater, or marine realm; major habitat type; and biogeographic realm.[a]

Realm and ecoregion	Biogeographic realm[b]	Conservation status[c]
Terrestrial ecoregions		
Tropical and subtropical moist broadleaf forests	**Neotropical**	
	1. Atlantic forests – Brazil, Paraguay, Argentina	CE
	2. Northern Andean montane forests – Ecuador, Colombia, Venezuela, Peru	CE
	3. Andean Yungas – Ecuador, Colombia, Venezuela, Bolivia, Peru	V
	4. Coastal Venezuela montane forests – Venezuela	CE
	5. Greater Antillean moist forests – Haiti, Cuba, Dominican Republic, Jamaica, Puerto Rico	CE
	6. Chocó-Daríen moist forests – Colombia, Panama, Ecuador	V
	7. Varzea flooded forests – Peru, Brazil, Venezuela	CE
	8. Talamancan and Isthmian Pacific forests – Costa Rica, Panama	V
	9. Napo moist forests – Ecuador, Colombia, Peru	RS
	10. Rio Negro-Juru· moist forests – Colombia, Brazil, Peru, Venezuela	RS
	11. Southwestern Amazonian moist forests – Peru, Brazil, Bolivia	RS
	12. Guayanan forests – Venezuela, Brazil, Guyana, Suriname, French Guiana	RS
	Afrotropical	
	13. Madagascar moist forests – Madagascar	CE
	14. Guinean moist forests – Ghana, Guinea, Ivory Coast, Liberia, Sierra Leone, Togo	CE
	15. Eastern Arc montane forests – Tanzania, Kenya	CE
	16. East African coastal forests – Tanzania, Kenya, Mozambique, Somalia	CE
	17. Albertine Rift highland forests – D.R. Congo, Rwanda, Uganda, Burundi, Tanzania	CE
	18. East African highland forests – Kenya, Tanzania, Uganda	CE
	19. Seychelles and Madagascarene Islands forests (e.g., Mauritius, Seychelles, Comores, Reunion, Rodrigues)	CE
	20. Gulf of Guinea Islands forests – São Tomé and Príncipe, Equatorial Guinea	CE
	21. Macaronesian forests (Azores, Madeira, Canary, Cape Verde Islands)	CE
	22. Congolian coastal forests – Cameroon, Gabon, R. Congo, Nigeria, Equatorial Guinea, Benin	CE
	23. Western Congo Basin forests – Central African Republic, Cameroon, R. Congo, Gabon, D.R. Congo, Equatorial Guinea	RS
	24. Northeastern Congo Basin forests – D.R. Congo, Central African Republic, Sudan, Uganda	RS
	25. Southern Congo Basin forests – D.R. Congo, R. Congo, Angola	RS
	Indo-Malayan	
	26. Annamite Range moist forests – Laos, Vietnam, Thailand	V
	27. Western Ghats moist forests – India	CE
	28. Sri Lankan moist forests – Sri Lanka	CE
	29. Kayah Karen/Tenasserim moist forests – Thailand, Myanmar, Malaysia	RS
	30. Peninsular Malaysian lowland and montane forests – Malaysia, Thailand	CE
	31. Sumatran-Nicobar Islands lowland forests – Indonesia, India	CE
	32. Sumatran montane forests – Indonesia	V
	33. Central Borneo montane forests – Indonesia, Malaysia, Brunei	RS
	34. Northern Borneo-Palawan moist forests – Malaysia, Indonesia, Philippines, Brunei	CE
	35. Philippines moist forests – Philippines	CE
	36. Sulawesi moist forests – Indonesia	RS
	37. Moluccas moist forests - Indonesia	RS
	38. Northern Indochina subtropical moist forests – Myanmar, Thailand, Laos, Vietnam, China	V
	39. Southeast China subtropical forests – China	CE
	40. Northeastern India and Myanmar hill forests – India, Myanmar, Bangladesh	RS
	41. Andaman Islands forests – India	V
	42. Taiwan montane forests – Taiwan	V
	43. Hainan Island forests – China	CE
	44. Nansei Shoto Archipelago forests – Japan	CE
	Australasian	
	45. New Caledonia moist forests – New Caledonia, France	CE
	46. New Zealand tropical forests – New Zealand	CE
	47. Queensland tropical forests – Australia	V
	48. New Guinea montane forests – Papua New Guinea, Indonesia	RS
	49. New Guinea lowland forests – Papua New Guinea, Indonesia	RS
	50. New Guinea outer islands/Solomons moist forests – Papua New Guinea, Solomon Islands	RS
	51. Lord Howe and Norfolk Island forests – Australia	CE
	Oceanian	
	52. Hawaii moist forests – United States	CE
	53. South Pacific Island forests – Fiji, Tonga, Samoa, I Sisito, American Samoa	CE
Tropical, subtropical dry, and monsoon broadleaf forests	**Neotropical**	
	54. Bolivian lowland dry forests – Bolivia, Brazil	CE
	55. Tumbesian and North Inter-Andean Valleys dry forests – Ecuador, Peru, Colombia	CE
	56. Southern Mexico dry forests – Mexico	CE

continued

Table 1. *(continued)*

Realm and ecoregion	Biogeographic realm[b]	Conservation status[c]	
	Afrotropical		
	57. Madagascar dry forests – Madagascar	CE	
	58. Maputaland-Pondoland dry forests – South Africa, Swaziland, Mozambique		CE
	Indo-Malayan		
	59. Eastern Indochina dry and monsoon forests – Vietnam, Laos, Thailand, Cambodia	V	
	60. Lesser Sundas dry and monsoon forests – Indonesia		V
	61. Eastern Indian monsoon forests – India		V
	Australasian		
	62. New Caledonia dry forests – New Caledonia, France		CE
	Oceanian		
	63. Hawaii dry forests – United States		CE
Tropical and subtropical conifer forests	**Neotropical**		
	64. Mexican pine-oak forests – Mexico, United States		CE
	65. Greater Antillean pine forests – Haiti, Cuba, Dominican Republic		CE
Temperate conifer and broadleaf forests	**Nearctic**		
	66. Klamath-Siskiyou coniferous forests – United States		CE
	67. Appalachian and mixed mesophytic forests – United States	CE	
	68. Pacific temperate forests – United States, Canada		CE
	69. Sierra Nevada conifer forests – United States		CE
	70. Southeastern conifer and broadleaf forests – United States	CE	
	Neotropical		
	71. Valdivian temperate rainforests – Chile, Argentina		
	Palearctic		
	72. Russian Far East temperate forests – Russia, China		V
	73. Altai-Sagan montane forests – Russia, Kazakstan, Mongolia, China	RS	
	74. Caucasus and Northeast Anatolia temperate forests – Georgia, Azerbaijan, Turkey, Russia, Iran, Armenia		V
	75. Middle Asian mountains temperate forests and steppe – Kyrgyzstan, Turkmenistan, Afghanistan, Uzbekistan, Kazakstan, Tajikistan, Pakistan, India, Mongolia, China, Iran		V
	76. Western Himalayan temperate forests – Pakistan, India, Nepal		CE
	77. Southern European montane forests – Bulgaria, Greece, Spain, Italy, France, Andorra, Switzerland, Austria, Slovenia, Poland, Slovakia, Hungary, Czech Republic, Germany, Romania, Ukraine, Yugoslavia		CE
	78. Central China temperate forests – China		CE
	79. Eastern Himalayan broadleaf and conifer forests – Bhutan, India, Nepal, Myanmar, China	V	
	Australasian		
	80. Eastern Australia temperate forests – Australia		V
	81. Tasmanian temperate rainforests – Australia		CE
	82. South Island temperate rainforests – New Zealand		RS
Boreal forests and taiga	**Nearctic**		
	83. Canadian boreal taiga – Canada		RS
	84. Northern Cordillera boreal forests – Canada		RS
	Palearctic		
	85. Central and Eastern Siberia boreal forests and taiga – Russia		RS
	86. Ural Mountains boreal forests and taiga – Russia	RS	
	87. Kamchatka boreal taiga and grasslands – Russia	RS	
Arctic tundra	**Nearctic and Palearctic**		
	88. Alaskan North Slope coastal tundra – United States, Canada		V
	89. Low Arctic tundra – Canada	RS	
	90. Chukotsky coastal tundra – Russia		RS
	91. Taimyr coastal tundra – Russia		RS
	92. Scandinavian apline tundra and taiga – Norway, Sweden, Finland		V
Temperate grasslands, savannas, and shrublands	**Neotropical**		
	93. Patagonian steppe and grasslands – Argentina, Chile		V
	Nearctic		
	94. Tallgrass prairies – United States		CE
	Palearctic		
	95. Eastern Himalayan alpine meadows – Bhutan, Nepal, India, Myanmar, China	RS	
	96. Tibetan Plateau steppe – India, China	RS	
	97. Daurian steppe – Mongolia, Russia, China		RS

continued

Table 1. *(continued)*

Realm and ecoregion	Biogeographic realm[b]	Conservation status[c]	
Tropical and subtropical grasslands, savannas, and shrublands	**Neotropical**		
	98. Llanos savannas – Venzuela, Colombia		V
	99. Cerrado woodlands and savannas – Brazil, Bolivia, Paraguay		V
	100. Beni savannas – Bolivia		V
	Afrotropical		
	101. Angolan Escarpment woodlands – Angola		CE
	102. Zambezian woodlands and savannas – Zambia, Tanzania, Malawi, Zimbabwe, Mozambique, Angola, Namibia, Botswana, D.R. Congo, Burundi		V
	103. Sudanian savannas – Central African Republic, Chad, Uganda, Ethiopia, D.R. Congo, Cameroon, Sudan, Nigeria, Eritrea		V
	104. East African acacia savannas – Kenya, Tanzania, Sudan, Ethiopia, Uganda		V
	Indo-Malayan		
	105. Terai-Duar savannas and grasslands – Nepal, India, Bhutan, Bangladesh		CE
	Palearctic		
	106. Arabian fog woodlands and grasslands – United Arab Emirates, Oman, Yemen, Saudi Arabia		V
	107. Red Sea fog woodlands – Egypt, Sudan, Djibouti, Eritrea	CE	
	Australasian		
	108. Northern Australia and Trans-Fly savannas – Australia, Papue New Guinea, Indonesia	RS	
Flooded grasslands and savannas	**Neotropical**		
	109. Pantanal flooded savannas – Bolivia, Brazil, Paraguay		V
	110. Everglades flooded grasslands – United States	CE	
	Afrotropical		
	111. Sahelian flooded savannas – Mali, Chad, Niger, Nigeria, Cameroon, Senegal, Mauritania	V	
	112. Zambezian flooded savannas – Botswana, Namibia, Angola, Zambia, Malawi, Mozambique		CE
	113. Sudd flooded grasslands – Sudan, Ethiopia		V
Tropical montane grasslands and savannas	**Neotropical**		
	114. North Andean paramo – Ecuador, Venezuela, Colombia, Peru		V
	Afrotropical		
	115. East African moorlands – Kenya, Tanzania, Uganda, D.R. Congo, Rwanda		RS
	116. Ethiopian Highlands – Ethiopia, Somalia, Eritrea, Sudan		CE
	117. Zambez. mont. savannas and woodlands – Zimbabwe, Mozambique, Malawi, Zambia, Tanzania		CE
	118. South African montane grasslands and shrublands – South Africa, Lesotho, Swaziland	CE	
	Indo-Malayan		
	119. Mt. Kinabalu montane and alpine scrub and forests – Malaysia		RS
	Australasian		
	120. Maoke Range alpine heathlands – Indonesia		RS
Deserts and xeric shrublands	**Neotropical**		
	121. Sonoran and Baja Deserts – Mexico, United States		V
	122. Chihuahuan and Tehuacán Deserts – Mexico, United States		V
	123. Galápagos Islands scrubs – Ecuador	V	
	124. Atacama Desert – Chile		CE
	Afrotropical		
	125. Namib and Karoo deserts and shrublands – South Africa, Namibia		CE
	126. Kaokoveld Desert – Namibia, Angola	V	
	127. Madagascar Spiny Desert – Madagascar		CE
	128. Horn of Africa deserts – Somalia		V
	129. Socotra Island Desert – Yemen		V
	Palearctic		
	130. Central Asian deserts – Turkmenistan, Kazakstan, Uzbekistan, Tajikistan		CE
	Australasian		
	131. Sandy Australian deserts and central ranges – Australia		RS
Mediterranean shrublands and woodlands	**Neotropical**		
	132. Chilean matorral – Chile		CE
	133. Californian chaparral and woodlands – United States, Mexico		CE

continued

Table 1. *(continued)*

Realm and ecoregion	**Biogeographic realm**[b]	**Conservation status**[c]
	Afrotropical	
	134. Fynbos – South Africa	CE
	Palearctic	
	135. Mediterranean shrublands and woodlands – Portugal, Spain, France, Italy, Monaco, Greece, Yugoslavia, Bosnia and Herzegovina, Croatia, Albania, Turkey, Libya, Lebanon, Israel, Morocco, Algeria, Tunesia, Malta, Cyprus, Macedonia, Bulgaria, Egypt, Syria, Jordan, Slovenia, Gibraltar	CE
	Australasian	
	136. Southwest Australian shrublands and woodlands – Australia	CE
Freshwater ecoregions		
Small rivers and streams	**Nearctic**	
	137. Mississippi piedmont rivers and streams – United States	
	138. Southeastern rivers and streams – United Sates	
	139. Pacific Northwest coastal rivers and streams – Unites States	
	140. Gulf of Alaska coastal rivers and streams – United States, Canada	
	Neotropical	
	141. Guayanan highlands freshwater ecosystems – Venezuela, Brazil, Guyana, Colombia	
	142. Greater Antillean streams – Cuba, Jamaica, Haiti, Dominican Republic	
	143. Upper Amazon and Orinoco Rivers and streams – Ecuador, Venezuela, Colombia, Peru, Brazil, Bolivia	
	144. Upper Paran River – Brazil, Paraguay	
	Afrotropical	
	145. Madagascar freshwater ecosystems – Madagascar	
	146. Gulf of Guinea rivers and crater lakes – Gabon, Equatorial Guinea, Cameroon, Nigeria, Benin, Togo, R.Congo, D.R. Congo, Central African Republic, Ghana	
	147. Congo Basin piedmont rivers and streams – D.R. Congo, R. Congo, Angola, Zambia, Central African Republic	
	Indo-Malayan	
	148. Sri Lanka rivers and streams – Sri Lanka	
	149. Sundaland rivers and swamps – Malaysia, Indonesia, Brunei	
	150. Western Ghats rivers and streams – India	
	Palearctic	
	151. Russian Far East rivers and wetlands – Russia, China, Mongolia	
	Australasian	
	152. New Guinea rivers and streams – Papua New Guinea, Indonesia	
	153. New Caledonia rivers and streams – New Caledonia, France	
	154. Eastern Australian rivers and streams – Australia	
Large rivers	**Nearctic**	
	155. Colorado River – United States, Mexico	
	Neotropical	
	156. Varzea and Igapo freshwater ecosystems – Brazil, Peru, Colombia, Venezuela	
	157. Brazilian Shield Amazonian rivers and streams – Brazil, Bolivia	
	Afrotropical	
	158. Congo River – D.R. Congo, R. Congo, Angola	
	Indo-Malayan	
	159. Mekong and Salween Rivers – Cambodia, Vietnam, Laos, Myanmar, Thailand, China	
	160. Yangtze River and lakes – China	
Lake and closed basin freshwater ecosystems	**Nearctic**	
	161. Great Basin lakes and springs – United States	
	Neotropical	
	162. Chihuahuan rivers and springs – Mexico, United States	
	163. Mexican Highland lakes – Mexico	
	164. High Andean lakes – Chile, Bolivia, Argentina, Peru	
	Afrotropical	
	165. Rift Valley lakes – D.R. Congo, Uganda, Ethiopia, Tanzania, Kenya, Rwanda, Malawi, Mozambique, Burundi, Zambia	
	Palearctic	
	166. Lake Baikal – Russia	
	167. Yunnan lakes and streams – China	
	168. Lake Biwa – Japan	
	Indo-Malayan	
	169. Palawan and Mindanoa streams and lakes (Lake Lanao) – Philippines	
	170. Lake Inle – Myanmar	
	171. Central Sulawesi lakes – Indonesia	
	Australasian	
	172. Lakes Kutubu and Sentani – Papua New Guinea, Indonesia	

continued

Table 1. *(continued)*

Realm and ecoregion	Biogeographic realm[b]	Conservation status[c]
Marine ecosystems		
Large deltas, mangroves, and estuaries	**Nearctic**	
	173. Chesapeake Bay and Delaware Bay – United States	
	Neotropical	
	174. Central American mangroves – Belize, Mexico, Honduras, Nicaragua, El Salvador, Panama, Guatémala, Costa Rica	
	175. Panama Bight mangroves – Ecuador, Panama, Colombia	
	176. Orinoco-Amazon mangroves and coastal swamps – Ecuador, Panama, Colombia	
	Afrotropical	
	178. Senegal and Gambia river mangroves and wetlands – Senegal, Gambia, Guinea, Guinea-Bissau	
	179. Guinean-Congolian coast mangroves – Nigeria, Cameroon, Benin, Togo, Ghana, R. Congo, Ivory Coast, Liberia, Equatorial Guinea, Gabon, São Tomé and Príncipe, D.R. Congo, Sierra Leone, Angola	
	180. East African mangroves – Kenya, Tanzania, Somalia, Mozambique	
	Palearctic	
	181. Volga River Delta – Russia, Kazakstan	
	182. Mesopotamian Delta and marshes – Iraq, Iran, Kuwait	
	183. Danube River Delta – Romania, Ukraine, Moldavia	
	184. Lena River Delta – Russia	
	Indo-Malayan	
	185. Mekong River Delta mangroves – Vietnam, Cambodia	
	186. Dundabans mangroves – India Bangladesh	
	187. Sundaland and Eastern Indonesian archipelago mangroves – Indonesia	
	188. Indus River Delta and Rann of Kutch – Pakistan, India	
	Australasian	
	189. New Guinea mangroves – Papua New Guinea, Indonesia	
Coral Reef and associated marine ecosystems	**Western Atlantic**	
	190. Mesoamerican Reef – Belize, Guatemala, Honduras, Mexico	
	191. Southern Caribbean Sea – Panama, Colombia, Venezuela, Trinidad and Tobago, Netherlands Antilles	
	192. Greater Antilles and Bahamian marine ecosystems – Jamaica, Cuba, Haiti, Dominican Republic, Cayman Islands, Bahamas, United States, Turks and Caicos	
	Western Indian Ocean	
	193. East African marine ecosystems – Kenya, Tanzania, Mozambique, Somalia	
	194. Western Madagascar marine ecosystems – Madagascar	
	195. Red Sea marine ecosystems – Egypt, Israel, Saudi Arabia, Yemen, Eritrea, Djibouti, Sudan, Jordan	
	196. Agulhas Current marine ecosystems – Mozambique, South Africa	
	Northern Indian Ocean	
	197. Arabian Sea and Persian Gulf – Bahrain, Saudi Arabia, United Arab Emirates, Qatar, Oman, Iran, Pakistan, Yemen	
	198. Maldives, Lakshadweep, and Chagos marine ecosystems – Maldives, India, United Kingdom	
	199. Andaman and Nicobar Islands marine ecosystems – India	
	Eastern Indian Ocean	
	200. Western Australian marine ecosystems – Australia	
	Western Pacific Ocean	
	201. Isthmus of Kra marine ecosystems – Thailand, Malaysia	
	202. Nansei Shoto marine ecosystems – Japan	
	203. Sulu Sea – Philippines, Malaysia	
	204. Sulawesi Sea – Philippines, Indonesia, Malaysia	
	205. Banda-Flores Sea marine ecosystems – Indonesia	
	206. Northern New Guinea and Coral Sea marine ecosystems – Papua New Guinea, Indonesia, Solomon Islands	
	207. Micronesian marine ecosystems – Palau, Federated States of Micronesia	
	Eastern Pacific Ocean	
	208. Panama Bight marine ecosystems – Panama, Colombia, Ecuador	
	Southern Pacific Ocean	
	209. South Pacific marine ecosystems (Vanuatu, Fiji, New Caledonia, Samoa, Tonga, Tuvalu)	
	210. Great Barrier Reef – Australia	
	211. Eastern Polynesian Island marine ecosystems (particularly, Hawaii, Marquesas, Easter Island, Societies and Tuamotus)	
	212. Lord Howe Island and Norfolk Island marine ecosystems – Australia	
Coastal marine ecosystems	**Northern Atlantic Ocean**	
	213. Icelandic and Celtic marine ecosystems – Iceland, France, Ireland, United Kingdom, Denmark	
	214. Grand Banks – Canada, United States	
	215. Wadden Sea – Denmark, Germany, Belgium, The Netherlands	

continued

Table 1. *(continued)*

Realm and ecoregion	Biogeographic realm[b]	Conservation status[c]
	Western Atlantic Ocean	
	216. Northeast Brazilian coast marine ecosystems – Brazil	
	Eastern Atlantic Ocean	
	217. Gulf of Guinea marine ecosystems – Equatorial Guinea, Gabon, R. Congo, D.R. Congo, Angola, Cameroon, Nigeria, Benin, Togo, Sao Tomé and Principe	
	218. Western Guinea current marine ecosystems – Senegal, Gambia, Guinea-Bissau, Guinea, Sierra Leone, Cape Verde, Liberia, Mauritania	
	Southern Atlantic Ocean	
	219. Benguela Current – Namibia, South Africa, Angola	
	220. Southwest Atlantic coast marine ecosystems – Argentina, Uruguay, Brazil	
	Mediterranean Sea	
	221. Mediterranean Sea	
	Western Pacific Ocean	
	222. Yellow Sea and East China Sea – China, North Korea, South Korea, Japan	
	Eastern Pacific Ocean	
	223. Californian Current – United States, Mexico	
	224. Sea of Cortez – Mexico	
	225. Peru Current – Peru, Chile	
	226. Galápagos Islands marine ecosystems – Ecuador	
	227. Magellanic marine ecosystems – Chile, Argentina	
	Southern Pacific Ocean	
	228. South temperate Australian marine ecosystems – Australia	
Polar and subpolar marine ecosystems	**Antarctic Seas**	
	229. Antarctic Peninsula and Weddell Sea	
	230. New Zealand marine ecosystems – New Zealand	
	Arctic Ocean and Seas	
	231. Bering and Beaufort Seas – Russia, United States, Canada	
	232. Sea of Okhotsk and Northern Sea of Japan – Russia, Japan	
	233. Svalnbard/FranzJoseph Land marine ecosystems – Russia, Norway	

a We anticipate that there will be some minor modification of the Global 200 list in the future as new information becomes available and on-going analyses are finalized.

b Numbers of ecosystems correspond to Figs. 1 and 2.

c CE, critical or endangered; V, vulnerable; RS, relatively stable or intact.

The Impacts of Human Activities on Biodiversity in Natural Tropical Forests

Timothy Boyle

Abstract

The conservation of biodiversity is both an indicator of, and an essential component of sustainable forest management. Management systems that are more effective at conserving biodiversity are consequently more likely to be sustainable over the long term. Although the negative consequences of certain catastrophic human activities are well publicized, relatively little is known of the impacts resulting from the majority of human activities. Recent research at the Center for International Forestry Research has focused on different types of human activity and the assessment of impacts on components of biodiversity. Although the sheer variety of human activities and forest ecosystems means that generalizable results are hard to determine, certain patterns have become evident. For example, while logging is perhaps the most prominent activity in tropical forests, impacts on biodiversity are often not as severe as is sometimes assumed. More significant than the process of logging itself is the degree to which management guidelines are ignored or exceeded. These same problems apply to other types of activity, such as non-timber forest product harvesting, or grazing.

Introduction

There is widespread agreement that one of the most critical issues affecting forest biodiversity is the need to understand the impacts of human activities. This is reflected in guidance from the SBSTTA that was adopted by the Conference of the Parties to the Convention on Biological Diversity, and it has also been the subject of much discussion and speculation in scientific and popular literature. Concern over the impacts of human activities has focused most sharply on tropical forests, for two reasons. Firstly, tropical forests contain very high levels of biodiversity, so any deleterious impacts will be more serious in tropical regions. Secondly, human population growth is concentrated in developing nations of the tropics and in most tropical countries the population remains more closely rooted to a rural culture, resulting in closer and more varied interactions with forests than in the more developed temperate and boreal regions.

Since the topic is so widely recognized as being critically important, it might at first seem surprising that so little is known about the consequences of human activities for forest biodiversity. However, because there is such a variety of forest types in the tropics and so many different forms of human activities in forests, the combination of forest types and activities is almost infinite. Furthermore, the degree of impact will depend on a combination of factors, including the intensity of the activity, the length of time it has been undertaken in the locality, the other activities in the same area and, if the activity has ceased, the length of time that has elapsed since. Given these complexities it may be surmised that it should be virtually impossible to generalize about the impacts of human activities.

Nevertheless, in recent years the Center for International Forestry Research (CIFOR) has attempted to shed some light on this daunting problem. In order to overcome the complexities listed above, CIFOR adopted a research strategy that sought to simplify the problem while maintaining sufficient flexibility to yield generalizable conclusions. Central to this strategy were the following principles:

- A focus on typical activities in typical forest types for example, logging in lowland humid forests, and NTFP collection in both humid and seasonal forests.
- The use of gradients of intensities of exploitation, but:
- Centering these gradients on „standard" intensities of exploitation
- An inter-disciplinary approach, and
- A focus on processes that maintain diversity, rather than on assessing current status.

The third point, above, deserves further elaboration. Studying extremes of exploitation intensities is not very useful, as the results are self-evident. Where logging is aimed at a single or a few extremely valuable species in a policy environment lacking effective regulation – as, for example, with mahoganies in Central/South America, or with *Aquillaria malaccensis* in S.E. Asia, the consequences are obvious. These situations are not typical of logging in tropical forests, yet most of the anecdotal evidence for the negative impacts of logging relate to just such situations. Equally, the study of especially benign interventions is obviously unlikely to shed much light on real-life situations.

This paper reports on some of the results generated from CIFOR's research on impacts of human activities, in the context of previous and current studies by other institutions. Some of the research is still underway, or the data are still being analyzed. Most of the results are also being prepared for publication elsewhere, so some of the details that will appear in other publications are omitted here.

Impacts of Logging

Lee et al. (1996) studied the impact of selective logging on genetic diversity of a range of plant species, including both those which are harvested, and those which are not. They recorded losses in genetic diversity for all species, and those losses were greatest for harvested, rare species, and least for non-harvested, common species. Similarly, Tsai and Yuan (1995) recommended that in order to reduce negative impacts on genetic diversity, harvest levels should be adjusted in proportion to the census numbers of mature and sub-mature individuals for each commercial species.

Although the impacts of logging, based on the research done in Malaysia, were evident on all species sampled - not only on those which were harvested - the loss of genetic diversity, measured as expected heterozygosity, did not exceed 24%. Similarly, research in Thailand where there was harvesting of wood for construction and fuel, the only significant impact occurred at very high intensities of harvesting.

The Thai research also clearly demonstrated that the intensity of impact is dependent on the reproductive ecology of the species (Ghazoul et al. 1998). Those species which are pollinated by weakly flying insects show increased levels of inbreeding as the density of reproductive individuals decreases, while species affected by more strongly flying insects are less affected. Depending on the behavior of pollinators, and the degree of host-pollinator specificity, there may also be clear thresholds in the intensity of disturbance that affect the mating system and, consequently, genetic diversity.

Research on the impacts of logging has also been conducted in Central Kalimantan, Indonesia, at both the genetic and higher levels. Since dipterocarps did not flower locally in 1997, sample collection of *Shorea parvifolia* was made from leaves of seedlings growing underneath each of these mother trees. The locations of the seedlings were mapped within their presumed mother tree crown diameter. Only small seedlings were selected (height less than 30 cm) so as to ensure that they originated after logging. About 1400 seedlings have been analyzed using both isozyme and RAPD, making it possible to obtain estimates on outcrossing rates and genetic diversity parameters in the regeneration after logging (manuscript in preparation). These results indicate a significant increase in inbreeding following logging, though levels of genetic diversity were not significantly affected.

The impact of logging on quantitative characters was investigated by planting *S. parvifolia* seedlings collected from beneath each mother tree in a field trial. This progeny test was established at 2 locations, i.e., one nearby the origin of the seedlings and the other a little further away, with 20 replications in each site. Since it was only assumed that the seedlings were originated from mother trees grown above them, molecular maternal analyses are required to establish their true maternal parent. However, results of early survival and growth rates based on pooled samples from the two sites showed no difference between the logged and unlogged sites. This suggests that adaptive traits are not affected by logging.

The need for accurate predictive information for forest management planning is vital. Detailed biodiversity surveying over more than a fraction of a forest management unit is impractical. The ability to predict species occurrence and habitat type from simple environmental information that can be obtained from GIS and remote sensing would therefore be a valuable management tool. In addition such prediction would assist in survey design for further biodiversity studies. Elevation is known to be an important factor in determining species composition, topography may also have significant influence on the ecological resources and resultant biodiversity of an area. There is a need to include these parameters in biodiversity research to increase the relevance and applicability of results. CIFOR is conducting research in Central Kalimantan to assess the impact of logging operations on biodiversity in lowland dipterocarp forest and to identify the relationship between topographic variation and biodiversity.

This study investigated the effect of topographic variation and logging on several species of wildlife (small mammals, birds and primates) and the components of their habitat as represented by vegetation structure. These variables had been chosen as indicators of biodiversity to enable rapid assessment and to include a range of interrelated elements. Topographic variation was used to predict various environmental parameters and these were sampled in compartments with different logging histories.

Logging was the most important factor in determining vegetation structure in the study area. The aspects of vegetation structure affected may be grouped as follows: canopy / understorey structure (height and furcation index of trees, frequency of poles and saplings); abundance of lianas, volume and state of dead wood and leaf size classes. In general the landscape factors predicted by the environmental model had little effect on vegetation structure in the analysis. This does not necessarily imply that no relationship exists but that the landscape as predicted by the environmental model does not have a great effect, and that any effect was overwhelmed by logging effects.

Vegetation structure variables were correlated with various indices of species diversity and the species richness within different bird guilds. Height was the single most important variable in determining bird species diversity. Crown depth added little information, but dbh, furcation index and crown radius were also important factors. Litter depth and the frequency of bryophytes, epiphytes and non-woody lianas were also important for small mammals. The various decay states classes of coarse woody debris were all related to some species variables. These results suggest that logging operations designed to minimize changes in these key vegetation structure variables may reduce the impacts on diversity of various groups of animals.

Impacts of NTFP Collection

The impacts of non-timber forest product (NTFP) collection are often considered to be more benign than logging impacts (e.g. Panayatou and Ashton 1992), though Hall and Bawa (1993) concluded that there are few, if any, examples of sustainable NTFP collection systems. In a series of comprehensive studies on NTFP collection in the Biligiri Rangan Hills of south India, Hegde et al. (1996) demonstrated a negative correlation between the amount of time spent collecting NTFP's and the availability of salaried labor, while Murali et al. (1996) found a significant impact on recruitment of the harvested species, especially where harvest levels were highest. The negative relationship between time spent collecting NTFP's and availability of salaried labor is a consequence of the seasonality and unreliability of NTFP collection, where crops in some years may be very low, and also the low value of the crop at the point of collection. Uma Shaanker et al. (1996) and Uma Shaanker and Ganeshaiah (1997) concluded that non-sustainable harvest levels were inevitable given these low value-added benefits accruing to the collectors. There are also numerous other examples of overexploitation of NTFP's (e.g. Browder 1992, Nepstad et al. 1992). While most of these studies focus on the direct impacts on the harvested species, Boot and Gullison (1995) use the example of collection of brazil nut (*Bertholletia excelsa* Hunb. and Bonpl.) to point out that there may be both direct and indirect impacts on non-harvested species. High removal rates of brazil nuts may directly affect squirrels and agouti - the main consumers and seed distributors of the species, and this may have indirect consequences on other plant species if these frugivores substitute other species into their diet.

Preliminary results provide some interesting insights concerning the interaction between people and forest genetic resources. For example, the socio-economic research in India indicated that, in general, it is the poorer households which maintain a greater reliance on collection of NTFPs. Members of the wealthier households often have access to salaried income, which not only provides potential for greater income, but is also more dependable than seasonal NTFP collection, yields of which can vary widely from year to year. With the incorporation of many NTFPs into a market economy, there is a marked tendency for unsustainable harvesting, even when the harvesting is undertaken by indigenous communities which have traditionally relied on these products for their livelihoods. Consequently, regeneration of species such as *Phyllanthus emblica and Terminalia chebula* is almost completely absent in areas of highly intensive harvesting, and genetic diversity of these species is consequently eroded.

Impacts of other Activities

In addition to logging and collection of non-timber forest products, there are a wide variety of other human activities in tropical forests, including grazing and burning. The problems associated with studies on logging and collection of non-timber forest products, namely the need to take into account the combination of time and intensity, and the confounding effect of other activities, is usually much worse for activities such as grazing and burning, which are seldom dominant activities.

Consequently, research results are much harder to generate. From the limited amount of research conducted in Thailand and India, the impacts of grazing can be assumed to be similar to those for logging, in that those species directly targeted are much more adversely affected than species only indirectly affected. The nature and severity of the impact of fire will also depend on the degree to which the ecosystem is adapted to fire. Thus, the seasonal forests of Indochina are likely to be less affected than when unusual and catastrophic fires affected humid tropical forest in several parts of Borneo in 1997 and 1998. Here again, however, the actual impact of fire is not easy to assess, since fires tend to occur more often in forest that has already been logged, and the greater the intensity of logging, the more intense the fire is likely to be – due to the volume of slash and dead wood.

Conclusions

Determining the impact of human activities in biodiversity in tropical forests is very complex due to the interaction of numerous factors, including micro and meso-scale variation in topography and associated environmental variables, spatial and temporal variation in the intensity of the activities, and interaction effects among several activities taking place in the same area. Nevertheless, recent research conducted by CIFOR suggests that significant impacts on biodiversity resulting from logging and collection of non-timber forest products may be limited to those species directly targeted, and to high intensities of harvesting. These results suggest that it should be possible to integrate production systems and conservation of biodiversity, most likely through a combination of modification of existing harvesting practices, and zoning uses of the forest to avoid the most sensitive areas.

The use of environmental modeling to identify sensitive areas within a landscape may assist in conservation of biodiversity. Further insights into the impacts of human activities can be derived from process modeling. The adaptation of models designed to predict forest productivity to incorporate indices of biodiversity is currently a field of research at CIFOR.

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Workshop: Biodiversity as Value in Society

The Link between Value, Biodiversity Loss and Policy Design: A Case Study in the Bajo Atrato, Colombia

Aurelio Ramos

Abstract

The question this paper wants to answer is:

„Why does biodiversity loss occur in many places if it is socially better to give it a persistent use?"

A natural resource (biodiversity) will be conserved or used in a persistent way if its present net value is greater than the present net value of it been used or converted into a new form of capital. Nevertheless, many times natural resources are being diminished even though it is better to use them in a persistent way. This means that there are valuation distortions which do not allow society to choose its best available alternative at that moment. Section 1 of this paper will explain what constitutes the total economic value of biodiversity and why it is important for decision makers to perceive this total amount in order to choose the best option.

Neoclassical economic theory has described the mentioned phenomenon as a consequence of market failure. Immediate policies have to be designed in order to counteract this situation. New fields of economic theory are searching for alternative ways of explaining why societies are not able to choose the best option and why they come up with other forms of strategies. Section 2 of this paper will present and combine both approaches in a simple model. It will give insights on how to explain the case study, presented in Section 3, where decision makers (local communities, multinationals, NGO and government officers) in El Bajo Atrato (Colombia) chose an inefficient option when the best alternative was to use the „Cativales Forests" in a persistent way.

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Biodiversity – Source of Inspiration and Innovation

Werner Nader

Since its beginning mankind uses inspirations from biodiversity for inventions and technical solutions. Biodiversity offers three principal sources for innovation: DESIGNS, GENETIC INFORMATION and CHEMICALS. Bionics is a branch of engineering and analyses designs and mechanisms from living organisms like wings, sensors and flight. Architects have used structural elements like the principal of radial ribbing of Victoria regia for the construction of buildings like the crystal palace in London. Genetic engineering uses genes from wild living organisms for the development of new pharmaceuticals, transgenic crops and catalysts. Biotechnology promises to solve many problems of mankind. Its real potential is not yet untapped, but is already threatened by the current destruction of the genetic pool offered by biodiversity. The chemical diversity of natural compounds is needed for the development of drugs, pesticides, plastics, oils and cosmetics. The problems of mankind are increasing exponentially and with it the necessity for solutions. Conservation of biodiversity becomes a matter of human survival and inventors have to take responsibilities to maintain the source for their inspirations.

Biodiversity – Basis of Life and Development

Biodiversity refers to the variety and variability of living material and ecological complexes in a given area and comprises species, genetic and ecosystem diversity. Biodiversity is not only the basis of life on earth, but also provides the goods and services essential to support every type of human endeavor. Accordingly, biodiversity enables societies to adapt to different needs and situations (US National Research Council, 1992). Thus extinction of species and reduction of genetic and ecosystem diversity destroys the basis of future human development.

Extinction of biological diversity by man will not necessarily destroy the basis of life and evolution on earth. On the contrary, it might work the other way around. Several times during the history of this planet biodiversity had been reduced by catastrophes. Each time living nature recovered and reached an even higher degree in development and diversity than before, because those species had been eliminated, which prevented further evolution due to their dominance. The extinction of the once dominating dinosaurs opened the path for the development of mammals. Thus the current endeavor of man to extinguish himself seems consequent.

Biodiversity is more than a treasure in the world's forests: it is the key for mankind to adapt to the needs of the future and a necessity for future survival.

Biodiversity – Source of Inspiration and Innovation

Creativity needs diversity. This is true in nature and in all aspects related to human life including economy, politics and culture. To be creative man needs inspirations and these come from traditions, culture, history, science, technology and the living and lifeless nature. The more diverse these resources are, the more creative man can be.

Living nature offers three sources of inspiration: DESIGNS, GENETIC INFORMATION and CHEMICALS.

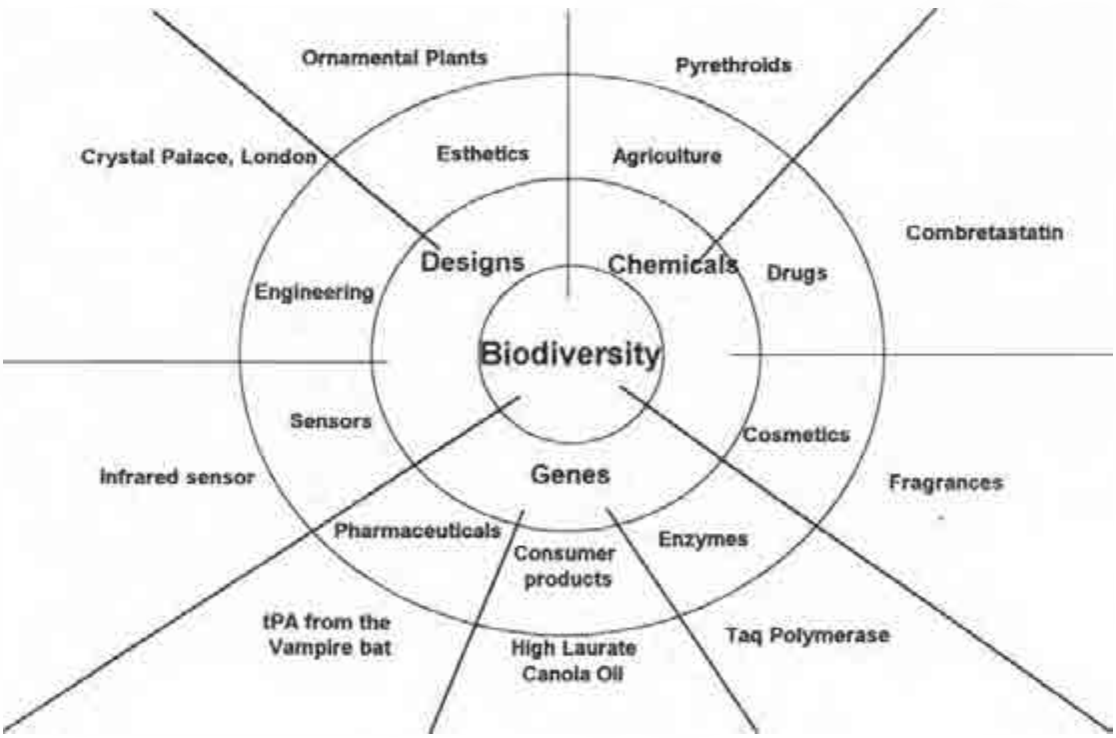

Fig. 1: Biodiversity – Source for Inspirations and Innovation

Designs: The Shark and the Airbus

First men probably used designs from nature to develop their primitive weapons after teeth and claws of wild animals. Engineers created the science of bionics to deduce principles from living nature for solution finding (Hill, 1997). In most of these technical concretizations we do not recognize the prototype from nature, take inspirations for granted and as an offspring of the human genius, and do not recognize the importance of living nature for our everyday life. Josef Baxton discovered the principal of radial ribbing in the structure of the giant sea anemone *(Victoria regia)*, and created the cupola of the crystal palace in London (Fig. 2). The nose of the dolphin was the prototype for the torus bow of ships and the skin of the shark for a kerosene-saving surface of an Airbus prototype (Nachtigall, 1992, Fig. 3). Numerous other inventions were made through inspirations from nature and numerous others are to be made. Successful inventorship through inspirations from biodiversity requires careful observation and analysis of natural phenomena. Otto Lillienthal studied over years the flight of birds, analyzed their wing structure and the principle of air lift (Lilienthal, 1889), before he started for man's first successful gliding flight in the year 1891. The process of invention and inspiration comprises the definition of the problem (humans cannot fly), the observation of a prototype in nature, which has solved the problem (the stork), the abstraction of its function (flight), its analysis (wing structure and principle of the air lift), the synthesis (artificial wing structure) and finally the technical concretization, the glider airplane (Hill, 1997).

Insects – Masters in Design and Engineering

A huge potential in tropical biodiversity for the inspiration of the engineer is still untapped: the insect world in the tropics. Insects are the most diverse group of organisms in nature with over 5 million species. Only a minor fraction of insect species is known and characterized. They have reached this diversity by adaptation to countless ecological niches. Every adaptation requires a different design of claws, grabs, mandibles, wings, legs, sensors etc.. Insects are the masters in mechanical engineering, lightweight construction and sensor technology. They are perfect designers (Nader and Hill, in press).

Genetic Information:

Genes from plants and animals have been used by man for the breeding of cattle, pets and crops. Gene technology opens revolutionary new opportunities for man, if one can count also in the future on the gene potential in the biodiversity of our forests (Tamayo et al., 1997).

Billion dollar enzymes from the Yellowstone National Park

Man has used traditionally enzymes, biocatalysts, for the production of cheese (renin from the calf stomach), softening of leather (proteases from the beef pancreas), fermentation of tea and tobacco and many other applications. In modern industry enzymes are gaining increasing importance in chemical engineering, processing of animal feed, human food and textiles, for laundry detergents and for the diagnosis of diseases. Today enzymes can be produced at low costs and high yields by the fermentation of genetically engineered microorganisms.

Examples for some successful products are:

– Hydantoinases from soil and thermophilic bacteria are used for the cleavage of chemically synthesized hydantoines. D-amino acids are generated, which are building blocks for the production of half-synthetic antibiotics like ampicillin and amoxillin. Particularly useful are those from thermophilic bacteria with thermostable enzymes. Hydantoin is poorly soluble in water and solubility increases with higher temperatures. The Yellowstone National Park proved to be an exceptionally rich source for new thermostable hydantoinases (BASF AG, 1987).

– Approximately 7 % of all food for poultry and pigs is processed with phytases from micro-fungi like *Aspergillus niger.* This enables these monogastric animals to assimilate the phosphorous from plants, diminishes the amount of phosphorous in the manure and subsequently entering the environment (Wodzinski and Ullah, 1996).

– The enzyme Taq polymerase from the thermophilic bacterium *Thermus aquaticus* from the Yellowstone Park is the key ingredient of the Polymerase Chain Reaction (PCR, Mullis, 1987). This reaction revolutionized gene technology and clinical diagnosis. The company Hoffmann-La Roche bought the patent for PCR for over US $ 450 millions and the market potential for PCR based diagnosis is estimated to be far over $ 3,000 millions per year.

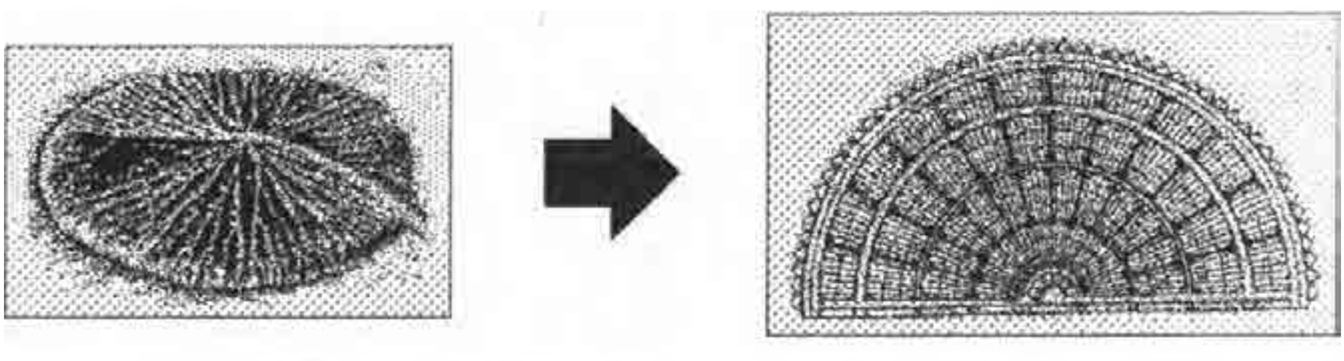

Fig. 2: From the giant sea anemone (Victoria regia) to the crystal palace of London (Hill, 1997). The Principle of Radial Ribbing enabled the construction of this building within 9 months.

With the Vampire Bat against the Heart Attack

Leeches *(Hirudo medicinalis)* have been used in traditional medicine to treat thrombosis. Their saliva contains the protease inhibitor hirudin, which inhibits blood coagulation. Hirudin was among the first proteins produced by recombinant DNA technology at large scale in bioreactors (Fortkamp, 1986). Calcitonin is the peptide hormone in the human body, which inhibits the release of calcium ions and phosphate from the bones. As a synthetic drug it has therapeutic uses against osteoporosis. The investigation of hormones from animals revealed that the salmon calcitonin is even more potent and has a longer half-life within the human body (MacIntyre et al., 1987). Since over a decade chemically synthesized salcatonin is on the market.

The potential to develop new pharmaceuticals from proteins and peptides from wild living animals is boundless. Similar to the invention of the first glider (Lilienthal, 1889) successful and innovative product development in genetic engineering is a biorational process rather than a random screening.

Researchers from the Schering AG recently developed a medication against heart attack from the saliva of the Latin American vampire bat *(Desmodus rotundus)* (Schleuning et al., 1992). The problem, the heart attack, is caused by blood coagulation. The prototype from nature, the vampire bat, prevents coagulation by a protease in his saliva, while sucking blood from his victims (observation and abstraction). This protease is related to the tissue plasminogen activator, which occurs in the human body (analysis). The gene from the bat can be transferred by genetic engineering into mammalian cell lines (synthesis) and the bat's tissue plasminogen activator produced by fermentation at large scale as a pharmaceutical (the technical concretization) against heart attack.

Frog Skin against Insect Pests

Although frogs live in a wet environment, their skin gets scarcely infected by bacteria and fungi. This observation inspired inventors to transfer this resistance to crops. In the skin of the frogs anti-bacterial and anti-fungal peptides were discovered, the magainins. The analysis of their amino acid sequence revealed the mechanism of their toxicity against bacteria and fungi. By reshuffling of the amino acid sequence new magainin variants were developed with higher potency against pathogens and undegradable by plant proteases. These can be genetically expressed in plants to confer resistance against fungal and bacterial pathogens (Everett, 1994).

Biotechnology will be a dominating technology in the new millennium. It can solve many problems of health, the environment, agriculture and nutrition and it might generate new problems. Whether solutions outnumber problems at the end, depends on how humans will apply the new technology. The potential of biotechnology will at the end depend on the genetic pool, which will be available for the genetic engineer. Careless destruction of biodiversity today reduces this pool and thus our opportunities to find solutions for the future.

Chemicals:

Since its beginning mankind is using chemicals from nature for survival. Natural polymers like cellulose, lignin and wool are used for clothing and construction, fats and oils of plant and animal origin for lubrication and heating and secondary metabolites from plants and microorganisms as medicines and pesticides (Tamayo et al., 1997).

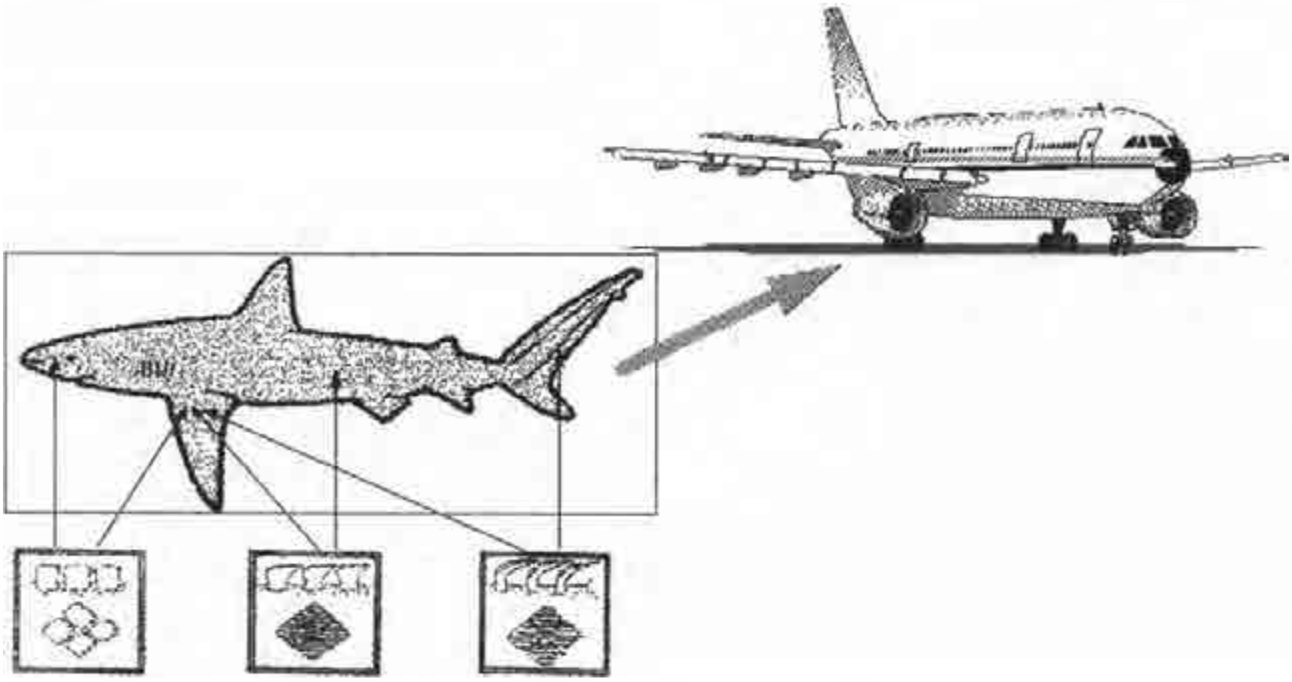

Fig. 3: From the shark to the Airbus (Nachtigall, 1992). Small spikes on the surface of the shark prevent the formation of micro-turbulences. The same principle applied to the surface of an aircraft saves up to 2 % of kerosene.

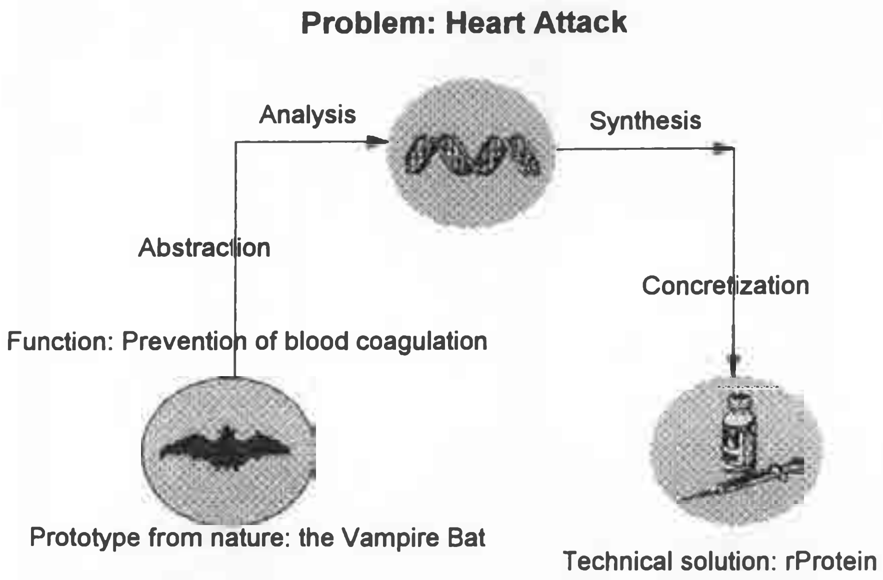

Fig. 4: Application of nature-orientated invention techniques on the development of a pharmaceutical against heart attack (modified after Hill, 1997)

Palm Kernel Oil from the Midwest

Examples for fats, waxes and oils in modern industry are:

■ Coconut and palm kernel oil for the production of soaps, chocolate and candies. In 1992, the US alone imported 600,000 tons of these oils, which contain up to 50% of trilaurin, a medium-chain dodecanoic unsaturated fatty acid.

■ Long-chain wax esters for a variety of industrial applications including pharmaceuticals, cosmetics, detergents, plastics and lubricants. Such products, especially long-chain wax esters, have previously been available from sperm whales. Hunted because of their valuable content these whales soon became endangered. Fortunately a plant, the desert shrub jojoba *(Simmondsia chinensis or californica)* was found to contain similar waxes.

Genetic engineering will revolutionize the production of these commodity products. In the Californian biodiversity, in the undomesticated bay *Umbellularia californica,* a gene has been recently detected, which transforms the common rape seed to a producer of high laurate canola oil, a perfect substitute for tropical palm kernel and coconut oil (Voelker et al., 1992). Seeds are already on the market under the trade name Laurical and 70,000 acres under cultivation (number from 1997) in the USA and Canada. The Plant Biotechnology Performance Report of Monsanto promises: Previously, industrial and consumer products companies relied on coconut or palm kernel oils from tropical regions. Laurical provides an alternative to coconut and palm kernel oils at a reduced cost. Laurate canola can be grown in multiple geographies globally, eliminating the concerns of seasonability and the pressure on tropical rain forests.

What is good news for the farmers of the North American plains, is bad news for the oil palm growers in the tropics. Laurical might cut off their export markets on short term and destroy their income.

The TOP TWENTY of Pharmaceutical Industry

Of the 20 best selling non-protein drugs in 1995 (PharmaPipelines, 1996), eight were either derived from, or developed as the result of leads generated by natural products. These include the angiotensin-converting enzyme inhibitors enalapril and captopril with antihypertensive activity and yearly sales of $ 2,310 millions and $ 1,540 millions in 1995, respectively. Enalapril had been derived from a peptide in the venom of the Brazilian fer-de-lance *Bothrops jararaca.* The old rule of Paracelsus (1493-1541) of a poison to become a medicine at low concentrations remains valid in the high-tech age.

Chinese Red Rice competes with a High-Tech Drug

Lovastin ($ 1,250 millions) and pravastin ($ 1,115 millions) lower the blood cholesterol level and are lactons, derived from natural compounds from micro-fungi. Source of lovastin is the soil fungus *Aspergillus terrestris.* Lovastin can be also found in the fermented Chinese red rice. Here a yeast produces lovastin and its extract is sold in the USA as the cholesterol lowering dietary supplement Cholestin. A chemical derivative of lovastin is simvastin with $ 1,960 millions of sales.

Augmentin ($ 1,300 millions) is a βlactamase inhibitor from the soil bacterium Streptomyces clavuligerus and is used to break resistance of bacterial pathogens against antibiotics of the cephalosporin- and penicillin-group. Cefaclor ($ 1,430 million) is a chemical derivative of the antibiotic cephalosporin from the fungus *Cephalosporium spec.*

Ciclosporin ($ 1,200 millions) is a powerful immunosupressant and a cyclic peptide from the filamentous fungus *Tolypocladium inflatum* Gams. It is also produced by other fungi including *Chaunopycnis alba.*

Not included in the 1995 Top Twenty is taxol, a powerful drug against solid tumors and derived from a plant, the North American yew *Taxus brevifolia.* This drug has probably achieved billion dollar sales by now. A billion dollar anti-cancer drug in spe is currently undergoing clinical trials: Combretastatin from *Combretum caffrum,* a plant species indigenous to South Africa and used in the traditional medicine of the Zulu (Pettit et al., 1995).

This Top Twenty of the best selling drugs reveals the importance of micro-fungi and bacteria of the *Actinomycete* family for the development of new drugs from natural compounds. Bioactive secondary metabolites from these micro-organisms had been nearly exclusively found by a random screening approach without using knowledge from traditional uses or observations of natural phenomena.

Even in plants the value of traditional knowledge is limited. Taxol was found by random screening. Topotecan is a new cancer-drug, derived from camptothecin from the bark of *Camptotheca acuminata.* This tree was extensively used in China as an ornamental and as a source of firewood with no medicinal applications being reported. Even the frequently cited vinca alkaloids from the Madagascan periwinkle, *Catharantus roseus,* have been found randomly. The traditional use for *Catharantus roseus* is against diabetes, whereas vinca alkaloids are most successful anti-cancer drugs.

A Deadly Snake saves Lives

A most remarkable example for a biorational approach in drug discovery is the development of enalapril. The venom of the Brazilian fer-de-lance *Bothrops jararaca* decreases the blood pressure of its victim (observation) and a peptide was isolated, which inhibits the angiotensin-converting enzyme (ACE) in the human body (abstraction). The enzyme-product, angiotensin II, is a potent vasoconstrictor. Investigation of the mode of action of the snake peptide (analysis) led to the development of a series of chemically synthesized ACE inhibitors including captopril, enalapril, perindopril, rampril, quinapril and lisinopril (synthesis and technical concretization) (Wyvratt, 1988).

The tropical forest offers for the inventor many more opportunities than snakes and vampire bats to observe biological prototypes for solutions in medicine. We have to maintain this potential for future investigators and developers.

Development of pharmaceuticals is risky and expensive. From 10,000 chemicals, which enter a screening program, only 1 has a chance to get through to the market (Fig. 5). The statistics on plant extracts looks similar. During 1960 to 1982, the National Cancer Institute of the USA tested over 114,000 extracts of some 35,000 plants species in their anti-cancer screens (Cragg et al., 1994). Today only two drugs from this gigantic screening effort are on the market, taxol from *Taxus brevifolia* and topotecan, a derivative of camptothecin from the bark of *Camptotheca acuminata* (see above). The costs for the development of a new pharmaceutical are by now probably above US $ 400 millions and the development process lasts over at least a decade.

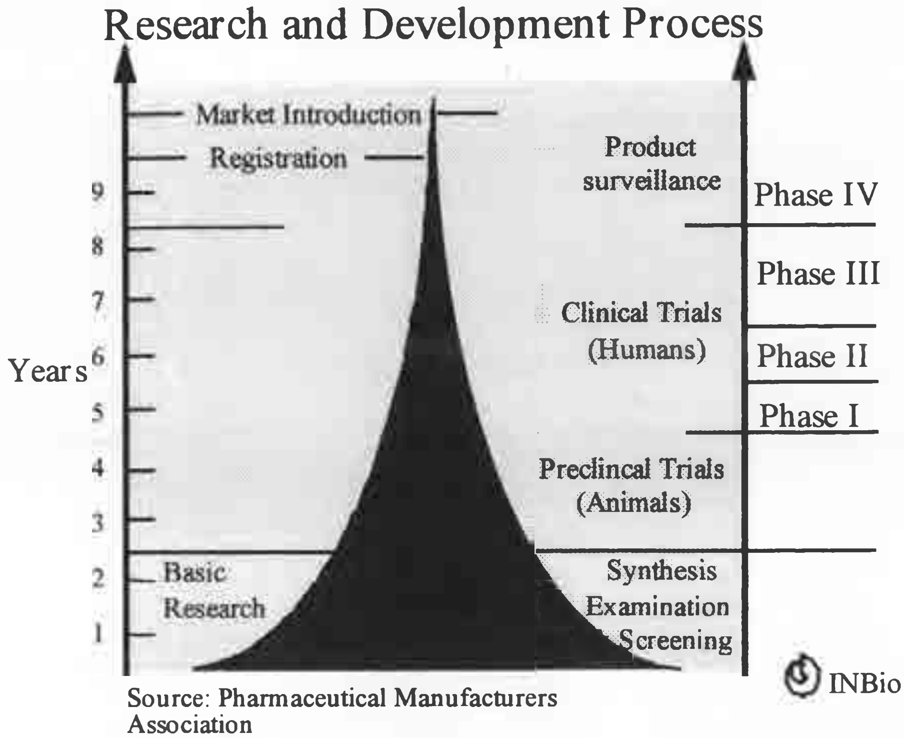

Fig. 5: Development of a new pharmaceutical

Plants against Insects

Traditionally secondary metabolites from plants have been used in agriculture as natural pesticides. Examples are nicotine from tobacco leafs, rotenone from roots of the genus *Derris,* quassin from the wood of *Quassia amara,* ryanodine from leaves, stems and roots of the tree *Ryania speciosa,* azadirachtins from the Asian neem tree and pyrethrins from the perennial *Chrysanthemum cinerariifolium,* originated from Dalmatia and Montenegro (Wink, 1993) .

After 1848 until the advent of DDT, rotenone became one of the most widely used insecticides worldwide. The USA imported substantial amounts of *Derris* roots from South East Asia, alone in 1947 6727 tons. In Europe *Derris* extracts were usually combined with pyrethrins.

Synthetic derivatives of pyrethrins, the so-called "pyrethroids", are up to a factor of 1000 more potent than the natural products and in addition stable against light. They became the most important and successful insecticides of this decade due to low toxicity in mammals and good biodegradibility. But more and more insect species are developing resistancies and the discovery of new insecticides is urgently needed. Again plants (of the genus *Calceolaria*) provided an important inspiration: a new class of naphtoquinone derivatives (British Technology Group, 1995). These new compounds had been found by random screening and not through traditional knowledge.

Bacteria against Plants

The herbicide Basta is chemically synthesized after phoshinothricin or glufosate, a secondary metabolite from soil bacteria of the genus *Streptomyces.* The enzyme Phosphinothricin-N-Acetyltransferase inactivates this compound and the gene has been cloned from a *Streptomycete* from soil in Cameroon. Transformed into crop this gene confers resistance to the herbicide. Basta-resistant canola, Soya, cotton etc. require less cycles of herbicides than conventional plants with less chemicals brought into the environment.

Biodiversity and Economic Values

Markets related to products derived from biodiversity are huge (Table 1). One successful pharmaceutical derived from a natural compound can sell for over 2,000 millions dollars (see above). The market for pyrethroids alone is estimated to be in the range of several billion dollars. Biodiversity in itself has no commercial value, but has the potential to turn markets up-side-down through inspirations for innovative product developments.

Table 1: Markets, related to biodiversity (modified after ten Kate, 1995, and Grünwald, 1995)

Markets	US $ billion
$ Drug Market, 1997:	295
$ Drugs from plants, 1993	59
$ Phytomedicines, 1993	12.4
$ Pesticides world-wide	47
$ Seeds (estimate for 2000)	7
$ Horticulture (UK, 1991)	1.6
$ Enzymes (1993)	1
$ Cosmetics (USA, 1994)	20
$ 2.5 % natural cosmetics	> 0.5
$ Tourism (global, 1995)	3.400
$ Nature tourism, 1988	12

Recently several attempts had been made to put a price tag on natural resources, including biodiversity. The idea is to express the pharmaceutical potential of biodiversity in dollars and to add it to the per hectare value of tropical forests (Mendelsohn and Balick, 1995). This effort might be worthwhile from the view of an economist, but is futile from the view of an inventor. It is simply not predictable how many inspirations an inventor needs for solution finding. It is also not predictable how many solutions mankind will need in the future to survive. Considering the serious global threats like global warming and overpopulation one can predict that the need for inventions will increase exponentially. Future generations will need all available resources on earth and one of the most important is the innovation potential from biodiversity. The value of biodiversity is no longer a matter of dollars, but of long-term survival of mankind.

Industry and Biodiversity Conservation

Up to recently inventors and industry took the existence of biological diversity on this planet for granted. The tropical forests were far away from their laboratories and samples from plants and microorganisms could be obtained without any obligations at low prices. It was the research agreement between Merck and INBio, which send out a signal to the scientific and commercial world (Nader and Rojas, 1996). For the first time in the history of drug discovery a pharmaceutical company acknowledged its responsibility for the conservation of a major resource for pharmaceutical innovation and for the obligation to share benefits from future products with the source country to support conservation. Meanwhile royalty obligations for conservation are becoming an industrial standard. But more important than royalties and money is the building of research capacities in the source countries. Awareness about the value of biodiversity for innovation and human future survival can be only generated through science education and this awareness has to be formed in the source countries. A new generation of scientists has to be enabled to use the inspiring potential of biodiversity for solution finding. This is the major achievement of INBio, of the INBio-Merck agreement and of 8 other agreements with international industry (Nader and Mateo, 1998).

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Conserving Biological Diversity in Cameroon's Forests: Problems and Prospects for the Future

John W. Forje

Abstract

Cameroon's biological potentials cannot be questioned. It harbors a major proportion of the planet's biological diversity. Unfortunately this biological potential is under serious threats and destruction. The portion of diversity of actual or potential use to people are freely available for exploitation to support development. However, the trend of socio-economic transformation in the late 20th century makes us to realize that biological resources have limits, and that we are exceeding those limits and thereby, reducing biological diversity.

The paper looks at the extraordinary change in the relationship between people and the biological resources upon which their welfare depends and why there is urgent need to take actions now to protect threatened biological resources. The premises of departure is that of a conflict situation (between the expansionists and conservationists) arising out of the kind of policies articulated and aggregated by government which directly or indirectly promotes rapid socio-economic development through accelerating forests loss – thereby harming the interests of forest-dwellers and eroding the biological diversity base of nature's gift to society.

The conclusion is that of an urgent need for both sides to adopt a more humane (human-centered development) approach to the socio-economic transformation of the country which eventually leads to the protection and conservation of biological diversity. In this vein, proactive strategic policy measures are recommended.

The Underlying Issues

The Rio Earth Summit of 1992 developed plans to reduce the effects of environmental degradation, threat to biodiversity as well as to promote sustainable and environmentally sound economic development in all countries. These plans resulted in the establishment of Agenda 21 - an international community response and a comprehensive programme of action. The central notion of the plan is that humanity has reached a crucial moment in history. Humanity's numbers have now become so large and their activities so pervasive that they are having significant environmental effects at both the national and global scale. Earth's land cover is increasingly converted or dominated by human activities, the worldwide decline in biodiversity is accelerating, the composition of the atmosphere is changing, and climate apparently being modified because of anthropogenic influences. Given this evidence of unsustainability, there are growing calls for changes to human development to place it on more sustainable pathways.

The word forest is ambiguous since it refers to a set of often greatly differing plant formations that may be considered from two quite separate view points:

- First, a forest is a part of a complex ecosystem with a tree cover varying in density;
- Second, a forest is an area producing various natural resources, including wood, that are exploited by man for economic purposes.

Forests are difficult to manage because these two view points must be simultaneously taken into account to ensure sustained development. Hence a state of conflict exist between these two view points. In addition, one should also bear in mind that forests also constitute different ecosystems (for example, dry tropical forests, moist tropical forest, mountain forests, savanna regions in Cameroon): These different forests form complex and diversified ecosystems in which numerous factors interact; climatic factors (temperatures, winds); geological and pedological factors (nature of parent rock, soil composition and depth), topographical factors (altitude, slope exposure); and biotic factors (type of wild life) all interact in different ways to influence the nature and structure of the forest cover. Conversely, the forest cover influences the microclimate, soil characteristics and plant and animal life.

Different methods of forests exploitation exist. Action by man has in fact left its mark for thousands of years and, combined with natural factors, has contributed greatly to establishing the forest evolutionary process. Mankind's impact on forests has constantly increased over the centuries. Whilst the Cameroon forests were intact with ancient rural civilization, the new wave and clamour for good living and industrialization within and outside the country is moving in the direction were they would soon be practically no virgin forests left in Cameroon. Sad enough, serious efforts are not being made to regenerate these forests. Four main stages can be distinguished in the way human societies use forest resources, depending on the amount of timber removed and the type of forestry operations. These include:

1. Gathering: This is the spontaneous form of resources utilization by both primitive and advanced societies when the resources exceed needs.

2. Non renewal exploitation: This situation arises when resource regeneration no longer offsets timber removals. If it persists, the resource may disappear, at least locally. In response to this risk, management rules are frequently imposed, often by government in order to ensure resource renewal.

3. Classical "Rational replacement" exploitation: Its purpose is to ensure regular use of the resource in a way compatible with its regeneration. Forest management methods have been developed to achieve this goal especially in the developed countries.

4. Intensive Tree Growing: When cultivation techniques are used intensively (planting of selected varieties). This is a system where tree growing increasingly resembles crop farming.

The term gathering is appropriate as long as the removal rate is less than the renewal rate; if the latter rate is exceeded, there is a risk of depletion.

Generally Cameroon has embarked on Non-Renewal Exploitation (NRE) and gathering because the removal rate exceeds the renewal rate. This is an indication that Cameroon's unique area of rainforest is under threat from the very government that has been charged with protecting it for future generations. Cameroon's forest, and all the life that depends upon it, are being sacrificed for the potential wealth of foreign timber companies and supported by individual Cameroon interests. Very soon there would be great pressure from the mining industry (once minerals are discovered) to divide most of the forest areas up between the mining and logging corporations. When competition and exploitation attain this stage, the implicit partners will for more than ever before ignore the rights of the indigenous peoples who live there, and ignore as well all the national and international agreements they have signed agreeing to protect the area.

Cameroon's resources and territory should be seen as protected status intended to strike a balance between conservation and economics. Long-term logging and other industries have been allowed in many parts of the country.

Opposition to the destruction of Cameroon's forest and biodiversity base has been growing across the country. Indigenous groups and peoples whose very future is threatened by Government's inconsistent forestry action plan have in different ways taken up the struggle to save the forest for the indigenous people, "the forest is our home, our laboratory, our hospital, our university. It is the source of the knowledge we need to survive." (Earth Action, June 1998);

Cameroon's rainforests, with their wealth of ecosystems and biodiversity, are rivaled by few places on Planet Earth. For this reason, the Cameroon Government should show global leadership in protecting this invaluable inheritance. Why should the government take such a lead? Two factors are outstanding in this context; the economic and social perspectives. The economic uses of forests are numerous and have varied greatly with different civilizations and periods of history, some of these use have been mentioned and included (animals living in forests providing meat; forest plants for gathering as food and providing medicinal properties). Forests as providing food for domestic use; forest wood for construction etc. Secondly, from the perspectives of the "social" role of forests. Like their economic uses, the social uses of forests are numerous. Their availability for recreational activities, sports, gathering, hunting. In addition to these "objective" uses, the forest has a very strong emotional and symbolic conception in the many great cultures of the Cameroon society. The forest is seen as a special place lying outside the everyday social ambit in the symbolism of these cultures, the forest is perceived as a permanent rather than a temporary feature, and sacred as opposed to profane.

This relationship with the forest has persisted in modern societies: the forest is seen by town-dwellers, for instance, as something natural in contrast to the artificiality of everyday urban and industrial life. The current longing for nature is very closely associated with forests. This emotional relationship may explain why people react so sharply when forests seem to be in danger, especially if the danger is caused by something artificial like pollution or building sites. The forest's social role thus far exceeds its directly observable recreational uses, for attachment to forests is part of the overall feeling for nature which is now becoming more pronounced in developing countries. From this perspective, the attachment of indigenous peoples to the forests is clear and should not be compromised in any way. It is all the more difficult to take this role into account since it goes beyond rational considerations, such as economic uses, to symbolic and emotional aspects. That is why it is extremely important that forests be conserved, protected and nurtured for the benefits of present and future generations.

Cameroon's biological potentials cannot be questioned. It harbours a major proportion of the planet's biological diversity. Unfortunately this biological potential is currently under serious threats and destruction. The portion of diversity of actual or potential use to people are freely available for exploitation to support development. However, the trend of socio-economic transformation in the late 20th century makes us to realize that biological resources have limits, and that we are exceeding those limits, and thereby, reducing biological diversity.

To meet the goals of Agenda 21, that is, to sustain the rich biological potentials of Cameroon's forests, the scientific understanding of the interactions between humanity and the forestry environment of Cameroon must be strengthened. Proactive policy measures contributes to this goal by describing and studying the interactive physical and biological processes that regulate the forestry system of the country, the unique environment that it provides for life especially for the forest dwellers and indigenous people, the changes that are occurring, and how they are influenced by human actions.

It becomes imperative, in this light, to take a look at the extraordinary change in the relationship between people and the biological resources upon which their welfare depends and why there is urgent need to take action now to protect threatened biological resources. The premises of departure is that of a conflict situation between the expansionists and conservationists arising out of the kind of policies articulated and aggregated by government and stake holders which directly or indirectly promotes rapid socio-economic development through accelerating forests loss - thereby harming the interests of forest dwellers and eroding the biological diversity base of nature's gift to society.

This is an urgent need for both sides to adopt a more humane (human-centred development) approach to the socio-economic transformation of the country but through a conscious protection and conservation of biological diversity. In this vein, proactive strategic policy measures are recommended. Political will being necessary to see through such articulate policy measures which should be a social contract between civil society and the State.

Cameroon has a population of 15 million inhabitants with a 2.6 percent annual growth rate, doubling time 26 years. It covers an area of 475.500 km^2. There is a rapid population increase but land does not. The country has also witnessed a sharp decline in GNP per capita from US$ 960 (in the 1980s) to less than US$ 600 in 1996. Poverty is written on the faces of the majority of the population following the degree of economic recession that has ravaged the country in the past decade or so, as a result of the World Bank/IMF imposed structural adjustment program (SAP); two months of unpaid salaries to workers in 1993, a 70 percent cut in salaries as if this was not enough, 100 percent devaluation of the CFA francs in 1994, and above all, government's incomprehensive and disarticulated policy approaches.

It cannot be gained said that human population growth has a very negative effect on the environment particularly in underdeveloped regions like Cameroon. This is so because while the former remains progressive, the latter is stagnant. The situation is more complicated given the state of underdevelopment and corruption in the country which puts the poor at a very disadvantageous situation of living far below the poverty line. As indicated earlier, the situation is further compounded by the fact that man's survival greatly depends on the exploitation of the physical environment whose resources are mostly exhaustible.

The effects are many and different in magnitude; perhaps one of the most dangerous ones is deforestation, which also has its attendant consequences: An exhaustible resources like wood is exploited not only for construction and furniture, but also as a source of energy. A very large proportion of the country's population particularly in the rural areas use wood as a source of energy for cooking. Thus, x-raying the rate of population growth in Cameroon, the risk of the country loosing all its forest in no distant future is very great. The degree of logging seriously add to the problems of deforestation.

By and large, forests and their influences constitute important economic and environmental factors. The forestry sector occupies the first place in export tonnage and third place in foreign exchange earnings. It accounts for four percent of the gross domestic product and for about 45.000 jobs. This performance is judged below expectation for forests as rich in species and as extensive in area as Cameroon's.

Cameroon possesses some of the most important protected areas in Africa. Some of the area include the lowland rainforests: Korup National Park, Takamanda Forest Reserve, Mbam et Djerem, and Pangar-Djerem Game Reserve, Dja Forest and Game Reserve, Douala-Edea Game Reserve and Campo Game Reserve. There are other biologically interesting forests in the country which require protection for the survival and sustainability of the country's rich biological heritage. For example, in the West, forests like Ejagham, Manne River, Nta ali, Mokoko River, Barombi Mbo, and Bonepoupa. In the remote Southeast, the following forests are of importance; Nki, Bownba Bek, and Lake Lobeke. The savanna zone has four national parks – Waza, Benoue and Bouba-njida are of high priority which include some internationally important large mammals.

The conservation of the mountain forests in Western Cameroon is of great importance due to the number of endemic species that live in the area. For example, Mount Cameroon in the Bamboko Forest Reserve, and, in the North West, Mount Kilum (Oku) forest is severely threatened and a home to number of rare species. Other areas blessed with vast potentials include the Bamenda Highlands; Oshie blessed with vast and different fauna and flora. The Mount Maneguba, Bakossi Mountain, Mount Nlonako, the Rumpi Hills etc. all harbor significant biodiversity potentials. Apart from their unique biological values, Cameroon's forests constitute essential water catchments for Nigeria and Cameroon. The Centre, East and South Provinces are endowed with enormous biodiversity potentials.

Some existing problems

A number of problems can be associated with the state of Cameroon's forests; for example, its administration lacks proper management and silvicultural techniques for the complex-structured tropical rainforest. Secondly, most of the forest exists on what is known as public domain as opposed to state-owned forest reserves, where access is open to anyone for purpose of agriculture.

Thirdly, there is the problem of over-accessibility to available forests which has led to over- exploitation by both authorized and illegal users. Increasing demand by urban dwellers for wood products and sources of energy and backed with the increasing industrialization of the forest sector have in different ways intensified the exploitation of the forests. Fourthly, faced by a rapid declining economic situation, the government has turned to forestry exploitation as a means of foreign earnings. Fifth, Governments forestry logging policies have equally contributed to deforestation and with it, the destruction of the biodiversity base of the forest. Sixth, lack of the necessary human capacity to promote conservation, management and sustainable use of the forest. There has been the tactical error of opening up more of the forest for logging than the forestry service has the personnel, means and capacity to supervise. Wrong policy approaches have contributed to compromising the rich biodiversity potential resources of the forest. The result is that much of the logging is unsupervised, hence certain monitoring functions are not undertaken. In the seventh place, forest dwellers are constantly exploited by the loggers, uprooted from their habitat. Eighth, the search for more farm lands either by big plantation owners or individual small farm holders leads to rapid destruction of the biodiversity base of the country's forest.

Given this and other obstacles, species and habitats should be safeguarded to the extent that it is technically, economically, culturally, naturally and politically feasible. Determining priorities is a complex task. The genetic landscape is constantly changing through evolutionary processes which require explicit conservation programs and especially drawing from the indigenous knowledge of the people. These people constitute a treasure and library of knowledge that text books cannot provide. In many cases, the capacity of governments and private organizations to deal with environmental problems is limited. The various bodies seeking to conserve biological diversity must be selective, and ask which species and habitats most merit a public involvement in protective measures. The Cameroon Government has demonstrated gross incapability in handling the issue of biodiversity destruction through its forestry policies and general governance system characterized by corruption and mismanagement particularly concerning the award of contracts to logging companies.

Existing Forest Policy

Cameroon, Bawak (1992:37) points out, has no specific formal forest policy to unify all operations and strategies in the forestry sector. The guiding principles of the existing policy can be inferred from the forestry law and regulations as well as from the sixth-five year development plan. From the Cameroon Forestry Law of 1992, "forests shall be used rationally for maximum production, on a sustained yield basis, of all the products and benefits obtainable from them for the greatest good of all the people of Cameroon in perpetuity". The country sees the primary role of the forest in these terms:

– to provide revenue for the state, in particular, foreign earnings;

– to provide revenue and food for the rural populations;

– to provide wood for energy as well as for construction;

– to provide opportunities for public education, research and creativity;

– to provide food and shelter for animals, protect watersheds and conserve biodiversity;

and

– to provide raw materials for industries (and thus enhance employment and population stability in rural areas).

Prime Minister Peter Musonge (1998:2-4) in his budget speech for the 1998-99 financial year presenting to the National Assembly on the environment and forestry section had only one sentence, "the implementation of a national biodiversity management program" (see Cameroon Tribune June 1998:1-3). Given the degree of deforestation, logging and environmental degradation of the country's forests are subjected to, the statement indicates clearly that a comprehensive policy on the development, conservation and protection of the forestry sector, the environment and its biodiversity does not exist or is not seriously taken by the state. Yet, the forest remains one of the major source of foreign exchange earning; in addition, it is a delicate area that if not properly attended to will compromise the situation of future generations in many respect.

Looking at the present state of biodiversity conservation and management in the country, we are confronted with the fact and reality of serious threat due to rampant deforestation and other forms of degradation specifically from the perspectives of:

– the extent and location of biodiversity "hot spots"

– status of protected and non-protected areas;

– the status, use and management (if any) of forests outside protected areas and their implication for biodiversity conservation;

– the main policy issues affecting biodiversity conservation (Wencelus 1992:22).

Cameroon's tropical forest areas are confronted with serious problems of degradation. This constitutes the major cause of the rapid decline in its rich biodiversity potential. The rate of deforestation is tremendous. The main direct causes of deforestation and biodiversity degradation being:

– Conversion of the natural forest coverage into perennial cash crops. This is effectuated either under large-scale industrial schemes or through individual farms with slash and burn activities destroying the biodiversity structure. Logging in Cameroon has a direct impact and influence on the amount of deforestation as it opens the way for farmers and is thus detrimental to the natural forest covers.

– Shifting cultivation - also slash and burn method farming contributing seriously to the erosion of the biodiversity base.

The two causes are accelerated by land-grabbing process, penetration into the hinterlands which often consumes more forest land than is needed by agriculture. These direct causes can be traced through (a) rapid population growth, (b) industrial expansion which puts great demands on raw resources; and (c) man's quest and rightly so for good quality living standard which puts great pressure on more consumer goods - housing, transportation, energy etc.

Following the theory of the "forest refuges" a number of biodiversity "hot spots" can be located as:

– Low land rainforest areas which include the Korup National Park; Takamanda Forest Reserve, The Mbam et Djerem, Dja Forests, Campo, Kilum and Douala-Edea forest reserves.

– Highland savanna areas being threatened by desertification; extreme dense forest regions seriously threatened by pressure from agriculture and the impact of logging.

– Where biodiversity in the savanna

and dense forest zones will very soon be threatened by the construction of the Chad-Cameroon Pipeline Project Construction activities.

The Chad-Cameroon Pipeline is likely to have a major impact on the Mbéré Rift Valley, a region known to be the home of significant biodiversity and wild life, including elephant populations, bongos and hippopotamus. Possibly, Cameroon's small population of endangered black rhino might be impacted as well. Medicinal plants will be destroyed. Indigenous people depend on this for their health and well-being.

Status of Protected Areas

Cameroon has made some efforts to establish protected areas. Unfortunately the existing systems of protected areas are not extensive enough and very often poorly managed. Most of Cameroon's protected areas are gazetted as state forests but receive many different types of legal status and various levels of actual protection. These areas fall within two categories (a) wildlife reserves areas (WRA) and (b) totally protected areas (TPA).

Wildlife Reserve Areas (WRA): These comprise different types of protected areas where existing legislature provides at best, for total protection of wild life or what is known as "reserves de faune" in Cameroon. However, many of the WRA are victims to encroachment and poaching. In addition, these areas seem to exist only on paper being completely invaded and taken over in many of the WRA.

Logging is legally authorized or permitted de facto by the State. The most affected areas include the Centre, South, East and Southwest Provinces.

Totally Protected Areas (TPA): Provision is made within existing legislation for total protection of the forests. This is meant to provide security to biodiversity and to resist encroachment from surrounding populations. Totally protected areas include the Korup National Park, The Kilum Mountain Forest Reserve, Dja Forest Reserve and the Campo Game Reserve amongst others.

Common Issues Related to TPA/WRA

A major issue in biodiversity conservation is that these areas do not cover the whole range of forest ecosystems and wild life species that need protection. Existing protected areas cover about 50% of the sites identified as crucial for biodiversity protection and conservation. Furthermore, there is urgent need to widen the range of protection areas. In addition, existing areas are poorly protected, lacking comprehensive management plans, buffer zones, actual participation by local populations and security guard force.

Efforts have been made to develop a comprehensive management plan for the country's protection areas, for example: The Korup National Park, Dja Reserve have been experimenting with the buffer zone concept. Unfortunately, legislation remains inexplicit in respect of provisions regarding core areas. However, a major draw back is that local populations near protected areas including forest dwellers have not been thought to be interested in forest management and protection. The system in practice forces them not to develop one. They are sideline.

Status of Forests Outside Protected Areas

So far nothing is done in forest outside protected areas to ensure the sustainability of the country's biota. The permanent multi-purpose forest state, i.e. gazetted state forests has come under serious logging. The actual impact of logging on biodiversity depends on the intensity of logging. Logging is supposed to be carried out under the direct responsibility of the forestry administration. Very often it fails to leave up to that responsibility. Logging is done mainly by private companies. Top administrative officers, political figures and other personalities are either share holders in these companies, have special interests or do derive special benefits from whatever transactions and other activities of these companies which do not meet the regulations laid down by the government. The interests of the people in the forest areas and the country are compromised by these unethical civil servants.

The actual impact of hunting for bush meat depends on human population densities. With rapid decline in the purchasing power of the people, many can no longer afford to pay for the cost of "cow meat" and fish. This has increased the demands for bush meat. As such, most of the forest areas are subjected to serious encroachment and the eventual degradation that goes along with it.

It should further be noted that forests that are not gazetted - "domaine protége" other than TPA, WRA and gazetted forests (GF) still belong as state property. These DF are not property managed, regulations on logging give little consideration to technical forestry prescriptions and biodiversity conservation and existing regulations are often poorly reinforced. Logging concession are not established according to a clear strategy.

Impact of Logging

There is a serious impact of logging on forestry and the biotic canopy of Cameroon. The same applies to the impact of silvicultural treatments and of hunting. Over 10 percent of the forest canopy is destroyed as a result of logging depending on the volume felled and the methods of exploitation. The regeneration of forests after extensive logging is hardly practiced. The tendency and consequence is that forest regions are fast becoming deserts with grave impacts on plant biodiversity. The Centre, East and South provinces are seriously affected with the rate of uncontrolled logging and non-regeneration of the forests. Plantation agriculture adds new and serious dimensions to forest and biodiversity depletion.

In some cases, forests degraded by logging provide improved habitats for some animal species, for example gorillas, but intensive logging as is the case now in die East, Centre and South provinces is proven detrimental to species that live in tall trees.

As earlier mentioned, the impact of traditional hunting on biodiversity is generally becoming serious. Significant degradation of wild life, to supply urban centers with bush meat now affects large areas; poaching equally has intensified the degradation of the biodiversity of these forests.

Indigenous Peoples

Extensive logging and deforestation has serious impact on indigenous peoples particularly in the Centre, South and East provinces. The Chad-Cameroon Pipeline Project constitute a serious threat to both biodiversity and the lives of the indigenous peoples. Along the Mbéré Rift Valley region, the country's small population of endangered black rhino will be impacted. Korinna Horta and Nguiffo (1998) note that the Mbéré Rift Valley as "one area that is relatively less degraded than the other savanna region in the Northern sector of Cameroon" will be affected by the new road and the bridge over the Mbéré River to be built by the project.

Pygmy settlement and pygmy populations would be disturbed by the construction activities of the pipeline. Pygmies are recognized groups with a social and cultural identity distinct from the majority of society and require particular attention and whose indigenous knowledge of the forests are vital for the conservation of biodiversity. Unfortunately the alignment and construction of a road in Southern Cameroon which will be built or rehabilitated by the Chad-Cameroon Pipeline indicates that increased logging in previously inaccessible forest areas is likely to occur as a result of the project with very serious consequences to the biodiversity base of the country.

The Brundtland Report (1987) strongly advocated an extremely careful and sensitive consideration of the interests and role of isolated, vulnerable groups as a touch-stone of a sustainable development policy. The indigenous people should be seen as a library for the conservation of biodiversity in the country's forest whose knowledge Cameroon cannot afford to shy from but which unfortunately the government is doing everything possible to destroy through its logging policy. The government is destroying the fountain of knowledge of biodiversity treasures in the Cameroon's forests, thus contributing to unsustainable development of the country. A policy that contributes to global warming.

Policy Issue – Inadequacies

Efficiency in the use of forest resources can be judged initially by examining the ratio between annual increment and annual harvests: when greater than one it shows that these resources have not been over-utilized, when less than one it indicates that they have been over-utilized and that the sustained development of the resource is in danger if the trend persists. Over-logging is destroying the country's forests. In some cases, the forests and its resources are not managed with a view to sustainable development. In many cases, economically accessible forests are over-exploited.

Pressure on the government to meet its international obligation – payment of debts has made inaccessible forests to be exploited as well, leaving no forest sector untouched. Proper efficiency in the use of forest resources might be defined as encompassing other ecological and social functions of forest resources. Biological diversity is being rapidly lost through extinction of species and populations, and human alteration of the ecosystems. As the living component of the earth's ecosystems, wild life helps to regulate the cycles of energy, water, oxygen, nutrients and other basic elements. Loss of plants or animals can disrupt that function. The threat of global climate change, triggered by increasing amounts of carbon dioxide and other "greenhouse" gases in the atmosphere, has brought to public attention the role of forests in regulating CO^2. Growing forests absorb more CO^2 than they release, whereas forest clearing and burning does the opposite – hence the widespread calls for more tree planting and less destruction of the country's forests. That towns like Buea, Ndu, Bamenda etc have become hot is the result of the rapid decline in the forest base of the country and is no surprise.

Therefore, vegetation in all forms must be maintained and nurtured to ensure balance in our ecosystem. Plants and animals have evolved together, in a system of checks and balances. Human-caused loss of any part of this system results in rapid increase or disappearance or other parts, producing imbalance (such as insect outbreak) that is often harmful to human interests. Wild life affects economies in ways both obvious and subtle. Wild life, whether perceived as individual plants and animals or viewed collectively as "nature", is important to people simply because it comprises other forms of life that share the same planet. Man is attracted by wild life. Wild life is more than a resource, it is a part of the human psyche. Thus the more reason why conserving the forests and biodiversity is more important. And this requires comprehensive, concerted and long-term policy. There is need for crystallizing a new vision on man-nature relationship.

Biodiversity conservation is affected by political, legal, fiscal and institutional issues that call for more commitment on the path of the government of Cameroon and also for policy reforms including the behaviour, attitude and mentality change amongst the population. A strong commitment at the highest political level to biodiversity conservation has yet to emerge and crystallize in the country. Without such commitment it is impossible that environmental sustainability can be rigorously attained in the country. National forestry policies developed under the Tropical Forestry Action Plan (TFAP) falls short in giving the necessary protection and priority to biodiversity conservation.

Existing legislation in the forestry sector needs to be dramatically improved to take better account of biodiversity conservation and participation of the population at the local level. Cameroonians should not evolve in isolation of nature. The forest remains an inherit part of the society.

The main fiscal issue is that the present levels of forestry taxes pertaining mainly to logging and hunting do not reflect the actual value of forest resources. Other issues being that collection of forest revenues is poor and that procedures to make local populations benefit from a share of these revenues are diverted from their objectives or simply do not exist.

Existing institutional arrangements also need considerable readjustments to ensure effective improvement by government, local populations, NGOs, the private sector and civil society in general in conservation and management of biodiversity - treasures -in the country's forests. In this connection, one should also add the need for more effective and efficient enforcement of legislation by the courts, for better integration of government administration in charge of forest management and biodiversity conservation. Participatory management approach should be encouraged.

The absence of a long-term vision land-use planning constitutes a serious setback in forestry and biodiversity conservation. Thus, there is urgent need for the development of a "land-use planning" policy which should embody a national vision of the best use of the country's resources. It will guide sectoral policies as well as operational mechanisms for the ultimate realization of the vision. Such a land-use planning policy necessitates the developing of agro-ecological zoning of the country. It would constitute a coherent framework for land-use and national resource management. The purpose of agro-ecological zone would be to demarcate:

– areas that need to be fully protected for biodiversity conservation

– areas that should be preserved for forest dwellers for example the Centre, South and East provinces

– areas best suited for sustainable agriculture development, including agroforestry and live stock

– areas that should stay under permanent forest cover and be managed for production and/ or protection

– areas which have been subjected to serious desertification, requiring serious reforestation (South, Southwest, Northwest, West, Centre, South and East provinces)

– areas which have been subjected to serious desertification – the encroaching desert – requiring reforestation, for example the three Northern provinces – Adamawa, North and Far-North.

– the need for a new land tenure act or system, and the empowerment of the female gender.

Land use planning and agro-ecological zoning has to be compatible with other government sectoral policies, for example urbanization – de-ruralization, re-ruralization and de-urbanization; transportation infrastructure, population, location of industries and other development projects. Furthermore, it should be construed on adopting a multidisciplinary approach, aggregated and developed through mechanisms that ensure inter-ministerial consensus and civil society participation. As regards related forestry policies and biodiversity conservation, a national system of protected areas and multi-purpose gazetted forests should be planned and designed according to the zoning areas and taking into consideration the right of indigenous people and civil society.

The success of any land-use planning policy rests on the development of the necessary instruments to make it efficient and effective. These instruments include:

a) methods and mechanisms for participatory planning and management of land use and natural resource

b) institutional and regulatory framework to implement land-use plans

c) a system of monitoring land use and natural resource use throughout the country

d) concerted and comprehensive efforts towards training and educating civil society in-general and in particular, local population, government agents, private entrepreneurs and decision-makers in forestry and biodiversity conservation and protection; and finally

e) assessing the value of biological resources.

Policy Reforms and Strategies

The increasing national and international interest in biodiversity stems from the growing dangers of species extinction, depletion of genetic diversity and disruption to the atmosphere - water supplies, fisheries and forests. As climatic, political and economic conditions change over the coming decades, the various populations of "homo sapiens" are going to be challenged to live up to their name. Biological diversity provides the construction pillars with which each human group can use its intelligence and acquire wisdom to adapt to change and having more blocks to new conditions without, of course, destroying the main foundation sustaining our existence on planet earth.

Policy reforms are crucial to improving the legal, fiscal, and institutional environment geared toward the efficient and effective management of the biological base of the country. In order to implement new action for conserving biological diversity in a time when the Cameroon Government is confronted with and feeling the squeeze of external debt, the activities of the various interested stake holders - both national and international governmental and non-governmental – need to reinforce each other rather than work in opposition born of ignorance.

Seen within these parameters, international agencies should support positive and progressive government actions and policies, and NGO activities need to stimulate new approaches at both national and local levels creating awareness on the need for conserving biological diversity. The government of Cameroon should take the first and bold move in respect of reforming existing legislation to adequately respond to the need to:

- ensure a coherent and comprehensive set of legal provisions and regulations regulating land-tenure and use of natural forest resources

- encourage civil society participation and management of forests and biological resources as well as engaging private companies to be involved in management of production forests

– clarify the concept and role of buffer zones around protected areas

– articulate concise specifications about the content of management plan and other technical regulations regarding forest exploitation

– put in place clear guidelines and priority for assessing the value of biological resources

– encourage indigenous population as partners in the development process.

For the Government of Cameroon to successfully assess the priority accorded to investment in conservation of biological resources, there is the need to have a firm indication of the contribution of these resources to the national economy. For example, Barret 1988; McNeely 1988, Cooper 1981 and others outline the value of biological resources in respect of:

– Assessing the value of nature's products – such as fire wood, fodder and meat, that are consumed directly, without passing through the market "consumption use value".

– Assessing the value of products that are commercially harvested such as game meat sold in market, timber, fish, ivory and medicinal plants ("productive use value").

– Assessing indirect values of ecosystem functions such as watershed, protection, photosynthesis, regulations of climate, and production of soil, ("non-consumptive use value") and along with the intangible values of keeping options open for the future and simply knowing that certain species ("option value" and "existence value" respectively).

Cameroon's heritage of indigenous forests has been severely depleted. Yet these indigenous forests are significant for a number of varied reasons, namely:

– they constitute part of the nation's heritage

– they maintain the integrity of ecological systems, help soil stabilization and flood control

– provide scenic value as a major tourist attraction

– they absorb carbon dioxide thereby providing their share to mitigate the "green house" effect.

Thus Cameroon's forest requires "sustainable management" in a way that it maintains its ability to continue to provide products and natural amenities in perpetuity, while retaining or enhancing the forests natural ecological processes and genetic diversity for the benefit of both present and future generations.

Proactive Policy Strategies and Recommendations

The growing awareness about the importance of biodiversity on the part of the state and civil society has to a large extent resulted in a desire to ensure that no part of the country's natural heritage is lost through inadvertence or ignorance. Biodiversity converges together in a variety of constituencies: forest agronomy, biotechnology, pharmaceuticals, international trade, amongst many others.

A national strategy for conserving the greatest possible biological diversity is required to provide the framework for local and national efforts, and to provide vision, concise direction and guidance on the options and opportunities for the necessary actions capable of achieving national goals while addressing local priorities. A proactive policy strategy is necessary for seeking comprehensive solutions to the problems facing Cameroon's depleted forests and the destruction of its biological diversity, include:

– articulate and aggregate appropriate policy reform and management action plans in areas outside the "conservation sector" as traditionally perceived, that have major and significant impacts on biological diversity – for example: tourism, agriculture, forestry, transport, communication, education, defense etc. Ensure that "traditional" development activities are carried out in such a way that they contribute to conserving biological diversity.

– embark on civil society participatory approach, drawing from the indigenous knowledge – the living laboratory of the people – in the conservation, and development of the biodiversity heritage of Cameroon

– creating and enabling environment for enhancing the role of development agencies and indigenous NGOs in contributing directly to the conservation of biological diversity

– operate on the basis of people – centred development approach with a focus on improving the quality of life of the people

– strengthening the institutions in the "conservation sector" through enhanced training (manpower capacity building), financial mechanisms as well as building greater public support for conserving the forest and biological diversity

– articulate the right legislation with a follow-up action plan for the conservation of the forestry and biodiversity sector

– promote the further development of local, national and thematic action use of forests and biological diversity, and promote their implementation

– articulate policy measures that seriously and systematically work in the direction of narrowing the gap between "the expansionist and the conservationist" perception of the country's ecosystem

– promote a comprehensive action plan for conserving habitats, for example, the Tropical Forestry Action Plan (TFAP) in tandem with a Cameroon National Environment Action Plan (CNEAP) focused on the conservation of the diversity of the Cameroon forests and ecosystems.

Conclusions

Conflict between the "expansionist" and "conservationists" abounds in Cameroon. What is important is to balance the conflicting views and approaches. The various methods of forest management have different effects on the environment: non-renewal exploitation which Cameroon has embraced is embedded with many negative results and serious consequences on air, climate, water, soil, the diversity of flora and fauna, recreational activities and the symbolic value of forests.

Inadequate policy approach by government and the attitude of the forest exploiters explain the hostile reactions from the indigenous people and the community who closely identify forests with nature and themselves being part of it. To find effective solution to these and the other remaining problems identified necessitates both continuity and innovation in environmental policies. Cameroon has been slow in this direction thus enhancing the expansionists approach which depletes the biodiversity base of the country. Policy integration and new strategies are thus needed to deal with the critical issues of resources depletion. Civil society and indigenous people should not be sidelined but be an integral part of the process as they constitute the fountain and living library of knowledge needed for conserving the biodiversity and other treasures of the country's biota.

Civil society must also embark on a policy action campaign plan to save Cameroon's forests and its contents; in the South, Centre and East provinces were indigenous people, the Bakas, etc. and a huge variety of wild life and medicinal plants are on the verge of extinction. Tackling the problems of environmental depletion and conservation also requires a democratic governance system. Cameroon is in dear need of this, as is the need of a concerted forestry action plan oriented towards preserving the biodiversity riches of the society.

Prospects for the conservation of biodiversity in Cameroon remain bleak as long as the Government continues implementing existing inconsistent and extra-overt expansionist policy approach at the expense of nature's gift to mankind. A policy approach that builds on the vision of future generations – conservationist attitude – provides signs of hope for the state of biodiversity in Cameroon. Any failure to move in the direction of conservationism and sustainable development signals serious trouble not only this but future generations as well. Civil society has to be vigilant to guide the Government in the direction of maintaining a true balanced policy between "expansionism" and "conservationism". Development or industrial growth and nature must be partners in the process of socio-economic transformation. In no way will Government be reducing poverty and underdevelopment by destroying nature and all that it holds for humanity.

Some lessons from the Cameroon state of "Biodiversity" – Treasures of the Forests" remains eminent in that Cameroon has now entered into a period of political, economic, and societal structural adjustments, and – hopefully – human-centred development and transformation. This is a social, cultural and political as well as an economic necessity. Equally inevitably is the part of nature – environment - in that transformation process. Prominent among the waves of action include: human-centered oriented development, proper use of natural resources and human capacity, partnership between civil society and as important in shaping sequences and development trends, avoid complexity and parallel lines of operation. Safety nets are needed with innovative thinking and action from the people, coherence and coordination and collaboration within and across national frontiers, democratic governance, and, particularly in community-basing matters, power to the people approach with responsibility and sense of direction coming also from the people.

As for the future and lessons to be learned – biodiversity conservation requires affirmative action which basically includes "empowering and participation" in the development process – sustainable development being the goal.

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Conserving the Tropical Resource Base: Do we Title Land or Organize Community?

Robert Walker and Charles Wood

Tropical deforestation represents a major threat to biodiversity, given the widespread ecological changes that occur with forest clearance. Such changes often represent biomass and species reductions, particularly when human-dominated landscapes replace natural systems. Even when forest land is sustained under low intensity fallows, with cyclic regeneration of secondary forest, tree species are appreciably reduced from numbers found in old growth and primary forest. One key to controlling biodiversity loss is to reduce rates of tropical deforestation, which requires policy intervention on the part of government. An obvious approach is to set aside land in forest reserves, as parks or as forests managed for sustainable exploitation. However, such policies may not adequately address the issue of rural poverty and the needs of small farmers, who often represent a serious threat to the integrity of forest lands. Although small farmers may be kept out of well-protected areas on a local level, it is unrealistic to assume that such an approach would be effective at regional scale.

The key then is to encourage farmers to engage in resource conserving agricultural activity. A commonly advanced set of policy instruments advanced in this regard revolve around the issue of land tenure security. Many have argued that when farmers possess land tenure security, they are more likely to make land conserving investments, since they are guaranteed long-run access to the fruits of their labor. Although the theoretical arguments are cogent, little empirical work has been done to test this principle, which we refer to as the Land Tenure Security Paradigm (TSP) hypothesis. This paper reports on results of a statistical assessment of the role of land tenure in affecting small farmer logging activities on their properties along the Transamazon Highway in the State of Para, Brazil. Also addressed is fire contagion, a major factor in current de-struction of the tropical forest resource base.

Statistical analysis was undertaken on data generated from a survey of 347 properties along the Transamazon Highway in the state of Para, Brazil, undertaken in the summer of 1996. Data was collected on a variety of demographic, economic, and agronomic variables, and owners were queried about the type of document they possessed with respect to land ownership. On the basis of these responses, logit models and spatial statistics were implemented to assess the role of titling in resource conservation outcomes.

Results from the statistical work show that secure land tenure reduces small holder sales of timber from land holdings, promotes the long-term conservation of valuable trees on their properties, and increases the likelihood of reforestation. Ironically, small producers with secure land tenure are more likely to experience destructive fire contagion from neighboring properties, however. The statistical findings suggest that this result does not stem from conflict between titled owners and squatters, or because the spatial organization of properties would tend to induce greater fire risk among the titled holdings. Rather, community organization seems to mitigate fire contagion, and organizational work is more pronounced among those who do not hold title.

The statistical findings suggest caution should be used in designing incentive-based policies for resource conservation in tropical areas. Incentives arising from secure tenure are important, but community incentives also appear to play a role. In particular, community organization may develop the social relations essential to internalizing environmental externalities. This point is especially important with respect to fire, which crosses property boundaries and therefore cannot be effectively managed by individual land holders.

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Role of the Media in Biodiversity Conservation: Challenges and Opportunities

Mike Anane

The world is witnessing a major imbalance in the components of the environment due to man's over-exploitation of resources. Natural systems are increasingly under pressure; species are becoming extinct; the climate is also changing with fewer of nature's goods and services available to local people who need them for survival.

In most developing countries including Ghana, the extent of exploitation of natural resources to meet socio-economic needs has exerted negative impacts on biodiversity. Statistics from the forestry department of Ghana for instance suggest that only about 2 million hectares of the country's closed forest remain, of this about 0.4 million hectares lie outside lands set aside as forest reserves meaning that over 70% of the original 8.2 million hectares of closed forests have been destroyed. It is estimated that forests are being depleted at a rate of 22,000 hectares annually of the remaining 6.2 million hectares outside the forest reserves. In the Western region alone, about 20% of forest reserves (133,000) hectares is said to be damaged. This part of Ghana is known to contain 44% of the country's closed forest and with the rate of deforestation, experts believe that the forest area will be destroyed within 31 years.

Factors responsible for this alarming rate of deforestation are the increasing demands for agricultural lands, cutting of trees for fuel wood, logging, bushfires and lately surface mining.

The lands and forestry departments in Ghana has already confirmed that Ghana will become a net importer of wood in the 21st century if immediate afforestation programs are not pursued taking into account the country's growing population and dwindling forests.

A critical examination of the factors that account for the deplorable state of the country's forest treasures would reveal that lack of environmental awareness on the part of the public is largely to blame as majority of people are not aware of the need to conserve the country's rich biodiversity, and this holds not only for the uneducated but literates as well. In fact people do not understand the close ties between human activities and the threatened biodiversity resources.

It is essentially to meet the challenging task of raising consciousness regarding the country's threatened biodiversity and environment in general that the League of Environmental Journalists was established to mobilize and motivate journalists and the mass media to take a better and more serious interest in environment and development issues that are actually relevant to the lives of the people. The LEJ also aims at initiating regular dialogue with policy/decision makers and both local and international scientists, researchers and conservationists.

In fact the role of the media in addressing the lack of awareness of biodiversity issues should not be underestimated as it is widely acknowledged that the media is an effective instrument for environmental education and management as reflected in the growing popularity of environmental journalism.

Reporting on the importance of biodiversity in forest related plant, animal microorganism species as well as their genetic diversity can increase the awareness of threats they face, possible solutions and further establish an informed and active participation of individuals in their protection and the judicious use of natural resources.

Citizens are also important and their expressed needs and desires have to be taken into account and treated seriously if conservation ideals are to be realized. All citizens also have a right to be involved in decision making processes that affect their lives and for them to make intelligent decisions about public biodiversity policies, they need accurate , timely and unbiased information on the true state of their planet's resources.

Opinions also diverge and the electorate need access to a wide range of view points on biodiversity issues, particularly where few voters will have the opportunity to see much less talk with political party candidates in person when general elections are approaching, especially in our part of the world. Undoubtedly, they must rely on the massmedia to explain threats facing treasures in our forests and characterize the respective positions of candidates and their political parties; more so when over the years these issues have not been part of manifestoes of political parties.

The role of the massmedia in the struggle to conserve the last shreds of biodiversity of this planet is perhaps also significant because of the complex scientific and technical arguments which envelop most biodiversity issues. It must be borne in mind that public participation in activities relating to these issues is largely dependent on the extent to which arguments, analysis and evidence can be broken down, explained and disseminated to the general public, particularly where the biodiversity convention itself has left in its wake a host of important and very interesting issues at the cutting edge of environment and development as usual with winding drama and debate along North-South lines filling the air when issues like the sharing of benefits of the sustainable use of biodiversity and also the rights to those genetic resources rear its ugly head.

Given that the role of the print and electronic media is crucial for the enhancement of biodiversity, one would not be far from right to assert that conservationists, biologists, researchers and other experts working on biodiversity and forest issues should see the media as partners in development.

If scientists and conservationists involved in the promotion of the maintenance, conservation and appropriate improvement of biological diversity in forest ecosystems are to succeed in mobilizing, informing and organizing society to preserve our natural resources for a more sustainable development than cooperation with the media is imperative. In fact the attainment of success in their efforts would largely depend also on the level of awareness of problems and solutions among the public, notably grassroot communities and policy/decision makers in relation to the state of what is left of these resources on which people's basic livelihood and health of our planet depend.

However, it is no secret that existing relationships between the scientific community and the media in both developing and developed countries has been characterized by mutual mistrust with the former almost convinced that the media is only looking out for hot sexy news as such press releases sent to the media are thrown into the bin or when they are used at all, they are either distorted or tuckered away in some obscure corner of the newspaper.

The media have also not hidden its disdain for conservationists whom they often see as doomsday prophets who have no sexy news to offer except wild theories. As an African proverb goes: "when two elephants fight it is the grass that suffer", the health and welfare of the earth's inhabitants cannot be separated from that of the planet itself and yet there is insufficient information on these issues; in fact the wealth of information that experts have circulate within the scientific community, if anything gets to the media at all the language is technical and full of jargons which media practitioners often find difficult to break down to the understanding of the ordinary man who is therefore often kept in the dark. Interviews I have conducted in some European capitals and Africa suggest that this "cold war" between the media and researchers is the same.

Given the alarming rate of loss of biodiversity around the world, the need for cooperation cannot be ignored and for this cooperation to be meaningful and productive, both sides would have to appreciate the constraints under which they work. For example, it is true to some extent that the media does not seem to be interested in issues relating to the environment but this lack of interest can largely be attributed to the complex nature of environmental issues as journalists who dare are often intimidated by the complex terminologies that often involve a cocktail of atmospheric physics, organic chemistry and the use of natural resources.

This intimidation that journalists face can be partly attributed to the fact that few journalists in some developing countries and developed as well have any formal environmental education but are forced to absorb complex ideas in the field. In Ghana for instance, none of the media training institutions offer courses in environmental reporting which is a specialized area; as such, stories pertaining to biodiversity and forest issues are handled by general assignment reporters.

This lack of specialized training is indeed a drawback for many journalists in that one really needs an insight into the nature of biodiversity problems and their relatedness to be able to cover them for a wide audience. General assignment reporters often lack depth in their coverage of issues as they swing between economics, entertainment, politics and environment.

Promoting a global dialogue and networking among media, conservationists, and scientists in general is crucial to the success of global efforts to conserve biodiversity but the reality is that the media in most biodiversity rich areas in the south in particular appear to be handicapped as they lack the basic tools: computers for instance, cost far more in developing countries and therefore gaining access to a working computer capable of connecting to the internet can be a dream. The average cost of a low volume internet account in North America is less than $20 per month compared to about $65 in Africa.

It also remains a fact that the newspaper business and in fact the media in general thrives on advertising revenue but where big time advertisers who can provide the succour badly needed by the media for their sustenance are often big time industrialists whose activities impact negatively on biodiversity reserves, then the newspaper editor finds himself in a dilemma as these businessmen would not give you adverts for you to turn around and expose their environment unfriendly activities. This lack of adverts is indeed contributing to the refusal of some editors and media owners to devote their pages and airtime to reporting on the threats facing nature's gifts lest they saw at the hands that feed them.

Generally, environment news has also been labeled as a non-seller by most editors. Self censorship on the part of reporters is therefore to satisfy editors' priorities. Some editors are even known to turn down offers from writers willing to contribute stories on biodiversity even for free at no cost to the newspaper.

Despite these constraints under which the media operates, I must say that the future is bright as more and more journalists are showing interest in covering these subjects. The LEJ in Ghana is initiating a program to organize workshops for editors to sensitize them to the need to cover these issues. Similar workshops continue to be organized for reporters.

To solve the problem of lack of reliable and updated information on forests and other issues, the LEJ has established the Center for Environmental Journalism which is a resource center for environmental reporting. It consists of a library and reading room where journalists interested in covering these issues can find background information for the stories they want to write; case studies from other countries are also very relevant.

In the area of computers and internet connectivity, the LEJ believes that this is also very relevant as these information resources could facilitate the accessing and exchange of information on current research, provide the opportunity to contact both local and foreign experts and also search the profiles of thousands of others working on similar issues. In view of the prohibitive costs, internet development for environmental reporting in our part of the world would count largely on donor support and the LEJ is exploring the possibilities.

Indeed sustaining and maintaining the planet's biodiversity as a natural basis of life for future generations is certainly a challenge the whole world should face as a people. The threats are so enormous that no group of persons can hope to tackle them alone: they require that we act together as a world community and forge a global partnership. Without a concerted and united approach one could undo the gains of the other.

It would therefore be appreciated for instance if conservationists who undertake regular foreign trips to conferences and meetings could organize press conferences to brief the media on important issues that were discussed or conventions that were signed at these meetings as to enable them keep the public abreast of global developments. Further more, most northern Egos working on these issues publish press releases often with a northern bias which they send to journalists in Africa and other developing countries. It is important that these press releases at least have an African slant no matter how small as without this, there is a greater chance of the press release not being used more so when it is full of scientific jargon.

Invitation for press coverage of events relating to biodiversity should also encourage the reporters to stay throughout the program if they so wish instead of stating that they should cover the opening and closing ceremonies. Sitting through the discussion can be a learning process for the journalist who needs to understand the issues and as such can do follow ups or develop a story line. Inviting the media (at least I have met two other journalists here who have also been invited by the organizers to participate in the conference) alongside the experts is very commendable as we have learnt a lot.

These initiatives could fundamentally transform the prospects of journalists in the south. Most Africans for instance are constantly bombarded by conservation messages from the US and Europe but seldom are westerners exposed to the African point of view. Through these initiatives between conservationists, scientists and the media, African environmental journalists in particular can devise innovative means of transmitting their news and success stories on conservation and sustainable development while bringing the African perspective to the fore and counteracting the doom and gloom picture of Africa often portrayed in the western media.

Despite the high hopes that environmental journalism offers, stumbling blocks abound that could retard the realization of the noble objectives of awareness creation: Poverty, for instance, is certainly a major cause and effect of our environmental problems and one would be merely chasing the wind in an attempt to deal with environmental problems without a broader perspective that encompass the factors underlying world poverty and international inequality. Issues like the debt crisis and impact of structural adjustment and other IMF/World Bank loan conditionalities continue to reinforce the vicious cycle of debt, poverty and environmental degradation. The debt crisis for instance is indeed escalating and most southern countries like Ghana are increasingly being forced to orient their economies paying debts. The last shreds of the country's forests are being exploited or given out to mining firms to do surface mining as a way of earning foreign exchange. The truth is that even basic food production is neglected for the sake of generating export earnings. The mass dismissals of workers by governments in most developing countries euphemistically termed 'redeployment' in response to IMF structural adjustment policies (SAP) has pushed a large contingent of young men and women to rivers and forested lands to plunder and search for gold in a desperate bid to feed their families. Not only have these victims of SAP been putting their lives at risk, but also they are destroying the rich biodiversity in these areas in their desperation to survive. Indeed we in the developing world are caught in a spiral of environmental degradation that is mutually reinforced by poverty and economic growth. Not until this vicious cycle of debt, poverty and environmental destruction is broken, the genuine desire of using the media to promote biodiversity conservation and thereby creating the enabling environment for sustainable development will be an uphill task. It is time the developed world also realized that they are in the driver's seat and that we share this planet and in exploiting it, we are all digging our graves. There has to be a change around in the present pattern of resource transfers which are essentially from the south to the north largely because of debt service payments and terms of trade. The developed world has to stop the over-consumption of the world's resources at the expense of others inability to meet even their basic needs. The bitter truth is that poverty-stricken nations will not be able to finance their development if they are burdened with enormous foreign debts and if prices for their commodities remain low on the world market. Indeed, southern countries should also be given a fair chance to develop since this is also a prerequisite to sustainable development.

What is more, it is increasingly becoming clear that the idea of biodiversity conservation is not a recent phenomenon. Our fore fathers knew of the finite nature of our natural resources and the need for preservation. With conservation ideas shrouded in traditional religious practices, our ancestors used forests, water and land resources sustainable for many years thus promoting conservation of vegetation, biodiversity and ecological balance. Sadly, various governments particularly in developing countries continue to use scientific, political, geographical and economic methods to contain the alarming environmental crisis; the issues of culture, particularly traditional religious practices and indigenous knowledge seem to have been ignored as a major factor in biodiversity conservation.

In their writings particularly editorials and features, media practitioner can compare and contrast indigenous knowledge systems with other global knowledge systems with a view to creating the awareness of the strength and weakness of each system.

But despite these seemingly insurmountable hurdles partnerships between media, scientists, researchers and ecologists would greatly facilitate the enhancement of biodiversity conservation perhaps what is needed most is how to strengthen the dialogue and optimize contacts and communication between these parties on a regular basis and to build mutual respect between them. For now the question remains: Scientists are often wary of talking to journalists; how do we break this myth?

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Workshop: Biodiversity as a Resource

Requirements for Improved and Sustainable Use of Forest Biodiversity: Examples of Multiple Use of Forests in South Africa

Coert J. Geldenhuys

Abstract

Forests have always been a source to provide in the daily livelihood of people. In South Africa several concentrations of rural people live in the vicinity of the forests. The mixed evergreen forests cover a small area and have been fragmented due to natural fires in the generally dry landscape, and their survival are threatened by landuse practices, and by the resource use by rural people. However, more than 70% of the forests are under some form of government control and enjoy a good conservation status. The forests contain about 1500 plant species of all growth forms. A large proportion of the woody species have been used, or are still used for various timber, medicinal, food, crafts and other uses, by both people in rural areas and by the more affluent part of the South African society. A brief discussion is provided of the different uses. The current multiple-use management system which is controlled by the forestry department is discussed in more detail. The management activities include a scientifically-based single tree selection system on a 10-year felling cycle, fern harvesting, ecotourism developments, and conservation of nature reserves and other protected areas. The development of a lucrative fern industry, based on harvesting of fern leaves as greenery in the florist industry, both locally and abroad, is described as a model for sustainable commercialization of other non-timber forest products. In conclusion, requirements for sustainable resource use and an approach for development of alternative production systems which will also contribute to restoration of forest biodiversity, are discussed.

Background

Forests always have been, and still are, a traditional resource for daily livelihood of people. In rural communities traditional knowledge systems exist on the characteristics of the species and what they are good for. Generally formal statistics only provide data for commercial use and value of a few species, and usually only for the timber species. Ethnobotanic surveys show that traditionally many forest species are used for a wide range of needs, particularly subsistence needs, but very few of these are currently used for commercial gain in the formal sector. Such surveys usually list only the species and their uses, and mostly provide no information on their relative use-value and their use impacts on the natural resource. Many of those species have become overutilized and threatened by total eradication from the wild.

In South Africa several concentrations of rural people occur in the vicinity of the forests, such as in the Amatole mountain region (former Ciskei), along the Wild Coast (former Transkei), in KwaZulu/Natal, and in eastern Mpumalanga and north-eastern Northern Province. Some of the population and socio-economic issues which relate to sustainable management of the forest resources in these areas include land tenure systems, intellectual property misuse, and population growth and demography. Extreme poverty in many of the communities lead to increased pressure on the forests, and even forest clearing. Urbanization and changed life styles cause the loss of local indigenous (traditional) knowledge. There seems to be a relationship between satisfying rural resource use needs and biodiversity conservation. At least in the short to medium term there is a real need for commercialization and domestication of indigenous forest products to assist in rural socio-economic development and environmental conservation.

Many international initiatives, leading from the UNCED Earth Summit in Rio de Janeiro in 1992 (Keating 1993), have generally accepted the following definition of sustainable forestry: "the stewardship and use of forests and forest land in a way, and a rate, that maintains biodiversity, productivity, regeneration capacity, vitality and their potential to fulfil, now and in the future, relevant ecological, economic and social functions, at local, national and global levels, and does not cause change to other ecosystems." The definition requires policies that integrate forests in rural development efforts, and has environmental, economic and social components. It requires also that environmental and economic needs be balanced among local, national, regional and global interests.

The purpose of the paper is to

- briefly describe the mixed evergreen forests in South Africa and their management;
- discuss a few case studies of resource use from the forests;
- recommend a framework for sustainable multiple resource-use from the forests.

Forests and forest biodiversity in South Africa

Forest biogeography

Mixed evergreen forests form the smallest, most widely distributed and most fragmented biome in southern Africa (the area south of the Kunene and Limpopo rivers) and covers only about 3000 km^2, or 0,08% of the country (Anonymous 1987; Geldenhuys 1996a). Forests occur along the eastern coast and escarpment of the region, with high rainfall, from the Cape Peninsula (34° S) to the Soutpansberg (22° 40′ S) and the Tongaland coast (27° S) (Cooper 1985; Anonymous 1987). High forest (10 to 35 m tall) and scrub forest (3 to 10 m tall) persist in areas with mean annual rainfall >525 mm with strong winter rain and >725 mm with strong summer rain (Rutherford & Westfall 1986). They occur on a wide range of geological formations (Geldenhuys 1996a).

Few large forest complexes occur and these are widely separated. The largest single forest (25 706 ha) occurs around Knysna in the south (east of George) and is part of a complex of 60 560 ha at 34° S and between 22° E and 24° 30′ E (Geldenhuys 1991a). The Amatole forests in the Eastern Cape covers 40 550 ha between 32° S and 33° S latitude, and 26° E and 27° 30′ E longitude (Thompson 1991) with a single unit of >8 000 ha in the Pirie-Isidenge-Kubusie area. In Kwazulu-Natal the Dukuduku forest is the largest (3 500 ha) but is seriously threatened by uncontrolled settlement of people. The Woodbush-De Hoek forest (6 626 ha) is the largest forest along the Transvaal Escarpment (Cooper 1985). The majority of forests are less than 100 ha in size (Cooper 1985; Geldenhuys 1991a). Smaller isolated but geographically important forests occur in the areas between the larger forest complexes around Knysna, the Amatole forests, the Kwazulu-Natal coastal and montane forests, and the Transvaal Escarpment forests (Cooper 1985; Anonymous 1987; Von Breitenbach 1990; Geldenhuys 1991a, 1992; Cooper & Swart 1992; Everard & Hardy 1993).

The relic nature of the forests within the fire-adapted sclerophyllous shrublands (Fynbos) in the south-western regions, and grasslands and deciduous woodland in the summer-rainfall areas, had been attributed to the destructive activities of man during the relatively recent 100 to 300 years. However, patterns of forest distribution were affected by climatic and landscape changes over geological time scales (Deacon et al. 1983; Scholtz 1986). Geldenhuys (1994a) demonstrated that environmental factors (rainfall and substrate) determine the potential limits of forest distribution, but that actual forest location pattern is determined by the fire pattern, which in turn is determined by the interaction between the prevailing winds during dry periods and terrain physiography. Bergwind direction is locally changed due to barriers posed by the position and form of the mountain ridge to the windward (northern) side of the forests, and is channeled through valleys running from the mountains. Forest persist in the windshadow areas. Feely (1986) indicated that most of the present southern African grassland existed throughout the Holocene and was not induced by forest clearing over the last 100 to 300 years. For example, Iron Age farmers in Transkei settled in high density in preferred sites in presently wooded areas for at least the last 1 400 years. Forest and scrub forest have been continuously cleared and exploited for timber, plant foods and medicines. The fragmentation had been aggravated by current landuse practices, such as clearing for agriculture, forestry and subsistence utilization, and veld burning practices for grazing and improved water runoff in catchments (Phillips 1963; Cooper 1985; McKenzie 1988; Geldenhuys et al. 1986, 1988; Geldenhuys 1991a).

The forest interior is subject to regular small-scale disturbances causing gaps about 0,005 to 0,1 ha in size (Geldenhuys & Maliepaard 1983). Lightning and man-induced fires, flooding and landslides on steep slopes during heavy rainstorms (Bosch & Hewlett 1980; Pammenter et al. 1985; Geldenhuys 1994a,b) occasionally expose larger areas in the forests. Various studies have been conducted to understand the processes of recovery from these disturbances and to apply them in practice (Geldenhuys et al. 1988; Geldenhuys 1994c,d, 1995; Van Wyk et al. 1995).

Forest composition and biodiversity patterns

The mixed evergreen forests in South Africa represent two main forest types whose floras have strong affinities to the tropical forest flora of Africa (White 1983): forests of the Afromontane Region

Table 1: Number of species by growth form in the mixed evergreen forests of South Africa, based on 14 selected forests or forest complexes (adapted from Geldenhuys 1992)

Growth form category	Number of species	% of total
Canopy trees	109	7.6
Sub-canopy trees	185	12.9
Woody shrubs	274	19.2
Soft shrubs	58	4.1
Woody climbers (lianes)	77	5.4
Vines	122	8.5
Ferns (erect rhizome)	58	4.1
Ferns (creeping rhizome)	38	2.7
Epiphytes	58	4.1
Geophytes	75	5.2
Graminoids	94	6.6
Herbs	282	19.7
TOTAL	1430	100.0

along the escarpment; and forests of the Tongaland-Pondoland Regional Mosaic along the coastal dunes and lowlands. They are composed of a diverse range of species and growth forms. Geldenhuys (1992) listed 1 438 species which had been recorded for 14 forests or forest complexes representing the geographic range of the mixed evergreen forests in southern Africa. These included 155 families and 661 genera. The forests cover only 0.08% of the area and 7.1% of the vascular species, but have a relatively rich 0.58 species/km^2. Only fynbos exceeds the forest value with 1.36 species/km^2 (7 316 species). The third richest biome is grassland with 0.25 species/km^2 (3 788 species). Table 1 shows the composition of the forests in terms of growth forms.

Species richness remains relatively constant along the tropical-temperate gradient of southern Africa except for the south-western extreme (Geldenhuys & Macdevette 1989; Geldenhuys 1992). Forests of the east coast (Natal north coast and southern Natal/Pondoland Umtamvuna sandstone complex with a large proportion of endemic plants) have the highest number of woody species (254 and 338 species respectively) and the south-western Cape and Cape Peninsula forests and a high-altitude escarpment forest have the lowest number (78, 48 and 76 species respectively). In the southern Cape, the mountain and coastal forests are continuous in places (Geldenhuys 1991a) and contain elements of both the coastal and montane zones of further north and of the southern temperate element (Geldenhuys 1993b).

Species richness varied more within a forest than between forests (Geldenhuys & Macdevette 1989). Montane forests, in general, have fewer species than lowland, coastal and dune forests, both in KwaZulu/Natal and the southern Cape. Furthermore, drier (warmer?) forests are richer in species than wetter (cooler) forests. The different growth forms also show clear patterns amongst the different forest types. Relative richness of herbaceous plant species is greater in the moister areas, and of woody plant species is greater in the drier areas. Species richness for woody plants increases more sharply than for herbaceous plants from montane to platform (lowland) forests.

Taxa shared between forests show at least three patterns (Geldenhuys 1992). Firstly, forests share many more of their species with forests to their north and east than with forests to their south and west. This indicates the erosion of species from the two tropical source areas (in East Africa). Secondly, forests share many more species with their nearest neighbors than with forests further away. Thirdly, the Afromontane forests (including those near the coast in the south) share relatively fewer species with the forests of the subtropical coastal areas. A large proportion of the species are unique to individual forests: 33% of the woody and 42% of the herbaceous species.

Direction and rate of change in species richness also vary with type, intensity and frequency of disturbance. The general patterns suggest that undisturbed forest is somewhat richer than disturbed forest, and that mature forest is richer than regrowth or seral forest. Furthermore, along the seral stages from scrub, through bush clumps and forest margin to mature forest, the floristic and structural composition continually change and species richness increase (Geldenhuys 1993b). The major disturbances of the forests which relate to conservation requirements are of three types:

- Selective harvesting of forest products (Phillips 1963; Scheepers 1978; Geldenhuys 1980; Cunningham 1985), which cause different types of vertical and horizontal gaps in the forest by removing large canopy trees, layer communities or particular growth forms, must have long-term consequences on forest dynamics. However, Geldenhuys (1993c) recorded prolific regeneration of *Podocarpus latifolius* in the southern Cape forests after excessive preferential utilization of this species at the turn of the century (Phillips 1963).
- Fire is mentioned by many as the major cause for the rapid decline of the forests (Granger 1984; Cooper 1985; Everard 1986). Plantation forestry requires protection against fire and as such contributed to forest spread with the exclusion of fire (Geldenhuys 1997a; Geldenhuys et al. 1986).
- Clearing of forest for agriculture, development of infrastructure and dune mining causes the loss of species and fragments gene flow. Riverine and rare swamp forest in KwaZulu/Natal which contain many rare species have been cleared for sugar cane and other purposes (Cooper 1985).

Forest conservation status

Conservation status implies the extent to which populations, species or communities have been modified by the influences of man and the degree to which they might be expected to maintain their genetic diversity and ecological processes in the medium term (10 to 100 years). Conservation of the forests and forest biota has two major components: maintenance of the components and critical processes within a forest ecosystem through appropriate systems for sustained utilization of forest products and values, and maintenance of gene flow between the different forests through management of land surrounding the forest and forest corridors.

Ownership determines the type and quality of forest management and possible impacts on the vegetation (Phillips 1963; Cooper 1985; Cawe 1986; McKenzie 1988; Cooper & Swart 1992). The National and Provincial Governments and statutory bodies manage and control a very large proportion (>70%) of the forests and the largest forests, and only a small portion is privately owned (Cooper 1985; Geldenhuys 1991a).

Conserved forests in southern Africa range from forests in private and tribal ownership that are in good condition, to forests in conservancies and natural heritage sites, through to forests in nature reserves and wilderness areas proclaimed under the Forest Act. There are many forests outside the proclaimed areas which are well conserved but with insecure conservation status. The forest types and forest complexes in southern Africa are generally well conserved (Geldenhuys & MacDevette 1989). Along the entire South African coast the seaward slopes of the coastal dunes and the dunes within a 1 km restricted area are proclaimed under the Environmental Conservation Act. In KwaZulu/Natal where many forests are on private land, the Conservancy system and the Natural Heritage System hold out hope for conservation. It is noteworthy that controlled utilization of reserved trees and ferns on private land through a permit system contributed to forest conservation in many areas. A series of nature reserves provide for the conservation of large areas of forest.

Various sources still exert pressures on indigenous forests (Geldenhuys & Macdevette 1989):

- Growing human needs in rural tribal areas.
- High intensity farming interests such as in the eastern Cape lowlands cause the clearing of scrub forest and riverine forest for agriculture.
- Economic pressures cause uncontrolled exploitation, grazing and burning of forests on farms.
- Mining of forested dunes continue along the KwaZulu/Natal north coast.
- Development of infrastructure (roads, powerlines, dams) and township and resort developments (Geldenhuys et al. 1988; Geldenhuys 1993d).

Use of Forest Biodiversity in South Africa

General patterns

The forests in South Africa play a role in the welfare of society which is disproportionately greater than their small extent and low potential for commercial exploitation. Management of the forests range from a low income subsistence utilization of the headmen's forests applied in rural areas for building material, fuelwood and household goods, and the sophisticated multiple-use management system (timber, minor forest products, ecotourism) applied in the State Forests. Recognition of the uses and values of forests is one of the basic requirements in order to reduce conflicts in landuse options. McKenzie (1988) recognized many direct uses and indirect values of the South African forests. A species list for 14 forests and forest complexes in South Africa (Geldenhuys 1992) were used to summarize the uses recorded by Palmer and Pitman (1972) for the tree and shrub species in South Africa (Table 2). A recent survey of 21 villages for forest resource accounting in the Eastern Cape Province (with many forests in poor rural areas) showed much informal commercial and subsistence use of the forests (R. Hassan & J. Havemann, pers com 1997). The survey used local vernacular names, which means that the number of species covered is as yet unknown. Some common names cover more than one species, or one species may have several common names. A total of 140 tree and shrub "species" were recorded, some of which are more widely and generally used than others, but not all are indigenous species. The uses include a variety of poles (mainly for construction), firewood, crafts (from timber and non-timber species), binding and weaving, food sources (vegetables, fruits, and meat), and traditional medicine (bark, roots and other sources).

Direct uses

Many of the species are still used by people living in the rural areas. Poverty of the rural people and their inability to afford alternative commodities cause a contin-

Table 2: Number of tree and shrub species in the South African forests which have been or are still used, traditionally and/or commercially, according to Palmer and Pitman (1972).

Category and uses	Canopy trees	Sub-canopy trees	Woody shrubs
Total in forests	109	185	274
Total used	102	143	120
Timber:			
Furniture	43	13	–
Construction	40	26	6
Poles	15	22	6
Fuelwood	18	25	4
Ornamental	45	42	18
Traditional medicine (by plant part used):			
Leaves	10	22	15
Fruit	2	5	2
Bark	34	34	4
Roots	10	17	13
Other	18	16	13
Food (by plant part used):			
Leaves	–	3	3
Fruit29	38	29	
Roots	2	–	2
Other	2	2	–
Crafts (from other than timber):			
Basket	–	2	3
Weaving	1	–	–
Binding	2	7	6
Other (including dyes)	6	12	2
Other uses:			
Horticulture	83	100	93
Floristic	–	2	–
Other	15	10	12

uous use of goods they use from the forests and increased forest clearing to grow crops to support their families. Climbers, leaves, leaf petioles and tree bark are sources of binding materials (Cunningham & Gwala 1986). Wood use for building varies with building style and availability of materials but a variety of species have been recorded (McKenzie 1988). Livewood is cut for tall straight poles and laths. Selection for durable, termite resistant species results in cutting of species with low annual increment. Fuelwood represents the highest volume of forest products used by rural people. Fuelwood gathering focuses on forest where they are not surrounded by woodland or plantations and woodlots of introduced species. Where wood resources are abundant, hardwoods from the native evergreen forest, producing little smoke, are selected. When fuelwood resources are depleted, people either travel greater distances to collect preferred wood, or cut less preferred species and livewood from the same area, or reduce firewood consumption by using alternative but expensive fuels (McKenzie 1988).

Traditional medicines are important to rural communities for medical, psychosomatic and economic reasons (McKenzie 1988). Traditional medicinal forest plants include trees, shrubs, climbers, epiphytes and parasites. Some of the characteristic faunal elements of forests are also important for this purpose, particularly pill millipedes, baboons, genets, and snakes. Urbanization of people who migrate from the rural areas causes the loss of their traditional knowledge and dependence on some of the forest species. However, their dependence on species used for traditional medicine generated a local and countrywide multimillion Rand annual trade between rural source areas and urban markets and shops (Cunningham 1986; Williams et al. 1997). This trade increased the pressure on the forests in the rural areas.

Edible fruits, wild spinaches, honey and edible fungi provide important dietary supplements to rural people in less developed areas, providing nutrients deficient in the starchy staple diet. This role is increased during drought periods, particularly in marginal agricultural areas (Grivetti 1979). Fruits are primarily a source of vitamin C and are poor sources of Ca and nicotinic acid (Cunningham 1985). Forests provide habitat for animal species which are valued targets of communal (for food) and recreational hunting. Due to their aesthetic value there is an increasing demand for rare birds, butterflies and moths some of which occur in forest (McKenzie 1988).

Several home crafts are based on sources from the forest (McKenzie 1988). Various palms, reeds and climbers are used, mainly for baskets and mats. Forest hardwoods are used for sticks, grinding mortars and domestic items such as meat dishes. Commercial sale of wooden items probably accounts for higher localized use of wood than minor use for utilitarian purposes. Around Port St Johns along the Wild Coast (former Transkei) over 100 people are directly employed in craft work and they earn an annual income over one million Rand or 0.2 million US$ (Obiri & Lawes 1997). However, that craft trade is considered as unsustainable because marketing is poor, prices are unrealistically low, wood wastage is high and tree poaching is prevalent. Along the Wild Coast (former Transkei), a local craftsman sells wood carvings for R200 to R400 a piece, but is often not allowed to collect his preferred species. Some individuals earn about R600 a month from basket making.

Resource use from forests in many of the rural areas causes conflicts with government authorities who have the responsibility to ensure the conservation of the forests. The authorities control the harvesting of resources through a permit system, but even the very low permit rates exceed what the locals can pay, which leads to illegal activities. In many areas deforestation is continuing at an alarming rate, primarily for maize cultivation, to provide in the daily food needs of the very poor people. Cutting trees for construction poles and firewood is a secondary cause of forest degradation, but considered essential as the rural people have no money to buy such products. This degradation of the forest causes the loss of other sources of income such as wood crafts and the basket industry. The Eastern Cape Resource Accounting survey indicated a number of wrong perceptions on both sides which relate partly to the real meaning of sustainability, and partly to the true dependence of the poor rural communities on the forests for their daily livelihood. This accentuates the need for implementation of joint resource management strategies in the rural areas to resolve the conflicts and to ensure sustainable resource use and socio-economic development.

With the settlement of the European in southern Africa since 1652, large diameter trees of selected species were harvested for building and furniture timber, and for railway sleepers (Phillips 1963; McKenzie et al. 1977; Scheepers 1978; Cawe 1986). The number of species used for furniture timber has declined dramatically. Furniture timber is currently provided mainly from the relatively large southern Cape forests (Geldenhuys 1996b) where this industry has an annual turnover of >15 million Rand (about US$ 4 million) and employs about 650 people, and from the Amatole forests. Today commercial plantations of pines, eucalyptus and wattles, covering >1.4 million ha, provide in the structural timber needs of the region. They were established in the grasslands and shrublands surrounding the forests, and rarely in areas where evergreen forest were cleared. The plantations aided the rehabilitation of the forests, and expansion in places, released pressure on the forests for timber, fibre and firewood needs, and protected forest margins against frequent fires (Geldenhuys et al. 1986).

For some species new uses were developed, such as the plants used for gardening (see Table 2) and by florists. Many nurseries focus in part or entirely on indigenous species, many of which are forest species. Fronds of the fern *Rumohra adiantiformis* are used extensively in the florist trade, both locally and abroad. Epiphytic mosses have been harvested from Transvaal forests as packing material for flowers, for floral arrangements and exhibition purposes (Jacobsen 1978).

Forests play an increasingly important role in providing for the recreation and aesthetics of the growing urbanized and industrialized societies of southern Africa. Many picnic sites, view points, camping sites, forest walks and hiking trails in forests offer unique experiences (Levy 1987; Vermeulen 1993). The availability of such trails are also important in the tourist industry and in conservation education.

Forests also have cultural importance as burial sites such as Thathe forest of the VHavenda (Netshiungani et al. 1981) and the burial site of the Zulu chief Dingaan in Hlatikulu Forest (McKenzie 1988). Undisturbed forest and wooded copses persist around major grave sites in many parts of southern Africa due to the acknowledged importance of the role that ancestral spirits play in daily life and the value of ensuring them peace (Parker 1982).

Indirect values

Anecdotal evidence suggests that a protective forest cover ensures a sustained flow of water from catchments more evenly throughout the year (Cooper 1985). The forest cover prevents soil erosion and driftsand formation in coastal and inland areas (Bosch & Hewlett 1980; Tinley 1985). Faunistically and floristically forests are amongst the richest biomes known and are thus extremely important in terms of conservation of genetic diversity. Preservation of plants which may still have important utility is also important in order to allow experimentation and research. Some forest tree species have been identified as potential crop plants on the basis of their palatability, nutritional value and appearance (Cunningham 1985). Similarly, plants which have great potential to modern pharmaceutical medicine may be restricted to forests.

Forests are often affected by alternative land uses. They are used as winter shelter and grazing for livestock. Grazing by cattle causes soil erosion in upland areas in the eastern Cape and Natal midlands, destroy understorey vegetation to a larger degree than the natural browsers in many areas and open up the forest interior, and render them more prone to fire damage and invasion by alien invaders (Phillips 1963; Geldenhuys et al. 1986). Agriculture, forestry, power-lines, road-building and township development do cause some loss of forest cover (Cooper 1985; Geldenhuys & Macdevette 1989; Geldenhuys et al. 1988; Geldenhuys 1991a, 1993d).

Case study of multiple-use management system of the southern Cape forests

Two large forest complexes, the Knysna-Tsitsikamma (southern Cape) forests and the Amatole (eastern Cape) forests, are mainly state-controlled and managed under a formal multiple-use system, with close monitoring to ensure sustainable use. The southern Cape forests had formerly been heavily exploited by European settlers until 1939, but have never been, and are not subjected to recent or current pressures of a growing poor rural population. The initial timber exploitation and destruction of the forests was followed by forest protection and the development of scientific management systems (Phillips 1963; Geldenhuys 1980). Today timber and other minor but important forest products are utilized conservatively from ecologically suitable but small areas of State Forest in the southern and eastern Cape (Geldenhuys & Van der Merwe 1988, 1994; McKenzie 1988; Milton 1987a,b; Seydack et al.. 1990; Van Daalen 1991; Vermeulen 1993; Seydack 1995). Scientific and multiple use management principles are applied in order to sustain utilization of forest products, eco-tourism, and conservation. Five management classes determine the management objectives (indicated as proportion of the total area): production of timber and ferns (19.7%); protection of ecologically fragile areas (55.8%); nature reserves with enhanced conservation status to maintain ecological diversity and genetic resources (23.0%); recreation facilities for intensive public use (0.4%); and ecological and silvicultural research (1.1%).

Timber harvesting

Timber harvesting, the main management activity, is done on 26% of the total area of state-owned forests (35 700 ha), i.e. only part (49%) of the moist to medium-moist forests. The yield regulation system is based on Senility Criteria Harvesting and other scientific principles, and is aimed at providing sustainable yields over a 10-year felling cycle. Of the 20 potential canopy tree species in the moist to medium-moist forests, five species are in high demand on the timber auctions, and seven others are in more limited demand. Of the 20 potential sub-canopy tree species, only one used to be in great demand for the export trade, but that use has declined to zero. During the 1994/95 financial year, about 1100 m^3 of indigenous timber and 1500 m^3 of Australian blackwood (an invader tree in forest gaps) were sold for about 1.9 million Rand (US$ 0.38 million).

Two systems for the removal of marketable timbers are in use in the single-tree selection system applied in State Forests: optimal productivity harvesting of trees selected from a stand on the basis of species growth and mortality rates; and harvesting of dead and dying trees of commercially valuable species. Critical elements of the management system are:

- Timber is harvested by the State forestry personnel to control impacts on the forest;
- Large utilizable trees are topped before felling to reduce canopy damage and ensure minimize gap disturbance (Geldenhuys & Maliepaard 1983);
- Special extraction equipment is used to minimize soil compaction and drainage disturbances;
- Timber is sold by auction to realize the best timber prices through the supply-demand mechanism on the price. Through this system high quality silvicultural management can be practiced and the scarcity value of the timber is acknowledged.

In the optimal productivity harvesting system single trees are selected from a stand for removal proportional to the relative density of species in diameter classes above 300 mm. Large non-utilizable trees are girdled to die standing and gradually release shade (Geldenhuys 1982). In the mortality retrieval harvesting system dead and dying trees of commercially valuable species such as *Ocotea bullata* (Lauraceae)and *Podocarpus latifolius* (Podocarpaceae) are utilized. This method is also applied in the Amatole forests in the eastern Cape.

Forest inventory data have been used as a basis of yield regulation for sustained-use of the forests (Geldenhuys 1991b). The data are recorded on 400 m^2 plots sampled on a grid of 100 m x 80 m which cover the areas identified for timber harvesting. All trees 10 cm DBH are recorded per plot by species and DBH. The sampling data can be used to assess at least four components of the forests (Geldenhuys 1993a):

- Forest communities and the importance of different species in the different communities;
- Grain, i.e. the relationship between composition of canopy species in the regeneration and in the canopy of the same stand to gain some understanding of the scale of forest disturbance processes (Midgley et al. 1990; Geldenhuys 1996c; Everard et al. 1995);
- Shape of diameter distributions within species over different communities, which provide useful insights into the resource status and recruitment requirements or constraints for the specific species (Geldenhuys 1993a,c,e, 1996b);

■ Standing growing stock (stand basal area/ha, volume/ha) of useful species. The form of the diameter distribution indicates the ecological behaviour of a species in relation to the typical disturbance regime of each forest community as indicated by the analysis of grain (Geldenhuys 1993a, 1996b; Everard et al. 1995). For example, the inverse J-shaped curve in evergreen forest is typical of the shade-tolerant species of the small-gap forest, whereas the bell-shaped curve is typical of dominant species of forest with regular large-scale disturbances.

A small set of long-term study sites were established since 1987 to provide data on recruitment, growth and mortality for the South African indigenous forests to improve the yield regulation for sustainable timber harvesting (Seydack et al. 1990; Van Daalen 1991, 1993a,b,c; Vermeulen 1993; Geldenhuys 1997b, 1998). Growth data in relation to tree crown characteristics were used to develop the senility criteria for selection of trees for harvesting, i.e. trees which will most likely die during the next 10 years (Seydack 1995).

Fuelwood is prepared from branchwood of utilized trees and of trees removed for which there is no timber market.

Fern harvesting

Fronds (leaves) of *Rumohra adiantiformis* fern, a protected plant which was formerly illegally harvested, are now commercially harvested on a controlled and sustainable basis from about 20 000 ha of the southern Cape forests, for greenery in the florist trade. The fern has a wide distribution in the forests, and is particularly abundant in some parts of the forest. During 1982 interested people in the florist industry asked for approval to harvest the fern. Initially the request was declined by the forest managers, whereas the researchers were in favour of a pilot trial to harvest the fern. The conflict was partially resolved by agreement on a joint fern harvesting practice. This consisted of implementing a research programme on assumed critical aspects of fern ecology, harvesting by the contractor along agreed practices and a "conservative" harvest frequency and intensity, and monitoring by forest management personnel. No information was locally available and it was decided to adopt an "adaptive management research" approach. The research programme focussed on

■ Growth rate through leaf development stages

■ Allometric relations between leaf size, stalk length and rhizome thickness

■ Harvesting frequency impacts on growth rate and size of the leaves and nutrient content of plant parts as dependent variables

■ Long-term monitoring plots in harvested areas to assess potential impacts on the resource and changes in the fern population and forest regeneration

■ Study of fern composition in different forest types.

Interim results from the fern study and from the monitoring by the forest management personnel were implemented where necessary and after consultation with the contractor. After three years a thorough assessment was made of the fern harvesting practices. The main results were as follows (Geldenhuys & Van der Merwe 1988, 1994; Milton 1987a,b):

■ In the controlled field experiment leaf size decreased with frequent harvesting. Monthly harvesting reduced leaf size to 24% of the controls (no harvesting) and 5-monthly harvesting reduced leaf size to 51% of the controls. Maximum number of buds produced in the controls was about double those produced in harvested plots, but harvested plants produced new buds over a longer period. In the commercially harvested fern stands there was no difference in the production of buds and mature leaves between the harvested and unharvested areas. The effects on bud production and leaf size were attributed to the high content of potassium (K) and a disruption in the internal nutrient cycling within the plant of both phosphorous (P) and K. P and K declined with increasing leaf age. K levels are particularly high in young tissue and plant parts of intense metabolism, and promotes water content of the leaves. Too frequent harvesting of all mature leaves deplete the nutrient resources in the plant, decrease leaf size and decrease leaf longevity. Leaf size determined leaf quality on the market and therefore provided a basis for easy monitoring.

Both buds and mature leaves developed throughout the year, but maximum numbers developed during particular seasons, i.e. maximum bud production in spring to early summer, and maximum mature leaves during mid to late summer. Harvesting was therefore reduced during the spring - early summer period to reduce damage to the young leaves.

■ The total age of mature leaves varied considerably, i.e. 23 to 32 weeks. Harvesting frequency (cycle) therefore had to be longer than this period.

■ Fern density was highest in forest in a regrowth stage, from the mountain to the coastal forests. The fern prefers moist, well-drained sites, but dense stands are typical of fire-disturbed sites. Its density is low in forest with a dense shrub layer, i.e. in mature forest. This means that harvesting may increase the rate of successional development of the forest after disturbance. This was particularly evident during dry periods.

Through the joint fern harvesting and adaptive management research approach it was possible to ensure a sustainable fern harvesting from the forest. Within the first three years the harvest cycle was increased from 5 weeks to 15 months, and the harvesting intensity was reduced from 100% to 50% of mature leaves. The harvesting area was gradually increased from 4 000 ha (1982) to 20 000 ha (1994). Harvesting was done by two private contractors to ensure some competition between them. The allowed sustainable harvesting levels in the forest did not produce enough leaves to satisfy the market needs. Interested persons in the area were encouraged and assisted to grow the fern outside the forest. Farmers and other people started to grow the fern on their property, with irrigation, in the understorey of existing small forest patches and plantation stands of mainly pines. Others grow the fern in shade-cloth nurseries. The industry contributed to the following: i) a farmer-based co-operative to facilitate fern harvesting, packing and exporting; ii) extra job opportunities for several hundred members of farm worker families; iii) better protection of the small forest patches on the farms because of their added use value; iv) direct revenue for the forest service which amounted to US$ 0.1 million in 1994/95 plus several million US$ for the farm-based industry.

Bark harvesting

Historically the southern Cape forests were not surrounded by indigenous people who depended on the forest resources. Recently people migrated from rural areas to the east to look for job opportunities in the towns in the area. Bark harvesting for traditional medicine from this forest complex is not supported, but happens illegally. Thirty five of the canopy and sub-canopy tree species of this area are ethno-botanically used in the KwaZulu-Natal area, mostly the bark and/or roots. Of these, the bark of nine species have been illegally used from both state-controlled and private forests in this area (in 1989/90), and it is likely that this illegal use has increased since then. A preliminary study was conducted to assess the potential to use bark from the harvested trees to sell to the traditional healers (Geldenhuys & Lübbe 1991). It was also considered possible to develop a joint venture between some traditional healers and the forest management authorities to harvest bark from the forest on a sustainable basis, integrated with the other forest management activities. It will be necessary to conduct further studies to support such a joint venture.

Ecotourism

Ecotourism is intensively practiced in the forest through activities such as picnicking and camping, forest walks, hikes and views from vantage points, all of which have the rich biodiversity of the forest as the basic attraction. In 1994/95 the income from visitor use of some of these facilities (two sites with big trees and two forest walks) was 0.56 million Rand (US$0.112 million). Several local private tour operators are almost totally dependent on the forest for their small industries. Sale of indigenous plants from the forest nurseries amounted to 0.029 million Rand (US$0.006 million) for the same period, but many other private nurseries in the area also sell plants of indigenous forest species.

Conclusion: Requirements for Sustainable Resource Use

The multiple-use system practiced in the southern Cape forests provide for a sustainable use of the biodiversity of the forests. It is based on resource information, on a knowledge of the ecological processes (such as disturbance and recovery, recruitment, growth and mortality of the key species, and nutrient cycling), a monitoring system to timeously detect adverse impacts, a supporting ecological research programme, a knowledge of the market needs, and a price structure for products which relate to the scarcity value of the forest components. The process to commercialize the use of the fern provides a basis for development of strategies for better use of forest products in rural areas.

In the rural areas a process needs to be implemented to resolve conflicts between resource users and resource managers, to improve diverse commercial use of the natural resources and to ensure sustainable resource management. Figure 1 shows the relationship between different components of sustainable resource use.

The process to implement sustainable resource use should consist of the following components and activities:

- a survey amongst rural communities of current tree and non-tree products used from natural forest, in particular why they use the particular species for specific products;
- identification of high potential, high impact species for commercialization;
- implementation of a series of studies of the selected species to cover biological, ecological, genetic, production and socio-economic studies;
- support of the development of small, micro and medium enterprises, along with potential business partners, to the benefit of the rural communities and biodiversity conservation of the forests in the area.

The study of a specific species should

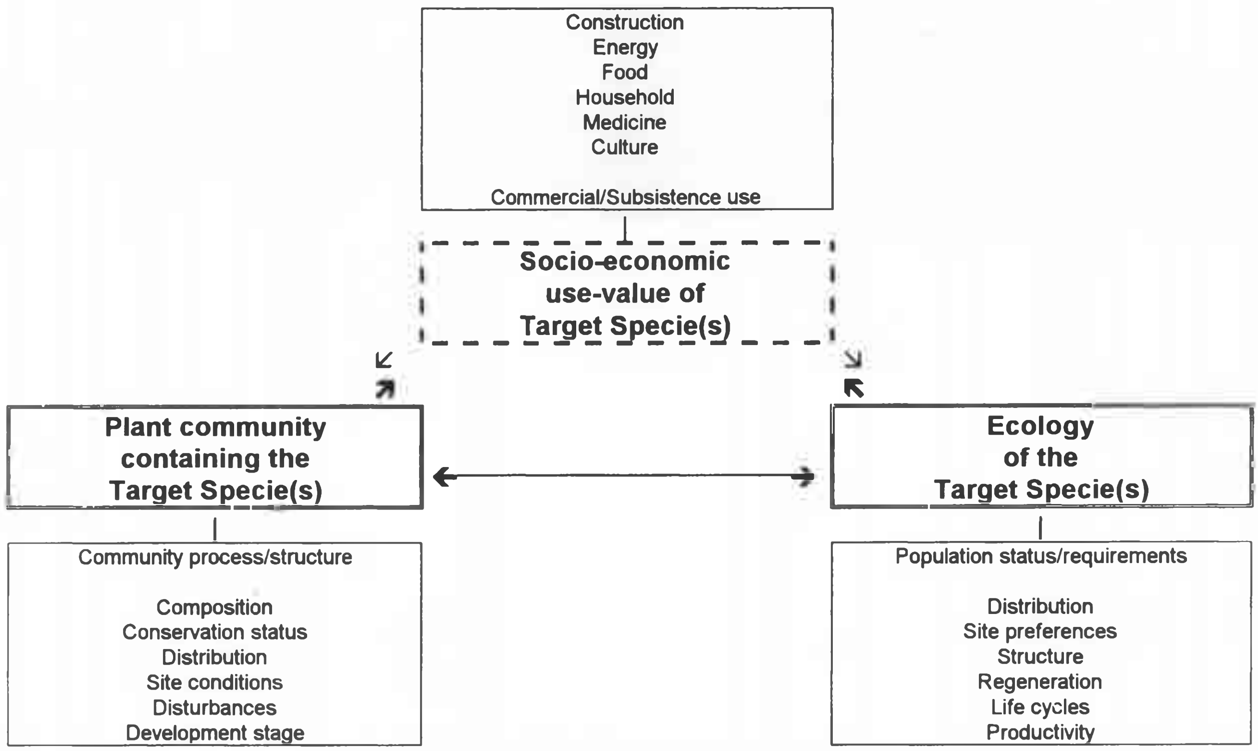

Figure 1. Relationship between the components of sustainable resource management.

incorporate the following studies:

■ Ecology and resource status of the species (population dynamics, biophysical site relations, key constraints of life cycle [development] stages, eco-physiological requirements, rates of growth)

■ Ecology and status of the vegetation in which the species occurs (key ecological processes, species composition in different development stages)

■ Socioeconomic value and use of the species - including

– local indigenous knowledge of species (names, why specific uses)

– traditional practices of resource harvesting

– local benefits

– market needs

■ Alternative production systems to supplement or substitute production from the forest, and biodiversity/production restoration systems. Recent studies of the catalyzing effect of tree plantings to restore forest biodiversity and productivity provide a basis for combining forest restoration and production of the plants used by rural communities for their daily livelihood (Geldenhuys et al. 1986; Geldenhuys 1996b, 1997a; Parrotta 1995, Parrotta et al. 1997). In the southern Cape forests this process is used to restore forest. Many introduced tree species were planted as commercial timber plantations in forest gaps, and in grassland and shrubland along the forest margins, since the late nineteenth century. The species selected were generally easily raised, fast-growing, light-demanding species from rainforest or other sources. They protected forest margins against frequent fires (because of the plantation fire protection practices) (Geldenhuys et al. 1986). They facilitated the establishment of the shade-tolerant forest species, as was shown from a study in the southern Cape (Van Wyk et al. 1995) and in the northern Province (Geldenhuys 1997a). They could also be used to convert stands of alien invader plants to regrowth indigenous forest (Geldenhuys et al. 1986). This nursing role of alien invader plants were shown to be similar to that of the indigenous pioneer trees. The initial pure stand of the indigenous or alien pioneer tree is gradually colonized and enriched by the shade-tolerant species of middle to late seral stages (see Figure 2). Litter accumulation in the seral stages after disturbance restore the nutrient cycling and determine the rate of colonization and recovery.

■ Core conservation areas (reference areas)

■ Monitoring of resource use impacts

■ Ecological and socio-economic research programmes to support and guide sustainable practices.

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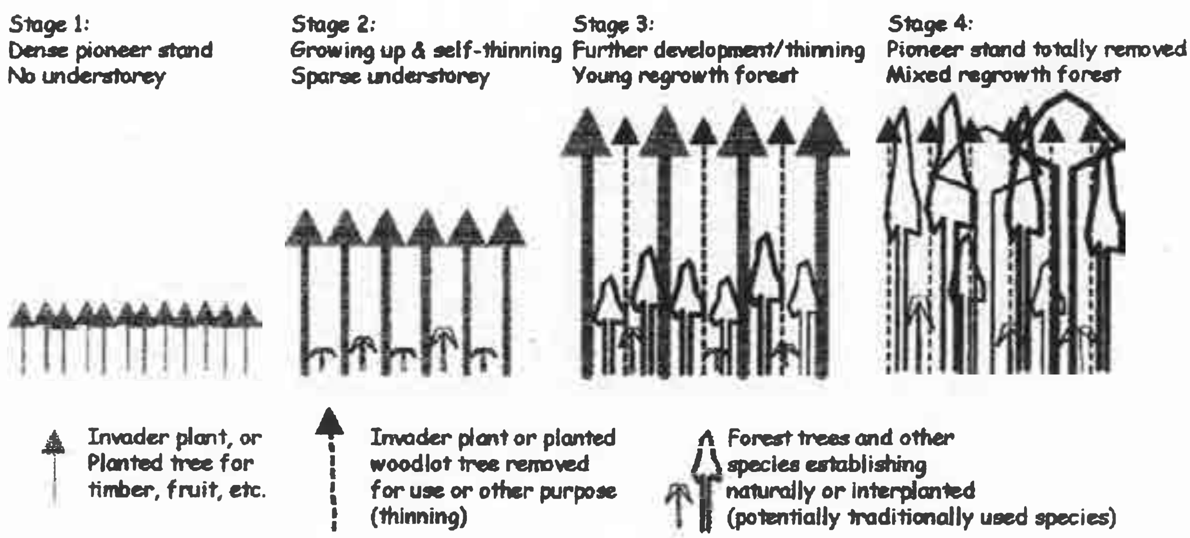

Figure 2: Conceptual model of the stages in restoration of the biodiversity and increase in potential use value of a woodland planted and 'manipulated' on the forest margin (adapted from Geldenhuys 1995).

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Importance of Vertical Stratification and Horizontal Patchiness Concerning Species-Diversity in Managed Forests – A Comparison

Wolfgang Scherzinger

Concepts for species preservation in managed forests require knowledge of two basic data:

– the species sample – specific to forests;

– the characters of forests, – significant to habitat quality.

Both questions should be discussed in relation to natural – respectively primary – woodland, as these ecosystems represent a remarkable part of our natural heritage!

1.1 Classical attempts to "nature conservation in forests" consider floral and faunal species of old growth in so called steady state or climax-phase. This means a focussing on ecosystems mature and old, with a high level of constancy – and therefore a point of gravity in species of a complex canopy and of ground-litter – usually in deep shadow – as well.

1.2 Following a dynamic aspect of forest development I recommend, to number the sum of all the potential characters of forest – within its natural development – as its specific diversity of habitats and species (this means successional stages, secondary forest, edges and gaps or even clearings created by disasters) – in addition to the sector of closed old growth with relatively poor diversity under a shadowing canopy.

Looking at a very different grade of rarity in the phases of forest development (like old growth-, die back- and break down-phases) and a very different grade of threat to single ecological guilds (like xylobiontic and epiphytic organism, big Non-Passerine birds), the discussion should select all these species, which are not able to resettle in the "wake" of conventional forestry or cultured landscape respectively.

2. Species-diversity is bound to a plenty of criterias, determining habitat quality of woodland. This paper will focus on structural characters – in a wide sense, drawing upon different levels of attempt (like a-b-g-diversity) and upon different dimensions of habitat (like area, space, time).

2.1 As structural characters of forests in natural long-term development, which are important for species-diversity, I point out:

– Characters of old growth ("roughness" of tree bark and canopy, massive branches, tall growing stems, dead wood and undergrowth, long lasting conditions in a constant biotope, especially in development of treestands and soil).

– Gaps in canopy and stands, including open clearings (full of sunshine, rich in nutrients, highly productive understorey).

– Vertical stratification (as effect of non-even-aged tree stands, high diversity in tree species, rejuvenation, tolerant to shadow under storey).

– Horizontal patchiness (as effect of disturbance, reorganization and consolidation – respectively of the dynamic development of forest stands, building a mosaic of different phases in space and time).

2.2 Although the plenty of structural parameters of stand-texture determine species diversity in woodlands mutually, I will pick out 7 (8) single dimensions, which seem to be most important – and therefore dominate the discussion on nature conservation regularly:

Characters like dead wood, proportions of forest edges, patch-size and degree of canopy cover-support species-diversity up to a certain threshold – and maximizing them will not automatically lead to a maximum of diversity!

This also is the fact with the pregnant structural character of vertical stratification, which means in its maximum development a dense forest in deep shadow and a cramped canopy – which f.i. will be hindering the flight of large birds (extreme types in selective cutting forest (like „Plenterwald" of beech, fir and spruce). – Its beneficial effect is induced by multiplying vegetational surface (substrat), structures and biomass (cover, food) as – simultaneous – by reducing distances between ground layer and tree-crown (refugial distance).

From an aut-ecological point of view surprisingly we find very view species – in instance of avifauna – which will profit by a rich stratification (2 Non-Passerines/18 Passerines – within 41 selected species of forests), but vertical structures allow a drastic increase in species diversity of a stand coincidentally, as a consequence of interlocking of elements of species-specific habitats!

The horizontal structure of patchiness support much more species directly (Non-Passerines/21 Passerines – within 41 selected species of forests), showing a clear positive correlation, as long, as patches will not transgress a medium size, as dead wood makes at least 10-30% of tree-biomass and stands of old growth are part of the mosaic. In horizontal structure the function of patch-diversity is important, including short-distance neighborhood of different phases within forest development, and the texture of a divers clearing-system as well.

Comparing the importance of vertical and horizontal structures in relation to diversity – what should be topic of this "round table"– the separation of these both parameters is not so clear, as within the horizontal mosaic the patches of old growth always represent also rich vertical structures (see: mosaic-cycle-concept in REMMERT 1991)! In this context, vertical and horizontal structures are not really contrasting but additional characters.

In contrast to popular meaning, parameters of "naturalness" and species-diversity do not show a positive correlation automatically.

2.3 Which strategies are suitable to establish such structural characters in our central European woodlands ?

A model of "integration" engages the forest authority to maintain or develop old growth, inclusive rich edges, a divers pattern of gaps in canopy and clearings and dead wood. In practical forestry the structures of vertical stratification looks equivalent to the layering in selection forest (Plenterwald), in coppice-with-standards-system (Mittelwald) or age-structured forests (hiebsreifer Altersklassenwald). Management should promote a high degree of this characters, but not a maximum, which may mean dense and dark woods.

Cultivated forest may integrate structures of a horizontal mosaic in age-structured-forest, in creating small clear-cuts (Femelbetrieb, Saumschlag) and selective cutting of tree-cohorts, in the course of which the diversity of age-classes and certain structures should get maximized.

I will point at the practical experience, that historical types of utilization and exploitation can induce an impressive level of species-diversity (like perforation of canopy, extraction of nutrients, f.i. forest litter utilization, coppice cutting, pasture woodland), what we could mostly maintain by conservational management today.

As every silvicultural system excludes the development of real structures of forests fundamentally, conservational concepts must aim at foundation of nature reserves, free of lumbering and large enough, to get the broad scale of habitats and conditions, which are typical for primary forests - and necessary to preserve diversity of highly specialized and less adaptive species.

3. Instead of summing up I deposit three basic statements:

– In spite of a high level of habitat quality and -requisites some forest species in flora and fauna do require, actually no strict specialists of real primary forest exist, what helps some of them to survive in adequate secondary habitats (like parks, cemeteries, gardens or avenues), respectively what helps us to compensate structures by forest management (as it is the case in sustainable forest [Dauerwald] f i.).

– To maintain a high diversity of species in the forests we need a high diversity of silvicultural systems and management types.

– It does not make much sense to draw a strict dividing line between vertical and horizontal structures, as both presuppose each other - or could be interpreted as the contrasting end-sectors of a continuum of patchsizes with gradual differentiation.

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Tab. 1: Importance of vertical stratification and horizontal patchiness for quality of habitats for European woodland birds.

Non-Passerines							Passerines						
	+	-	❍	+	-	❍		+	-	❍	+	-	❍
Total = 41 species	2	12	24	27	0	13	Total = 46 species	18	13	5	21	0	23
Assignment 0?	(3)	(14)		(18)			Assignment =?	(23)	(18)		(22)		(24)

Tab. 2: Species diversity as a function of structural architecture of habitats, induced by disturbances within different dimensions of habitat – like area, space and time.

<table>
<tr><th>Potential of species</th><th>Dimensions of habitat</th><th>Structural architecture</th><th>"Disturbances"</th></tr>
<tr><td rowspan="3">Natural history
Climate
Geology/Soil
Landscape morphology
Landscape pattern
History of exploitation
Quality of forest stands
Faunal geography
Faunal history</td><td>Area</td><td>Species-Area-Interrelation
Fragmentation
Isolation</td><td rowspan="3">"natural"
climatic fluctuations
abiotic disturbances
biotic disturbances
"anthropogenous"
global change
forest exploitation
forest culture</td></tr>
<tr><td>Space</td><td>Horizontal patchiness
vectical stratification
dead and down wood/
special properties
interlocking with special
habits (meadows, rocks, water)</td></tr>
<tr><td>Time</td><td>„stready state" (climaxforest,
old growth, longlasting
colonisation) "change"
(succession, species-turnover,
phases of forest development)</td></tr>
</table>

Impact Assessment of Working of Western Ghats Forests

C. G. Kushalappa and K. A. Kushalappa

The Western Ghats are a chain of highlands running along the Western edge of India. This hill range contains some of the most important tropical forests in the sub continent covering an area of 160,000 square kilometers. Western Ghats has overall effect on the South Western monsoons, which has resulted in very distinct and unique biological diversity in this area. Vegetation ranges from scrub jungles and grasslands at low altitudes to deciduous forest areas in middle elevation and tropical rain forests at upper reaches. The Western Ghats have 3,500 floral species which account for one third of the flowering plants in India. The floristic elements are not only unique but are highly endemic, the percentage of endemism ranging from 40-63% in different areas. The faunal diversity is also exotic and endangered, like Lion tailed macaque, Nilgiri thar and Great Indian Hornbill. This diverse and unique biodiversity has resulted in declaring Western Ghats as one of the 18 "hot spots" of biodiversity in the world, which means this hill range is a outstanding eco-region where conservation effort is of utmost priority.

The Western Ghats also produce coffee, tea, pepper, cardamom, rubber and minerals like iron ore, manganese and bauxite. Forests have been cleared for these developmental needs. Forests in Western Ghats have been worked systematically with the advent of British Rule around 1886 by means of approved working plans. Excessive fellings during the world wars has resulted in changes in structure and composition. The forests were worked later based on selection felling system mainly for plywood industries where large areas were leased out for working when selected soft wood species were removed.

Kodagu is a district in the state of Karnataka. The entire area of 4,107.75 square kilometers is under Western Ghats, Forests constitute 1,345.97 square kilometer of the total land area which accounts for 32.76 percent of the total geographical area. The district has some of the best evergreen rain forests known for its ecological importance and some of the most economically rich moist deciduous and deciduous forests. The district has 1332 species of flowering plants which includes many rare and endemic plants. The district is also rich in medicinal plants, which are endemic.

The forests in the district were worked as in other parts of the Western Ghats and the excessive fellings undertaken resulted in the complete ban of green felling in the government forests from 1986.

A scientific study was undertaken by the College of Forestry with assistance from state government with the following objectives:

1 . To study the impact of working in different forest areas like

I. Government owned forests managed by forest department

II. Government owned sacred grooves managed either by forest or revenue department in association with local people.

III. Forest areas leased for cultivation of coffee or cardamom

2. To study the impact of working on species diversity, regeneration and growing stock

3. To identify over worked areas and deviation from working plan

4. To suggest suitable management practices for managing these forest.

The studies with respect to forests managed by the forest department and worked on selection system were undertaken in 3 ranges and the worked area were selected from 1965 till 1985 at 5 years interval. These areas were worked mainly for the plywood species and the details like extent of worked area, major species felled and quantity of wood removed were collected from the forest department. Field studies were undertaken to compare worked and adjoining unworked areas with respect to biodiversity to assess the ecological status and regeneration and growing stock to assess the economic status.

Sacred grooves which are locally called "Devarakadu's" are forest areas owned by government but protected by local people for very long period of time. There are 1214 such sacred grooves ranging from 0.01 to 125 hectares. Over the years due to policy changes by the government and changes in the attitude of local people these community lands have either been fully encroached and deforested or shrunk in area and tree cover. Studies have been undertaken to asses the present status of these sacred grooves and undertake intensive field studies in areas above 10 acres to emphasize the need for conserving these sacred grooves which have become islands of biodiversity amidst changing land use pattern in the district.

There are large forest areas in the high altitude region of the district, which were leased by the local kings and later by British for promoting cultivation of coffee and cardamom, which were in great demand. These areas which were leased long time back have undergone a distinct change in ownership, extent and condition due to clear-felling and conversion to coffee and cardamom. There are two major kinds of such leases. "Coffee Saguvali Malais" are areas where the lease has rights over the land and "Jamma Malais" which are long term hereditary leases where the leases does not have rights over land. In both cases trees are absolute property of the government.

The studies initiated under the project funded by Department of Ecology and Environment of the government of Karnataka is an effort towards study of the impact of working in a fragile and ecologically important forest area in the world undergoing a change in extent and condition due to man induced changes that are common to any developing country.

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Is Normal Forest Management Able to Conserve Rare Species?

Jochen Kleinschmit

1. What is "normal" forest management in the present world?

At present forest management ranges form exploitation as expressed by an annual loss of forest cover of more than 15 million hectares (Tab. 1), over plantation forestry with single tree species, ecologically oriented forest management with prevailing natural regeneration to selective logging in virgin forests, sometimes associated by enrichment planting.

It is quite clear, that exploitation and monospecies plantation forestry are not able to conserve rare species. They cover today however the most extended part of managed forests. With an increase of natural regeneration and a decrease of human interference the conservation of rare species becomes more probable. The participation of rare species can be one intention of an ecologically oriented forest management as usual in some Central European countries.

It is most probable, that rare species are conserved in unmanaged natural reserves and virgin forests. But since their surface must be restricted due to human needs of wood, and their ecological conditions may change due to unintended human influences, they are not sufficient to guarantee the survival of all rare species.

2. Rare tree species as examples for their associated species complexes

There exist overall guesses for the annual loss of species. Of course these figures include a lot of speculation since even the existing number of species is not known (Tab. 2).

Most of the species are not evaluated and if they are evaluated the data are deficient. Only in few cases adequate data are available (Fig. 1). Those tree species which are under regular forest management, have the lowest risk of extinction.

If we look to the tree species which are under actual management (140 species) or those with more intensive breeding programs, where sufficient genetic information is available (Tab. 3) it becomes clear that only 0,3 % of the tree species are under actual management and only 2 % may be of potential interest in near future.

Tree species represent only 15 % of the higher plants and mosses, they have however associated species complexes which in number surpass by far their own numbers. Some are very specific, others more general.

Therefore rare tree species are only an indicator for complexes of other species.

3. Situation in boreal, temperate and tropical forests

Species diversity is lowest in boreal forests, increases towards temperate forest and has a maximum in tropical forests. To ensure the conservation of rare species by normal management is therefore easier in boreal forests and temperate forests as compared to tropical forests, where the most drastic changes in forest surface are occurring and where the knowledge of rare species is most restricted.

For temperate forests the noble hardwoods, which include most rare tree species in Central Europe, may serve as an example. An EUFORGEN network coordinates the conservation activities with these species in Europe. Table 4 explains the reasons for endangerment of noble hardwoods in Germany. Small population size, unregulated seed import, hybridization and diseases are major causes. Small

Tab. 1: Present world forest inventory and related changes (DIXON et al. 1994, see also for literature references and deduction of individual values).

Geographic latitude		Total	Areas in Million ha Protected Forests	Plantation	Annual changes in surface
Boreal					
	Russia	884	178	43	- 0,2
	Canada	436	9	3	- 0,5
	Alaska	52	2	1	–
	Total	1372	189	47	- 0,7
Temperate					
	USA	241	14	2	- 0,1
	Europe	283	40	1	+ 0,3
	China	118	–	31	+ 0,6
	Australia	396	18	1	- 0,1
	Total	1038	72	35	+ 0,7
Tropical					
	Asia	310	49	22	- 3,9
	Africa	527	113	2	- 4,1
	America	918	105	6	- 7,4
	Total	1755	267	30	- 15,4
Overall Total		**4165**	**528**	**112**	**- 15,4**

population size endangers the genetic base by inbreeding (loss of vitality) and genetic drift (loss of genetic information).

Therefore *ex situ* measures (Fig. 2) were necessary to reestablish genetical variable breeding populations and to conserve the available genetic diversity for utilization and for the future.

The present situation of the conservation program in Germany, coordinated by a Federal-State workshop, is reflected in Table 5 and 6.

To establish similar programs in tropical countries is much more difficult and expensive, therefore natural reserves can be an intermediate means to ensure the conservation of most rare species there, until normal forest management can include those more than it is possible today.

Tab. 2: Number of known and estimated number of unknown species (Conversion of a figure presented by the author).

Species	Number in Million	
	known	unknown
Vires		0.40
Bacteria		1.00
Fungi	0.07	1.50
Microbes	0.05	0.20
Alges	0.06	0.40
Higher Plants	0.25	0.35
Worms	0.02	0.40
Crabs	0.05	0.15
Spiders	0.06	0.75
Insects	0.95	8.00
Molluscs	0.05	1.00
Vertebrates	0.06	0.06
Others	0.10	0.25

4. Deficits, necessities and restrictions

There exists a number of gaps in the knowledge of rare species and there is a lack of control, that these species are maintained in normal forest management:

- Lack of knowledge of the present range and frequency of most rare tree and shrub species,
- Lack of knowledge of the genetic structure of biodiversity for most species,
- Lack of activities with minor species in most countries,
- Lack of control of biodiversity in most applied programs especially in practical forestry,
- Lack of regulations for minimum requirements to ensure that biodiversity is really an element of sustained forestry.

These gaps must be closed, which is much easier and partly on the way in temperate regions but difficult at the moment in most tropical countries. The necessities are:

- Improve the knowledge of the present range of rare tree species.
- Improve the knowledge of the genetic structure of rare tree species.
- Include minor tree species into forest management plans.
- Control if management improves the situation of rare tree species.
- Establish regulations for minimum requirements concerning rare species as elements of sustained forestry.
- Improve the utilization of minor species to rise the economic interest in these species.
- Establish a network of nature reserves regionally and ecologically at least as an intermediate step until the above prints are performed.

The establishment of a network of nature reserves seems to be the only possibility as an intermediate step.

With increasing population pressure the pressure on the reserves will increase

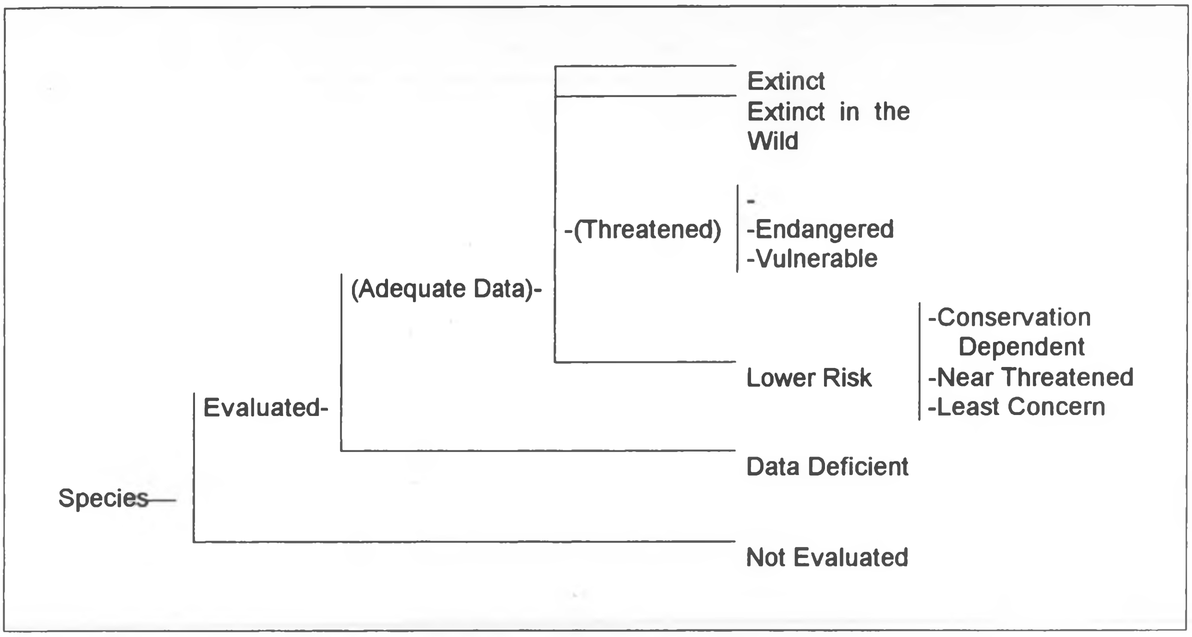

Fig. 1: Threatened species categories (The World Conservation Union).

Tab. 3: Estimated number of tree species (Sources: Board of Agriculture 1991, FAO 1996) (Conversion of a figure presented by the author).

	estimated number of tree species
tree species with more intensive breeding programme	60
tree species under actual management	140
tree species of potential interest in near future	1,000
total number of existing tree species	50,000

Ex situ measures

Plantations
Seed orchards
Clonal archives
— in the field
technically simple
not sophisticated

Storage of – seed
– pollen
– tissue
– DNA sequences
— under controlled conditions
technically susceptible
increasingly sophisticated

Fig. 2: Ex situ measures in hardwood conservation.

as well. Therefore a combination of conservation of genetic resources of rare and other species in conjunction with the production of utilities, especially wood, will be the only sound solution and this implies that forest management has to be able to conserve rare species as well.

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Tab. 4: Common species of noble hardwoods in Germany.

Species	**Importance**	**Seed Legislation**	**Unregulated Seed Import**	**Reason of endangering**			
Native species				**Hybridisation with other species**	**Hybridisation with cultivars**	**Small population size ⇨ Inbreeding, genetic drift**	**Diseases**
Acer campestre	***		*				
Acer platanoides	**		*			**	
Acer pseudoplatanus	*****	*					
Alnus glutinosa	****	*					
Fraxinus excelsior	*****	*					
Malus sylvestris	*		*		***	***	
Prunus avium	****		*		*	*	*
Pyrus pyraster	*		*		***	***	
Sorbus domestica	*		*		*	**	
Sorbus torminalis	**		*			*	
Tilia cordata	***	*		*			
Tilia platyphyllos	**		*	*		*	
Ulmus glabra	***		*	*		*	***
Ulmus laevis	**		*	*		*	***
Ulmus minor	**		*	*		*	****
Non native species							
Juglans regia	*		*				
Juglas nigra	*		*				

Tab. 5: Conservation of genetic resources of noble hardwoods in Germany in situ / ex situ.

Conservation of genetic resources of noble hardwoods in Germany in situ/ex situ (31. 12. 97)

Species	Conservation in situ			Conservation ex situ		
	Stands		Single trees	Stands		Single trees
	Number	ha	Number	Number	ha	Number
Acer campestre	10	19, 85	1236	–	–	–
Acer platanoides	14	4, 69	692	–	–	–
Acer pseudoplatanus	68	68, 09	226	6	10, 45	–
Alnus glutinosa	84	234, 13	216	–	–	–
Carpinus betulus	81	134, 48	117	2	0, 9	–
Castanea sativa	2	3, 2	10	–	–	–
Fraxinus excelsior	101	141, 49	145	–	–	–
Juglans regia	1	0, 1	272	–	–	–
Malus sylvestris	2	1, 1	2024	20	4, 4	1985
Prunus avium	40	21, 66	620	6	2, 61	700
Pyrus pyraster	6	2, 75	967	1	0, 1	400
Sorbus aria	1	0, 2	259	4	2, 6	–
Sorbus aucuparia	4	3, 5	251	7	2, 3	–
Sorbus domestica	1	0, 1	1928	7	2, 8	4243
Sorbus torminalis	244	4, 8	1661	13	6, 2	4707
Tilia cordata	122	124, 75	204	–	–	–
Tilia platyphyllos	125	21, 19	198	–	–	–
Ulmus glabra	90	49, 63	3189	7	6, 65	4625
Ulmus laevis	82	50, 78	3598	13	4, 13	120
Ulmus minor	3	10, 16	671	–	–	270

Tab. 6: Conservation of genetic resources of noble hardwoods in Germany: Seed orchards and clone archives.

Conservation of genetic resources of noble hardwoods in Germany Seed orchards and clone archives (Stand 31. 12. 97)

Species	Seed Orchards				Close Archives	
	Number	ha	Families	Clones	Number	Clones
Acer campestre	–	–	–	–	–	–
Acer platanoides	2	4, 4	–	110	–	–
Acer pseudoplatanus	17	29, 6	–	781	3	58
Alnus glutinosa	19	37, 97	–	822	1	21
Carpinus betulus	2	4, 4	–	157	–	–
Castanea sativa	–	–	–	–	1	20
Fraxinus excelsior	11	23, 8	–	719	1	52
Juglans regia	1	1, 5	–	39	1	9
Malus sylvestris	22	21, 05	232	514	1	28
Prunus avium	18	33, 6	1	1069	8	205
Pyrus pyraster	16	12, 87	40	400	2	57
Sorbus aria	3	2, 04	53	50	–	–
Sorbus aucuparia	4	3, 57	48	111	–	–
Sorbus domestica	6	4, 8	128	236	2	76
Sorbus torminalis	8	9, 6	100	282	2	41
Tilia cordata	19	39, 38	–	582	2	102
Tilia platyphyllos	2	4, 1	–	191	1	11
Ulmus glabra	9	11, 1	37	287	18	688
Ulmus laevis	1	2	–	109	3	80
Ulmus minor	1	1, 5	–	50	1	21

Successful Examples of Multiple Forest Use – the Model of Selection Forests

Marc Hanewinkel

Abstract

The paper deals with selection forests as a successful example of multiple forest use. Firstly a short definition of selection forests as stated in the paper is given. A selection forest is here defined as a type of permanent forest where trees of different age and dimension grow together on a minimal restricted area in a permanent and steady state structure (Schütz, 1989, p.2) and where the only form of harvesting executed is – single tree – selective cutting. The type of selection forest especially discussed in this statement is dominated by silver fir (*Abies alba,* Mill.). Selection forests as multiple use forests of high stability fulfilling recreation, protective and economic functions are presented.

Secondly, implications of selection forests concerning biodiversity are stated. Some aspects of habitat quality and conservation of "threatened" species with the example of silver fir (*Abies alba,* Mill.) are briefly discussed together with critical points (the low rate of decidous trees and the concentration on shade tolerant species).

Thirdly the question whether the management of selection forests can be economically efficient is discussed. Important economic input and output indices of selection forests are presented and compared to those of even-aged forests.

The conclusions of the presented aspects lead to the statement that selection forests can be looked upon as a very successful example of multiple forest use which – with small modifications – respects the main aspects of biodiversity.

Structure

1. Definition of selection forests

A selection forest is here defined as a type of permanent forest, where trees of different age and dimension grow together on a minimal restricted area and fill completely the whole vertical crownspace in a permanent and steady state structure (Schütz, 1989, p.2). The only harvesting executed in this forest type is single tree – selective cutting. The type of selection forest investigated in this study is dominated by silver fir (*Abies alba,* Mill.)

Fig. 1 shows the typical stem-distribution of a single-tree selection forest with an inverse J-curve.

The steady-state structure of a selection forest is based on three preconditions (Schütz, 1989):

1. Each tree leaving a diameter class due to harvesting, mortality or diameter increment has to be replaced by a tree from a smaller diameter class.

2. The ingrowth into the smallest diameter class has to be high enough to guarantee the long term steady state.

3. The sum of the harvested volume has to be equal to the volume increment.

1.1 Selection forests as multiple use forests of high stability

Selection forests show several elements that characterize them as multiple use forests of high stability:

- Selection forests are the perfect example of continuous cover forests with no clearcuts executed during the normal harvesting activities.
- They comply particularly with the demands of forest visitors for recreation and are due the very large trees looked upon as "virgin forests", although there structure is almost purely artificial and has to be maintained by constant harvesting interventions.
- Selection forests deliver a very effective protection function (e.g. against soil erosion, avalanches, ...). This is due to the complete lack of clearcuts but is as well a result of the low risk of calamities (windfall, icebreakage, insects ...) that characterizes selection forests.

Table 1 shows the results of an investigation (Hanewinkel & Willmann, 1996) in two selection forests (District XVII and Farm Forest Y) and two even-aged forests (State Forest B and Group I).

The results clearly point out that the percentage of incidental exploitations (due to windfall, snow-breakage, insects) in the selection forest enterprises is distinctly lower than in the even-aged forest enterprises.

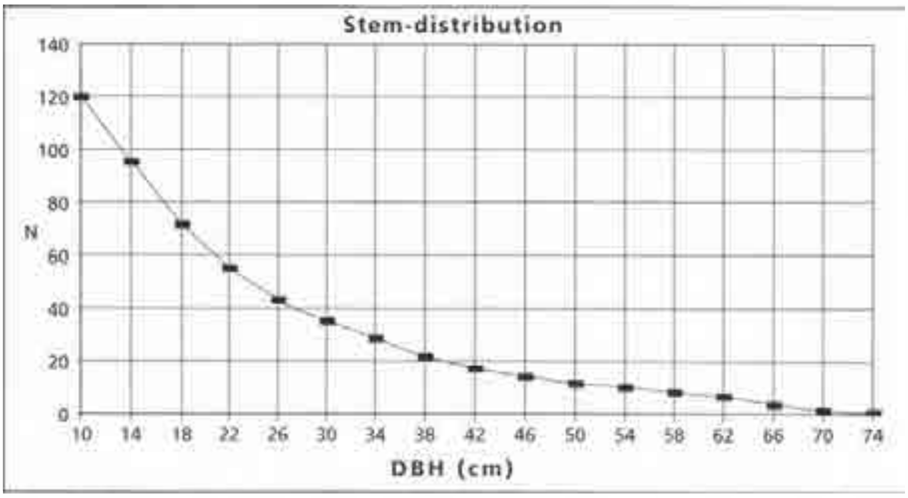

Fig. 1: Stem distribution of a selection forest (N = number of stems, DBH – diameter at 1.3 m).

Tab. 1: Planned annual cut, harvested volume, percentage of incidental exploitations and stemwood in the investigated survey- and comparative enterprises and groups. Weighted mean of the years 1980 (1984) to 1994.

	Index			
Enterprise/Group	Planned Annual Cut (m³/ha *a)	Harvested Vol. (m³/ha *a)	Incidental Exploitations (%)	Stemwood (%)
District XVII	6,1	6,1	29,0	87,8
Farm Forest Y	6,7	7,5	20,4	93,8
State Forest B	7,5	8,2	62,2	82,3
Group I	7,1	7,2	44,3	74,7

2. Implications of selection forests concerning biodiversity

2.1 Habitat quality and conservation of "threatened" species

Concerning habitat quality and species composition it can be considered that selection forests consist of trees with different sizes and hights on a minimal area which results in many edge effects and a distinct vertical and horizontal structure.

Furthermore, selection forests are dominated by – compared to even-aged forests – unusually large trees, which is of particular interest for the habitats of many birds or insects (Scherzinger, 1996). Looking at the natural vegetation potential, selection forests tend to have a more "natural" composition of species (e.g. less disturbance indicators) than even-aged forests under similar site conditions. (Walentowski, 1998).

In the 1980s during the discussion about "forest decline" in central Europe, silver fir *(Abies alba)* one of the dominant tree species in selection forests, was looked upon as a "dying species" (Bo Larsen, 1986). Very recently, one of the major NGOs in Germany proposed silver fir to be put on the "red list" of threatened species.

Figure 2 shows the distribution of the main tree species in the Black Forest region, one of the most important areas of the extension of silver fir in Germany, in different age-classes and in selection forests. It can be realized that the percentage of silver fir distinctly decreases with the age of the forests in the Black Forest region. Whilst forests stands elder than 140 years (Age class VIII+) have more than 25% of silver fir, the percentage decreases to less than 10% in the stands below 40 years. Besides other reasons like sensitivity to air pollution or climatic changes (mainly a rise in the mean temperature and drought), this decrease is due to inappropriate forest management. Particularly silvicultural systems with short regeneration times will lead to forests with a high percentage of Norway spruce (*Picea abies,* Karst.) and a loss of silver fir.

The highest percentage of silver fir (more than 40%) can be found in the selection forests, where the continuous crown cover promotes the shade tolerant species like silver fir. Selection forestry can therefore looked upon as a way to conserve silver fir (*Abies alba,* Mill.).

2.2 Critical points

However, at least two elements of selection forests must be considered as to be critical concerning biodiversity: Firstly, the concentration on coniferous trees (s. Fig. 2) in forests where the natural wood association would be dominated by deciduous

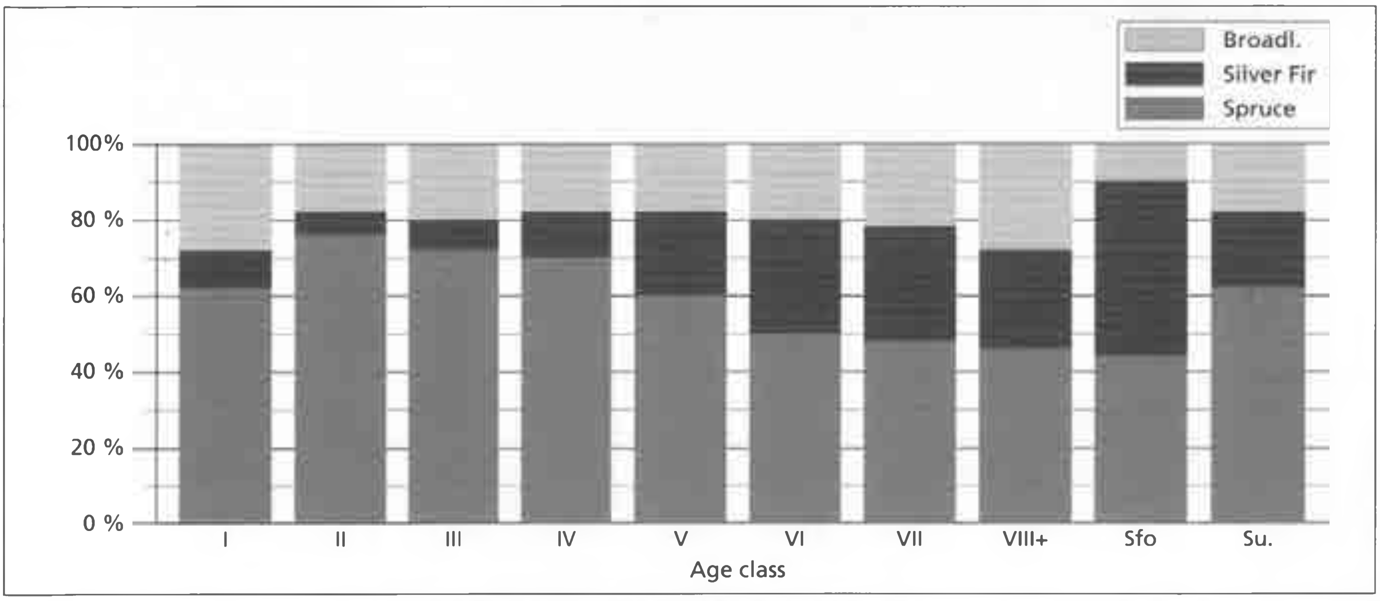

Fig. 2: Distribution of species in different age classes (I – VIII) of even-aged forests and in selection forests (Sfo) in the Black Forest region (National Forest Inventory, 1992). Age class I = 0-20 years; II = 20-40 years; ...).

***Tab. 2:** Planting Sites (Plantation and Pre-Plantation) in the selection forest district XVII. % = yearly area in % of the total forest area; N*1000 = number of plants x 1000 used; N/ha(ps) = number of plants per ha planting site, Ø= arithmetic mean of the years 1980 to 1994.*

District XVII		1980	81	82	83	84	85	86	87	88	89	90	91	92	93	94	Ø
Plantation		–	–	–	–	–	–	–	–	–	–	–	1.22	–	0.61	–	0.12
Pre-Plantat.	[%]	–	–	–	–	–	–	–	–	–	0.15	–	–	–	–	–	0.01
Sum.		–	–	–	–	–	–	–	–	–	**0.15**	–	**1.22**	–	**0.61**	–	**0.13**
Plantation		–	–	–	–	–	–	–	–	–	–	–	1.35	–	0.5	–	0.123
Pre-Plantat.	[N*1000]	–	–	–	–	–	–	–	–	–	0.25	–	–	–	–	–	0.017
Sum		–	–	–	–	–	–	–	–	–	0.25	–	1.35	–	0.5	–	**0.14**
Sum	[N/ha (ps)]	–	–	–	–	–	–	–	–	–	**1.67**	–	**1.13**	–	**0.83**	–	**1.077**

***Tab. 3:** Distribution of quality classes and mean index figures of the quality classes. (Stemwood of Norway spruce and Silver fir). Weighted mean of the years 1984–1994.*
( ) = Total amount of high quality timber (part-veneer, resonant wood, ...) assorted as A-quality. - = No information recorded.*

	Ratio							
Enterprise/Group	%-of Quality Class:				Mean Index Figure:			
	A	B	C	D	A	B	C	D
District XVII	10,1	79,0	10,7	0,2	53,6	48,5	48,1	49,5
	(58,7)*	(30,4)*						
Farm Forest Y	20,9	42,9	33,0	3,3	–	46,2	47,3	46,5
Group II	0,03	76,5	19,2	4,3	52,5	41,2	41,7	43,4

trees (mainly beech – *Fagus sylvatica*) and secondly the concentration on shade tolerant species. Therefore, the number of species in selection forests tends to be lower than in even-aged forests under similar site conditions (Walentowski, 1998). Biodiversity in selection forests could be improved by integrating beech (*Fagus sylvatica*) e.g. in groups and by limiting the standing volume or creating gaps.

3. Can the management of selection forests be economically efficient ?

3.1 Economic input and output indices of selection forests

Table 2 shows the results of an investigation in a selection forest district in the central black forest. Less than 0.2% of the total forest area had to be replanted yearly during the investigation period. Selection forests are characterized by low input indices concerning plantation or young growth tending, due to the continuous crown cover with constant natural regeneration and self-regulation. Harvesting costs are low as well due to the small number of large trees removed during the harvesting activities.

On the other hand a high percentage of stemwood (s. Table 1), an unusually high percentage of large timber and if pruning (the removal of branches at the small trees) is executed – of high quality timber can be expected in selection forest enterprises.

Table 3 shows that in selection forests (District XVII, Farm forest Y) the percentage of high quality timber (quality class A) can be distinctly higher than in even-aged forests (Group II). Looking at the average size of stemwood it can be considered that selection forests produce mainly large (index figure >46) or very large timber (>48), whilst the output of even-aged forests is mainly medium (43) or small sized (<42) timber.

3.2 Comparison of selection forests with even-aged forests

Table 4 shows that the operating profits (revenue/expense) of the survey enterprises dominated by selection forests (farm forest Y and community forest X with 60% of selection forests and 20% of forests in the state of conversion to selection forests) are extraordinarily favorable compared to those of neighboring even-aged forest enterprises (state forest A and B and Group I). Farm forest Y and community forest X reach between 450 and 500% of the operating profit of the state forest group I.

An adjustment of these results on the annual planned cut does not substantially change the results. The predominance of the selection forest enterprises is mainly the result of very high revenues due to high percentages of high value timber. In addition to that, the expenses in community forest X is clearly lower than in the comparative enterprises. The expenses in farm forest Y is higher than in the other enterprises due to a high proportion of fixed costs linked to the small forest area of the enterprise. Regarding the expense-sphere, the survey- and comparative enterprises can hardly be compared mainly due to their different size and their differing organization form. Taking into account mean administrative expenses for state forest enterprises, the operating results of the state forest A and the state forest group I – both dominated by even-aged forests – are negative.

Tab. 4: Profit and Loss (Operating Profit in % of group I and Input/Output Ratio). Revenues without grants. Expenses without expenses for administration and depreciation for roads. Mean of the years 1980 to 1994.

Enterprise/ Group II	Revenue	Expense	Operating profit	Input/Output Ratio
	DM/ha (DM/m³)	in % of Group I		%
Farm Forest Y	181 (174)	116 (111)	496 (495)	53
Comm. For. X	151 (152)	88 (87)	459 (480)	48
State Forest A	106 (116)	104 (113)	120 (135)	81
State Forest B	121 (107)	112 (103)	161 (125)	78
Group I	100 (100)	100 (100)	100 (100)	83

4. Conclusions

Selection forests as presented in this paper can looked upon as very successful examples of multiple forest use and thus of utilization of biodiversity. They fulfill perfectly the main functions of multiple use forests (protection, recreation, habitat) and can be, as shown in an investigation in the Central Black Forest (Hanewinkel, 1998), particularly efficient from an economical point of view. However some of the critical aspects of selection forests (e.g. the concentration on shade tolerant and coniferous tree species) should be taken into account by modifications of the management.

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Reserva Natural La Planada – 15 Years Experience in Protection, Conservation and Research for a Sustainable Development

Elvia Niño and Jens Bittner

Introduction:

La Planada nature reserve is located in the southwest of Colombia on the western Andean slopes in an elevation between 1500 m to 2200 m. The area covers 3300 ha, mostly montane cloud forest.

La Planada is part of the Colombian NGO called "Fundación FES". In the following pages we will present La Planada nature reserve as a regional example to use different concepts and the high biodiversity of a privately protected area to benefit the regional population.

Historical:

In 1982 La Planada was established in cooperation with the World Wildlife Fund (WWF). This reserve is a hotspot of biodiversity with a high diversity of birds, insects and plants.

In the region exist for example more than 280 species of birds, 10 % endemic, approximately 1800 species of vascular plants (more then 350 species of orchids). The territory is part of the Choco-Biogeographic-Region. Before 1982 this area was used for farmland and they cut tree for timber and firewood. In the first years after the establishment of the reserve most interest went into investigative projects to get the information about the diversity of species in the reserve. Also they started looking for the integration of the communities in concepts of conservation.

The cultural background:

There are different local communities around the nature reserve. To the north there are some "mestizo" communities; they are primarily farmers with an average of seven hectares land per family; sugarcane and cattle are the main sources of income. The people do not produce much crops for self consumption.

To the south, the neighbors are the Awa people, they call themselves as INKAL Awa ("people of the forest"). The Awa Communities in both Colombia and Ecuador have acquired collective titles to their lands with the establishment of the Awa Reserve in Ecuador and 36 "resguardos" in Colombia. Most of the Awa families practice traditional agrosystems.

These are highly diverse, and are based on a slash and decomposition system to cultivate beans and corn for self consumption. Banana, mandioca, bihao, and other edible crops appear in small spots along the mountain landscape side by side with montane cloud forest fragments. During the last ten years there has been an increase in the grassland areas for cattle rising, and sugarcane for "panela" production. The Awa have entered the monetary economy at last. These changes in using land have brought many problems for the Awa people: conflicts in land tenure, loss of biodiversity, deforestation, loss of edible crops for self consumption, to name just a few problems.

Administrative or organization of La Planada:

On this background La Planada started to improve the understanding of the ecosystem of the cloud forest, conservation and protection of this area and included the local communities in this ideas. There are four programs to work in this area:

Environmental Education, Community Development, Research, Financial and Administrative Management.

One result of this work is the realization that all ideas on conservation need the acceptance by the local community. This is only possible by including this locals in the work of the reserve. An example for this structures are local co-researchers who are included in research projects.

Tourism a way to income ?

A touristical concept of La Planada especially for those visitors interested in the conservation of biodiversity, landscapes and culture, will result in benefits. That means a visitor is open to learn about the region and understand the relation between people and nature. This kind of tourism will produce an income and raise the standard for living of those persons working in restaurants, transport services or local guides. These guides are working as co-researchers to help professionals and research projects. Indirectly the visitor brings income for persons working in handicrafts.

But it is clear that this income is not stable. Over the years a frequent change of the visitor numbers can be observed. Also the visitors' changing interest and political problems in the region are two examples of problems that might cause an instability in visitor numbers (Fig. 1).

In the experience of La Planada tourism alone is not a sustainable way to benefit the local people of this region. But it is a very important tool for the environmental education of persons living in towns, to start with the sensibilization for aspects of nature.

Non timber products and a way to use:

Another example of the integrated conservation - development ideas are agroforestry projects that involve local farmers in research design and development of sustainable systems.

On the other side exists a knowledge about non timber products that have been used by the communities long ago. Unfortunately mostly under non sustainable ways.

But also we can find damage by a lot of irrational use of fire and timber wood in the last 100 years. The recuperation of forest areas or the using of native tree species in grassland are object of the activities with locals. An important tool in this concept is the using of plant nursery for research and reproduction of endangered species of trees. Also the plant nursery in used for education programs to sensitize small local farmers. The result of this work is very interesting: The locals are highly interested in the results of the investigation and like to get trees for reforestation, but also experience for own plant nurseries to produce the trees for their own farmlands.

The idea is to use secondary forest areas for building agroforestry systems that can produce food crops, firewood and also plants for domestic uses. This includes also fiber plants for handicraft. All species are native in the reserve. The local people use them and sometimes steal them from the reserve area. This project aims at changing this mentality and raising the standard of living of local farmers.

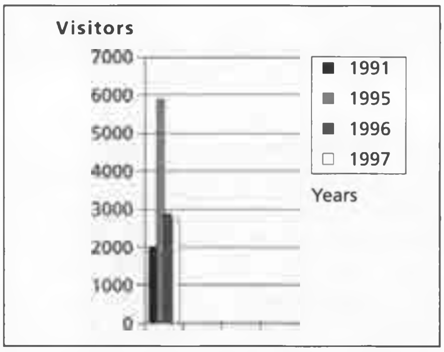

Fig. 1: Number of visitors in the last years.

Conclusion:

It has to be noted that the conservation of areas especially if there are communities near by the protected areas need different concepts of protection and conservation of landscapes and nature.

La Planada shows very clearly that it is possible to protect the last nature areas if we find a way to include the local community within this work. One aim has to be finding a way to bring direct and indirect benefits for the persons looking for employment, and finding out what the local people really need. In the case of La Planada it is also important to use the potential of the democratic structures of the communities to ensure fair treatment and knowledge of their political rights.

Only people that feel well within their own situation are open for new ideas of protection of nature or using new concepts for agrosystems. Tourism can bring benefits to the region but is not a steady source of income. In combination with other possibilities of income tourism can be used for environmental education and as a tool to try working together with locals. The participants in this work will see a possibility for a better income and learn to use the "treasure of the forest".

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Potential of and Development for Ecotourism in the Tsingy de Bemaraha near Bekopaka, Madagascar*

Coert J. Geldenhuys

Ecotourism Considerations

Ecotourism is a component of tourism and its options range from safaris, hiking, bird-watching to hard labour. Ecotourism should be an enlightening nature travel experience that contributes to better understanding and conservation of the ecosystems, while respecting the integrity of host communities.

Positive aspects of ecotourism

Positive aspects of ecotourism include the following:

■ It has the potential to bring economic benefits to the site and neighbouring areas, although these expectations are often unrealistically high, through

– earning of foreign exchange from investments in infrastructure developments such as hotels, lodges, resorts, roads, airports and services, and through the international tourist, and

– job creation.

■ It brings people in contact with the natural and cultural history of an area, and as such cultivates environmental awareness, contributes to cross-cultural understanding of human traditions and behaviour, and provides for relaxation.

Negative impacts of ecotourism

Negative impacts of ecotourism include the following:

■ Expectations for direct economic gain often exceed reality.

■ A variable fraction of foreign earnings is lost because multi-national corporations own and control the industry.

■ Priorities for local development are ignored in order to please the tourism industry. For example, developments bypass local communities or ignore their pressing needs. Basic commodities, often in short supply, are channeled to tourists, and land prices increase beyond the financial resources of the locals.

■ Misuse of the locals by tourists, tour operators or hotel institutions. Typical impacts include

– increase in social disorders such as increased crime and violence, begging, alcoholism, prostitution and other social disorders,

– leaving locals with unskilled, low-paid, demeaning jobs in service industries with no effort to provide the necessary training,

– turning locals into tourist attractions with their cultural activities being commercialized.

■ The local population may become concentrated around ecotourism sites with unattainable expectations for employment and other secondary benefits, with adverse social activities developing;

■ Environmental degradation of various forms of the ecotourism sites, including unwarranted commercialization.

Requirements for ecotourism development

The concept of ecotourism development has several underlying principles. It should

■ be environmentally sound, without degrading the resource;

■ provide direct, participatory and enlightening experiences;

■ involve education among tourists, local communities, industry and government;

■ encourage all-party recognition of the intrinsic values of the resource;

■ promote acceptance of the resource on its own terms and involvement of supply-oriented management;

■ promote understanding and involve partnerships between government, NGO'S, industry, scientists and locals;

■ promote moral and ethical responsibilities and behaviours towards the cultural and natural environment;

■ provide long-term benefits to the resource, the local community and to the industry.

Innovative approaches are needed to incorporate ecotourism appropriately and successfully into the regional economies, i.e. environmentally, socially and economically (Figure 1). Successful development of the ecotourism industry requires that it be incorporated into national, regional and local development plans. The host country should have some control over the development and possession of infrastructure and the provision of resources. The economic benefits should also be shared more equitably in the area. Locals should have a say in the type of tourism they wish to entertain, and have an interest in or benefit from the developments. Visitors should also be sensitized about the cultures of their hosts.

Considerations for Development of Ecotourism

In this section more general principles, guidelines and recommendations are given for ecotourism development in the Bemaraha project area.

General principles

Multiple ecotourism activities in the larger project area

The greater the variety of ecotourism activities in the region, the more cost-effective the ecotourism trade outside the park can become, and the scope for secondary industries will increase. For example, secondary benefits could include a need for a better road network and telephone communication, more flights, and a better local market for food products and handcraft. A better road network could improve the potential for transport of agricultural products to markets outside the area. Figure 1 indicates the potential to develop the different ecotourism potentials, each type of experience developed around a specific town of village. At the same time it becomes critical to maintain control over the developments in order to prevent adverse and imbalanced developments which may affect the environment and the local economy.

Short-, medium- and long-term planning

Planning should be done with a view to

* Extract from: GELDENHUYS, C.J. 1995. Potential of and development for ecotourism in the Tsingy de Bemaraha near Bekopaka, Madagascar. Report FOR-C 300, Division of Forest Science and Technology, CSIR, Pretoria. 28 pp.

short-, medium- and long-term objectives. Current planning is for what is required at the present. In all developments the planners should consider the question 'what will happen to this trail if the tourists increase by e.g. tenfold or hundredfold in the next ten years?' The question is what planning should be done now to provide for tourist developments in the future. Different scenarios need to be considered, for example

- How flexible is the current planning to cater for future exponential increases in tourist numbers?
- What will be the effect of tourist development on other sectors of the local economy, and what will be the effect on the local people if development is unbalanced - too much investment in development for tourism and too little or no investment which provide for the basic needs of the local people?

The rule should be 'Rather start small and expand with better experience than to start too big with irrevocable regret later'. A structure plan for development should guide developments over the short, medium and long term, and could be used to monitor actual versus expected developments.

Zonation of park

The park and surrounding area should be zoned to guide future developments. Clear criteria should be developed for different zones, and should be based on sensitivity of the area, the carrying capacity for tourists requiring a wilderness experience, specific interest groups, and the maximum developments that could be allowed. Criteria must be such as to avoid any future disputes between different interest groups (such as tour operators, local pastoralists). The principles and criteria for the zonation should be clearly described for future reference and also to avoid future conflicts between the park administration and other interested groups.

Several approaches, or a combination of approaches, could be followed to zone the area.

Biosphere reserve concept for broader zonation

Zoning for the larger area could follow the concept of the biosphere reserve:

- Core area. Unique habitats, sensitive sites, areas of special ecological interest, etc. In principle I consider that such areas should be accessible to tourists, but under special conditions, with special prices, and with very careful planning to ensure minimum interference in those systems.
- Buffer zone: Natural areas where some restricted development can be allowed which will not disturb or change the structure and functioning of the natural system, should form a buffer zone around the core area. Limited camping with minimum facilities (chalets with few tents, not for tour operators) and appropriate provision for preventing pollution (such as tourists remove their own litter on departure) could be allowed, but definitely no large-scale permanent developments such as major roads, permanent structures or hotels.
- Transitional or development zone: areas of villages and their pastures which would be used to move from one buffer zone/core area to another, and which would require special agreement between park authorities and local population. This is also the area where hotels and tour operators could develop their facilities.

Types of ecotourism use

In addition to the zoning into core, buffer and transitional areas, the area should also be zoned into different types of ecotourism use. For example, the area could be zoned into areas for

- High density – low value tourism (such as easy and nested walks through smaller Tsingy and forest near the pontoon, information centre and areas of future hotel developments) versus high value – low density tourism (such as Grande Tsingy, specific caves, other sensitive sites);
- Special sites to cater for specific interests of tourists or activities which should preferably not be combined with other activities because of their sensitive nature, such as

– birdwatching: such routes should cross habitats which would in total give the best chance of seeing a large diversity of birds over a relatively short distance. Bird-lovers would require slow movement and time to sit down and observe birds. Other activities should not disturb the birds for maximum interest.

– diurnal & nocturnal lemur spotting: This interest may require the same kind of planning as for the birds, or for spotting big game in Africa.

– dendrology or other special plant interest groups: such routes should cross habitats which would in total give the best chance of seeing a large diversity of plants of a particular interest group (such as trees or succulents).

– hiking: Some people prefer to walk from one interesting area to another, while camping along the route. Such a route should cover a variety of interesting environments, should be scenic, and would require adequate water points.

– rock-climbing: This is a specific sport which could only be done in areas with particular rock faces which should not be too fragile. Such activities should take place away from the normal tourist activities to avoid accidents by passing tourists who may try to do the same without the necessary equipment.

– canoeing: The Manombolo river, starting from east of the park and maybe going down to the coast, could provide for interesting canoeing. I would recommend that canoeing should be confined to the locally made pirogues to support the local skills and practices and to provide for unique experiences, and that no glass-fibre or other commercial canoes be used. However, it will be essential to monitor the practice to control excessive cutting of large trees.

– flying over Tsingy: Such an activity can be an exciting experience, but could also be a major frustration for tourists seeking a wilderness experience, and could affect the lemurs and rare birds in the Tsingy. For example, visitor numbers to the Grand Canyon in the USA declined due to the continuous noise from planes flying through the canyon. Good control should be exerted over such activities.

Development for economic benefits for locals and the area from ecotourism

In principle, over a longer period, the park administration should manage the resource to ensure that ecological principles are enforced, and that sustainable conservation standards and practices are adhered to, in particular in the core and buffer zones of conservation areas. They should refrain from management of any kind of business inside the buffer zone, because this will weaken their ability to ensure good control over sustainable resource management. Private enterprise should be allowed to develop and man-

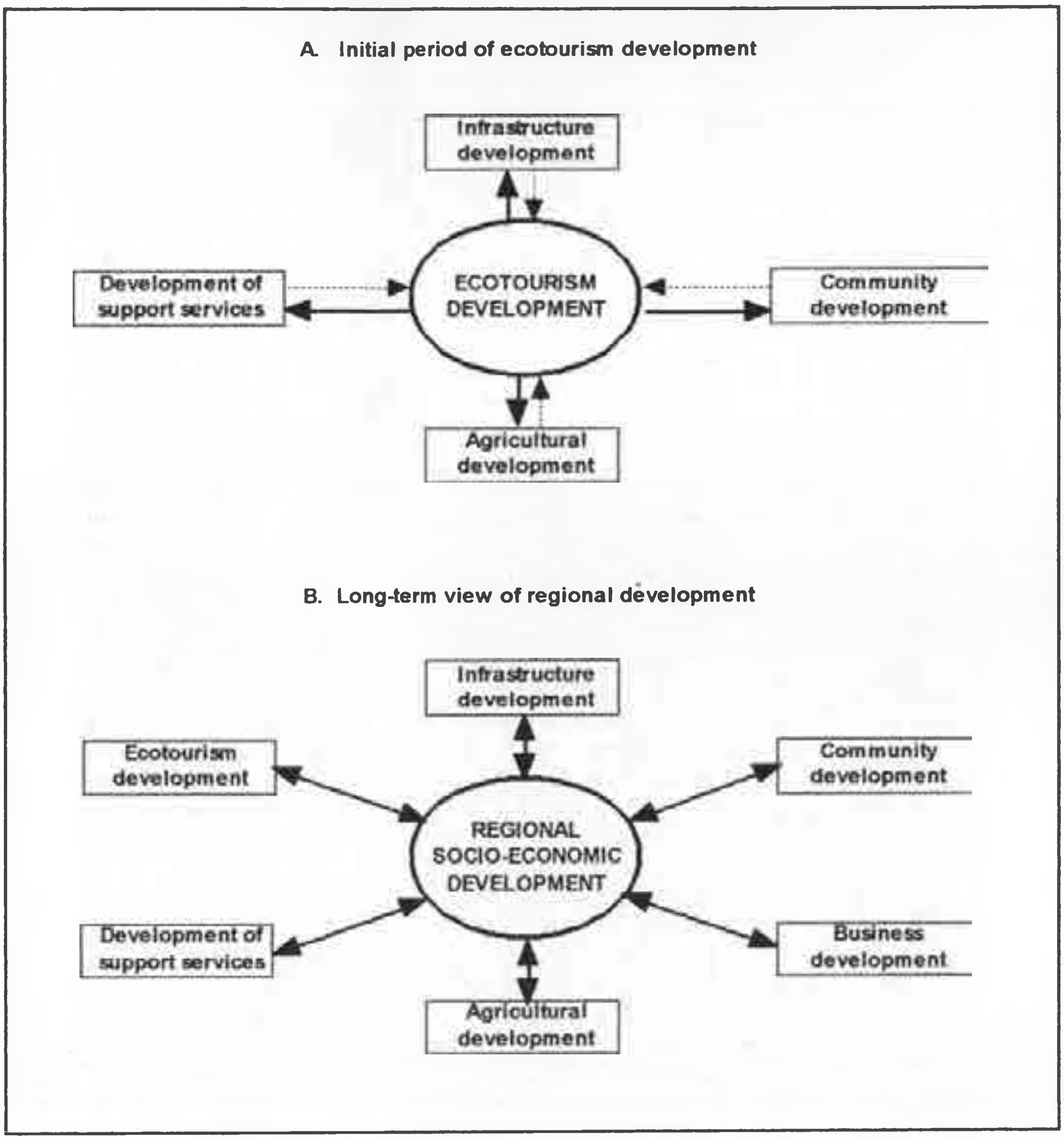

Fig. 1: Hypothetical view of the role of ecotourism in socio-economic development of the Bemaraha region.

age ecotourism activities on business principles in the vicinity of the park and designated ecotourism sites, i.e. this should be confined to the development zone. Incentives should also be put in place to ensure that the ecotourism industry is developed in such a way that the local economy will benefit from these developments without unnecessary interference from administrative bureaucracy. However, initially the park administration will have to develop the framework and establish a sound basis for socio-economic developments around the ecotourism industry. This will require a close interaction with the ecotourism operators, the local administration and the local people to ensure realistic developments.

Potential businesses around the ecotourism industry

A variety of small interdependent businesses could potentially be developed in the area to cater for tourist needs.

Tour operators and hotels

Initially tour operators and hotels may function from established businesses outside the area, but on sites within the area:

- that it would be preferable to allow two or more small hotel developments, of different ownership, rather than one big hotel, to ensure competitive developments and pricing;
- that the tour operators and hotels should eventually (say after 5 years)
  - employ most of their local staff, including managerial staff, from the people in the area. The implication would be that these businesses should provide for training of employees,
  - where possible, use local food products;

– sub-contract local people to provide in the needs for guides, food, transport of tourists to ecotourism sites, etc.

Campsite managers

It is possible that several camp sites could be required in the area in future. By definition of the minimum developments inside the Park, the camp sites should be established in the development zone outside the buffer zone. A campsite could be established near a village which should then be responsible for the maintenance of the camp site. A proportion of the fees for the particular camp site should then be paid to the person or village who is responsible for the maintenance (security, water, removal of refuge, general condition) of the site.

Guide services

It is possible that the numbers of tourists increase to a level where more guides may be needed. Furthermore, different tourist activities may require guides of different expertise. This would provide for an opportunity where an experienced guide may establish a guide service for which a number of guides may have to be employed. Monitoring of such guide services by the park administration may become essential to ensure a suitably high standard of service.

Food production

Different kinds of food, in both raw or prepared form, will be required by tourists, tour operators or the hotels. Food products should be of suitable quality, hygienic standards, etc. A particular village may provide all the food (vegetables, meat, etc.) that is needed at a particular site or hotel. Alternatively, a particular village or individual may provide one kind of food products, whereas others may be producing other kinds of food. It may be necessary to integrate the food needs with other local agricultural activities. Initially it will be essential to coordinate food production to ensure that there is not an over-production of one kind of food and no production of other essential food products.

Production and sale of handcrafts and clothing

It is normal that development of the tourist industry in an area is associated with the sale of souvenirs, handcrafts and clothing such as T-shirts, with features of the particular tourist interest printed on them. This kind of activity could become a flourishing industry, but it requires good control to ensure that plants, animals and artifacts are not exhausted from a particular area.

Maintenance of service standards

A basic principle is that if the services that are required for a particular need are not up to standard in the particular area, then suitable services will be obtained from elsewhere. This is particularly relevant for food provision and guide services. Alternatively, a particular campsite will not be used if it is poorly serviced or badly maintained. Initially there will be a need for training and to develop a business sense amongst the potential service providers.

Cooperation between park administration, ecotourism operators and local population

In order to ensure good cooperation between the different interest groups, and to maintain good standards, it will be necessary to enter into agreements between the local villages (for services, pasture use, etc.), the hotel and tour operators, and government for

- rights of different interested and affected parties,
- sharing of the fees paid for specific services,
- conditions of stay in or near the village,
- maintenance of service standards between different service providers.

Establishment and maintenance of ecotourism facilities

Selection of routes and sites

Several factors need to be considered when a route or site is selected:

Routes

- *Target group and objective:* Most trails are designed for general interest, but trails for specific interests, such as for bird-watching, adventure, rock-climbing, etc. need to consider the particular requirements of the user group. Each trail should have a specific objective, such as to see the Grande Tsingy, or a cave or a place of cultural interest.
- *Variety of features, scenery, experiences and interests:* Irrespective of the specific objective, each trail should provide for a variety of objects (trees, birds, rocks), scenery, experiences (difficult sections, wet sites, crawling through tunnel) which would maintain the interest and excitement of the user. Long monotonous sections could be made interesting by detouring to an interesting point for a break, with some discussion between the guide and the visitors.
- *Sensitivity of the terrain:* Once the route has been determined, sensitive sections which would require special care or maintenance or which should better be avoided need to be investigated to determine final selection of the best route. The following situations need special care:

– shallow roots: repeated walking over wet sites or sites with rock close to the surface will cause trampling of the shallow feeder roots of the plants which may cause the death of those plants, in particular the trees. If the section cannot be avoided, then either a wooden walkway could be constructed, or flat pieces of rock could be placed in the site to provide stepping stones for crossing the site. No path should take a user up or down the stem or root of a living tree. Leaf litter provides a good buffer against the trampling of many users, and should not be removed because 'it looks more tidy'.

– fragility of Tsingy: the logic is very similar as for the shallow roots. Again a wooden walkway at strategic points will not only protect the Tsingy, but will direct and ease the walking of the user.

– wet sites: the logic is again very similar as for shallow roots. In some cases it will be better to construct a little bridge across the wet site to avoid gradual widening of the path.

– erodibility: a path up or down a slope should not carry on for too far, and the best is to select a route which either zigzag, or take a more gradual slope. For example, the path into the cave at the Grande Tsingy need to be stepped and built with large, flat local stones (not small pieces) to prevent its degradation and becoming slippery.

- *Maximum degree of difficulty should not exceed the capability of the user:* If a path contains one very difficult section, then the users should be informed about it. For example, the crossing of a crevice over a narrow piece of rock may not be possible for a person who is afraid of heights. Such a person may hold up a whole group, or may even prevent the group to experience the climax of the trail. The following structures may help to ease difficult sections, or to prevent trail degradation: steps build from large flat local stones, or a wooden ladder, or a rope tightly secured up or down a steep section, to ease climbing or walking.

Camp sites

Visitors spend relatively long periods at a camp site. Special care will have to be taken for the following:

- *Shelter:* against hot sun or cold or strong winds. Preferably, the site should provide for direct exposure to the early morning sun, for shade during the day, and protection against prevailing cold or strong winds. Sites which are also used for shelter by animals such as livestock, or where birds or bats come to feed (large fleshy fruit) or roost (specific tree species), should be avoided.
- *Moisture content of substrate:* ensure that the soil is not wet or has the potential to be flooded after a sudden heavy rain. The site should preferably be situated on a raised portion of the general terrain.
- *Water for drinking and washing:* specify whether the water is safe for drinking or not. If the water is very shallow, provide for a place where the water level could be increased to facilitate collection of water. The point in the stream which will be used for washing should be downstream from the point of collection of water for cooking, and should be somewhat sheltered.
- *Security:* The following situations should best be avoided, if possible.
  - Presence of people in a nearby village;
  - Shrubby or thorny plants, unless this can provide protection to one side of the camp;
  - Fire danger, in particular from grassland;
  - Dangerous animals, particular near streams with the potential of crocodiles.
- *Scenery:* It always adds to the experience of a camp site if it provides a view across a valley, or onto a cliff face, or of a nice stand of trees.

Planning for additional routes

The following could be considered:

- To increase the control over tourists, and for greater experience by them, it is important to keep the groups small, in particular during peak tourist periods when the area becomes better known and more accessible;
- Planning of more routes into the area near the river, on both sides of the river, or provide more nested trails to cater for tourist concentrations during peak tourist periods;
- A route along the edge of the cliffs above the river. The southern side, with northern exposure, seems to offer the best options.

Construction of camp sites

In the buffer zone of the park, camp sites should only have simple structures of a temporary nature. If a site becomes degraded, the camp may have to be moved to another site. Currently it seems that very few tourists bring their own tents. This situation could be managed in one of two ways: either tourists should be informed to bring their own tents, or small tents which could easily sleep two people should form part of the facilities of a camp site, but should not be left pitched on the site. Camp sites outside of the buffer zone, such as the sites of the tour operators, could be of a semi-permanent structures, such as a overhead shelter made of treated poles from the local area, thatched with grass, with a sand-filled cement box for pitching the small tents.

Toilet facilities and practices

Special attention should be given to toilet facilities and practices, because this could be the most annoying or embarrassing aspect of the camp experience. At the temporary camp sites in the buffer zone, the practice of using a spade to make a necessary small hole is effective provided the soil is not too hard or the camp is not very often used. Permanent structures at the camp sites outside the buffer zone should provide for either a French Drain system, or the modern facilities which are available to cater for such situations.

Litter management in the camp sites and on the trails

The guides should make a special effort to inform tourists that

- they should keep their refuge with them and dispose of it in a poly-ethylene bag (which could be a bigger pollution problem if not correctly managed) provided for that purpose at the camp site;
- all litter should be taken back to a central site where it could appropriately be disposed of because locals may 'raid' the waste dumps in a camp.

Training and information

Training of guides

Training for guides is currently provided at the Bekopaka office. Unfortunately I did not ask for information on the contents of the training course, but would recommend that the following be included in such a course:

- basic ecology of different vegetation types and their associated animal life;
- educational value of features in the Tsingy, such as
  - geological features in relation to present-day geomorphological processes to be seen in the area (such as comparing modern versus ancient processes of erosion and sedimentation);
  - fossilized marine features;
  - xerophytic plants on Tsingy rocks versus evergreen forest trees in deep canyons;
- psychology of guide-tourist interaction;
- first aid.

Signposting of trails

Signposting of all trails are important to guide and direct the users, irrespective of whether guides are present to lead the route. The signs used should be clear and specific to enable the user to keep to the route as described but should also be aesthetically pleasing. They should avoid users who may fall behind for whatever reason to get lost and should therefore not be liable to vandalism.

Information to tourists

Different types of information should be given to tourists to assist them in preparation for the ecotourism experience, to provide them with minimum information on the ecological and cultural aspects of the route and area, and to contribute to environmental education. The information should be clear and specific, should indicate the rules and conditions for participation applicable to the specific trail, and should indicate features of a trail that may cause difficulty to some users (such as no drinkable water along the route, or crawling across a narrow ledge above a deep crevice). Most of this information could be included in a trail brochure, which tourists often also use as souvenir. The brochures could be prepared in different languages to cater for tourists from different origin. It could also facilitate communication when the guides are not fluent in some languages.

Another form of information transfer is through information boards.

Information centre

It would be beneficial to combine the administrative centre for control over the entrance of tourists with an information centre. I would recommend that

- its design should follow the typical style of houses in the area. Its exterior, and preferably also the interior, should look like a typical house in the local village. Its interior should however also facilitate preservation of the contents of the exhibitions.
- it should contain sections on the physical, biological and cultural (historical) environment, as well as of the current life style and traditional practices of the people in the area.
- it should introduce the entire project area, including the other potential ecotourism areas mentioned before, should indicate the different ecotourism options available in the area, the dangers and wonders of the Tsingy, and give an outline of all the other activities of the project.
- it could be combined with a kind of shop and restaurant area where traditional handcrafts, food and drinks could be sold by the locals.

Monitoring

Monitoring is the process through which operators of ecotourism facilities assess the condition of the facilities (trails, camp sites) and functioning of the activities to direct maintenance timeously and to the highest priority components. It is essential that standards be set against which to monitor. Standards should relate to the carrying capacity of specific sites and to the way the facility is managed and used.

Visitor carrying capacity

Visitor carrying capacity depends in part on the design of the trail and camp sites, which is determined by the sensitivity of the landscape (such as erodibility of the substrate, wetness of the site during peak periods), the expected visitor pressure and the construction methods that could be used in relation to maintenance of the aesthetics. Identifying suitable carrying capacity zones depends on the resilience and productivity of the environment and on management objectives. Carrying capacities which may appear to be sustainable over the short term may not be sustainable over the long term. Visitor carrying capacity has been defined as the amount of use that a trail system can support over a specific time without causing unacceptable change to the environment or to the experience of the user, which are inherently subjective criteria. Unacceptable change has both tangible and intangible components. Tangible impacts involve physical disturbance caused by human activities and include soil erosion, vegetation trampling, pollution and littering, disruption of the activities and habitat of sensitive and rare species, and the wear and tear of physical features. Intangible impacts include psychological effects that the presence of other humans or man-made objects (paved paths, wooden walkways and bridges, and trail markers) have on the 'wilderness experience' of the user. Carrying capacity has therefore three distinct dimensions: ecological, psychological and physical (facility).

- *Ecological carrying capacity* is set in relation to set management objectives of when ecosystem functioning is considered to be impaired and over what time scales the irreversibility of the impacts are measured.
- *Psychological carrying capacity* is highly subjective and is determined by both the environment and psychological make-up of the user. The carrying capacity for wilderness areas should be based on the psychology of the user, and will be much lower than those that result in tangible impacts. For example, it has been set at 12 persons per day with no more than one group encounter in some wilderness areas in South Africa. This carrying capacity is particularly relevant for the trails into the Tsingy.
- *Physical (facility) carrying capacity* relates to the facilities for sleeping, toilets and drinking water, and should not exceed the ecological and psychological carrying capacities.

Trail types can be categorized, using two dimensions: the mental and physical demands of the trail (toughness or roughness); and the aesthetic impressions, ranging from pristine wilderness (high) through to 'developed and commercial' (low). These provide four broad categories, which should be seen as generalizations to assist in setting management objectives:

	PHYSIKAL AND MENTAL DEMAND	
AESTHETIC VALUE	**High**	**Low**
High	hard/wild	soft/wild
Low	hard/tame	soft/tame

Monitoring of ecotourism facilities and operations

The purpose of monitoring is to measure the condition and operation of the facilities against the set management objectives for each trail. The goals should therefore be quantifiable. The objectives for a ecotourism monitoring system could be as follows:

- To provide meaningful and accurate information on the ecological and visual impacts changes which may occur on a trail;
- To identify causal factors where measurements do not comply with the management goals;
- To obtain information which would enable technical decisions on needed actions, such as whether to construct a boardwalk across the Tsingy or a wet site, or to provide toilet facilities at the campsites, or to make strategic decisions such as to limit visitor numbers, or to change a route.

Characteristics of a good monitoring system are:

- that it will allow utilization of meaningful measurements of impacts, which again depend on the variables selected for measurement of change;
- that it will use reliable and sensitive measurement techniques which would enable similar results from independent users;
- that the costs must be reasonable to allow for regular inventory at all sites;
- that it must allow for precise reloca-

Tab. 1: Some management implications of the four trail types.

Trail type	Description	Permissible tangible impacts	Permissible intangible impacts	Management Input
Hard/wild	Mentally and physically demanding, element of risk, experience required, no facilities or amenities	Very low or absent Infrastructure kept to a minimum	Low Carrying capacities limited by intangible impacts Minimal party size	Low „Hands-off" management
Hard/tame	Physically demanding, but no element of risk Amenities and facilities available	Medium Carrying capacity set by tangible impacts and facilities	Medium-high	Medium-high Impacts reduced through design and management Ecological carrying capacity increased
Soft/wild	Not very physically demanding, but area unspoilt	Low Carrying capacity set by tangible or intangible impacts	Medium-low	Medium
Soft/tame	Short nature trails or walks Maybe semi-urban areas	High	High	High Large reduction in impacts possible through e. g. paving

tion of measurement units during follow-up assessments.

A dual-monitoring system is recommended because managers and users rate the facilities differently. Top-down monitoring is the periodical monitoring by an official group or person. Bottom-up monitoring is the informal monitoring of trail and camp site conditions by users, and is usually complaint based. The following should be monitored, but the details and frequency should be worked out by the Bemaraha project team:

- *Continuous condition assessment,* which is a 'scoring' questionnaire which is completed by all staff on each occasion they use a path, or at set intervals, or at least once a season. Experienced trail users could also be asked to complete the questionnaire and to assist in general monitoring and management decision-making.
- *Quantitative transect measurements,* which involves sampling of path transects along the whole route, and which will give quantitative data on soil loss and changes in the path profile. The number of monitoring sites needs to cover the variation in path types and site conditions.
- *Camp site conditions,* and should include both ecological and aesthetic impacts such as soil erosion, vandalism, vegetation disturbances, pollution and littering, and water quality.
- *Guide-tourist and village-tourist interactions,* through questionnaires completed at regular intervals by the users.

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Ecotourism is a Viable Way of Using Resources

Dr. Sunaryo

Summary

Ecotourism is a way of using natural resources without extracting the natural resources. In this use, ecotourism can generate economic benefits without removing any materials, plants, and animals from the place where the ecotourism occur. Many local people may be involved in the ecotourism industries. When the local people are involved, ecotourism may be accepted socially and generates income to the local people. Although there are some negative impacts to the environment, ecotourism is considered less likely to damage the environment compared to other forms of land use. Since ecotourism is socially, economically, and environmentally acceptable, ecotourism becomes a viable way of using resources.

Introduction

There are many people trying to define ecotourism. The definition may differ from one to another, but they have one thing in common, that is natural resources as the base of the definition. The Ecotourism Society (June 1991) defined ecotourism as a responsible form of travel that conserves the natural environment and sustains the well-being of local people.

If we look through the definitions, ecotourism can be described as

- travel to natural areas
- study the natural history of the environment
- taking care and not altering the environment
- non consumptive use of natural resources
- understand the local people
- give the benefits to the local people.

From the definition above, ecotourism at least theoretically, is a sustainable way of using ritual resources economically, socially, and environmentally. This paper will discuss economic, social, and environmental aspects of ecotourism.

Economic Aspect

Tourism is an important source of revenue for Indonesia. It is the fourth largest revenue of Indonesia after oil, textile, and timber products and is expected to be the largest revenue in the future. It is difficult to separate ecotourism figures from other types of tourism, although, ecotourism is predicted to have a contribution to the national revenue of US $ 9 billion in the year 2000 with a total visitor number of 6.5 million people and an average length of stay of 11 days (Suprayogi and Hariurawati, 1997).

Gede Pangrango National Park (NP) is a famous place in Indonesia to come for recreation. The place is close to Jakarta, the capital city of Indonesia, and surrounded by cities with dense population. The park is important not only for ecotourism, but also for the protection of watersheds and biodiversity.

The types of revenue generated by ecotourism in the Gede Pangrango NP are

- Food and souvenirs
- Tour operation and guide
- Transportation and hotel
- Entrance fee
- Many other services

Although I do not know the economic figure of ecotourism in the Gede Pangrango NP, I would claim that the economic value of ecotourism in the Gede Pangrango NP combined with other economic benefits (maintenance of biodiversity, ecological processes, and watershed protection) may be greater than any other development option.

The Gede Pangrango NP is an important place for watershed and biodiversity conservation. Headwaters of the three main rivers flowing to Jakarta are in the Gede Pangrango NP. The Gede Pangrango NP also is a place for a lot of flora and fauna unique to Java. There are over 200 species of orchids to be found in the park, and the park is world famous for birds with over 250 species recorded. The Gede Pangrango NP is also a home for some threatened mammals such as javan gibbon, javan leaf monkey, ebony leaf monkey, leopard, and wild dog.

Since the Gede Pangrango NP is an important place for conservation of watershed and biodiversity, the economic value generated by ecotourism is a value added to the main value without damaging the main objective of the land use. Compared to any other use such as agriculture, ecotourism in the Gede Pangrango NP is a wise use of resources and economically viable.

Social Aspect

Ecotourism may give positive or negative impacts on the local people. Some negative impacts are occuring especially when:

- the local people are not involved in the ecotourism industries,
- the local people lose access to the resources inside the park,
- the local people are worse off than before.

These negative impacts, if not managed wisely, may cause social problems and may threaten the viability of the natural resources on which tourism is based.

The problems of social aspects can be alleviated only if tourism benefits are shared with local people equitably, including employment and other forms of income generation. Local people's participation should be given in planning as well as in implementing the ecotourism. Strong involvement of the local people means that the local people's interest will be more accommodated and the local people's understanding for ecotourism development will be greater as well. When the local people understand that ecotourism generates benefits for them, they will protect the natural resources used for ecotourism, and the ecotourism activity will be accepted by the local people.

Some examples of positive relationships of local people are occuring in the Gede Pangrango NP and Halimun NP. In the Gede Pangrango NP, many local people are involved in ecotourism. Many local people are selling food, flowering plants, vegetables and souvenirs, renting house for accommodation, guiding tourists, and providing some other services. On the other hand, when forest fires occur in the Gede Pangrango NP, many local people are willing to help to extinguish the fire.

In the Halimun NP, the ecotourism industries are just growing. In order to be able to contribute to the new industries, some local people had been trained to know how to manage ecotourism. The training was focused on how to be a guide, how to manage a house for tourist accommodation, and how to make handicrafts for sale to the tourist. After some time, they are able to run tourist accommodations in three different locations and they support the protection of the park.

Environmental Aspect

Although ecotourism is known as a sustainable use of resources, there are some negative impacts of ecotourism on the environments including flora and fauna. The negative impacts of ecotourism in the Gede Pangrango NP are water pollution, trail erosion, litter, and vandalism.

Water quality in some places are polluted by refuse. Sanitation facilities in the Gede Pangrango NP are not sufficient to support the tourists, especially in the remote areas such as at the top of the Gede and the Pangrango. In places of tourist concentrations such as at Cibeureum waterfall and Pondok Halimun camping ground, although there are some sanitation facilities available, some tourist still use the river as a final places for their refuse. Based on research in 1987 and 1995, there is an indication of water pollution. The bacterium coliform increased from zero to 130.

Soil erosion is occurring especially along the trails. Trail erosions are varying from low to severe erosion. Severe erosion occurs mainly on the steep trails. In some places, soil erosion on the trail may reach a depth of 100 cm.

Litter caused by the tourist in the Gede Pangrango NP is still a problem. Although efforts to stop littering inside the park are continuously enforced, the litter found in the park is about 100 kg/week. The tourist usually throw their garbage in the tourists' concentration areas and along the trails.

Vandalism in the form of painting and damaging facilities in the park is high. About 25% to 75% facilities are vandalized. Vandalism usually occurs on the trees, rocks, and on the facilities in the remote areas.

Although there are some negative impacts of ecotourism on environments, the negative impact is concentrated on some parts in the intensive use zone and it is not so difficult to be maintained. Compared to potential negative impacts if the park is used for another alternative of land use such as agriculture or mining, the negative impact of ecotourism is very low.

The natural resources are not extracted by ecotourism activities, and the negative impacts of ecotourism to the environment can be alleviated by managing the park well. Good management will be achieved when facilities and ranger are in good conditions, in quantity and quality. Setting up a carrying capacity of the tourists and providing guide to the tourists also will help preventing degradation of the environment.

Conclusion

Although there are some negative impacts of ecotourism, ecotourism may economically, socially, and environmentally be sustainable. Compared to any other alternative of use, some positive impacts of ecotourism combined with other benefits of protection may be greater. The positive impacts can be boasted and the negative impacts can be alleviated by providing enough facilities, good tourist guide, and enough ranger. Since ecotourism is economically, socially, and environmentally sound, ecotourism is a viable concept of using natural resources.

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Workshop: Interrelationship of Cultural and Biological Diversity

Cultural and Spiritual Values of Forests and Biodiversity: Valuing the Knowledge of Indigenous and Traditional Peoples*

Darrell Addison Posey

Many of the areas of highest biological diversity on the planet are inhabited by indigenous and traditional peoples, providing what the Declaration of Belém calls an 'inextricable link' between biological and cultural diversity (Posey & Overal 1990). In fact, of the nine countries which together account for 60 percent of human languages, six of these 'centres of cultural diversity' are also 'megadiversity' countries with exceptional numbers of unique plant and animal species (Durning, 1992: 6).

It is estimated that there are currently at least 300 million people worldwide who are indigenous. There are no reliable figures as to how many are 'traditional' societies, but, excluding urban populations, it could be as high as 85% of the world's overall population. These diverse groups occupy a wide geographical range from the Polar regions to the deserts, savannas and forests of tropical zones (IUCN/UNEP/WWF 1991). According to UNESCO (1993), 4,000 to 5,000 of the 6,000 languages in the world are spoken by indigenous peoples, implying that indigenous groups still constitute most of the world's cultural diversity (also see Maffi, 1998).

The definition of 'indigenous' is problematic in many parts of the world. Indigenous Peoples are defined by the Special Rapporteur of the UN Economic and Social Council Sub-Commission on Prevention of Discrimination and Protection of Minorities in the following manner:

Indigenous communities, peoples and nations are those which, having a historical continuity with pre-invasion and precolonial societies that have developed on

* This paper is based on the Introduction for the U.N.E.P. volume, Cultural and Spiritual Values of Biodiversity (Darrell Posey, Editor and Lead Autor), UNEP/Intermediate Technology Press/Leiden University, 1998

their territories, consider themselves distinct from other sectors of the societies now prevailing in those territories, or parts of them. They form at present non-dominant sectors of society and are determined to preserve, develop and transmit to future generations their ancestral territories, and their ethnic identity, as the basis of their continued existence as peoples, in accordance with their own cultural patterns, social institutions and legal systems (UN ECOSOC 1986).

This historical continuity is characterized by:

(a) occupation of ancestral lands, or at least of part of them;

(b) common ancestry with the original occupants of these lands;

(c) culture in general, or in specific manifestations (such as religion, living under a tribal system, membership of an indigenous community, dress, means of livelihood, life-style, etc.);

(d) language (whether used as the only language, as mother tongue, as the habitual means of communication at home or in the family, or as the main, preferred, habitual, general or normal language);

(e) residence in certain parts of the country, or in certain regions of the world;

(f) other relevant factors.

The International Labour Organization (ILO) Convention 169 Concerning Indigenous Peoples in Independent Countries (1989), identifies Indigenous Peoples as:

(a) tribal peoples in countries whose social, cultural and economic conditions distinguish them from other sections of the national community, and whose status is regulated wholly or partially by their own customs or traditions or by special laws or regulations

(b) peoples in countries who are regarded by themselves or others as indigenous on account of their descent from the populations which inhabited the country, or a geographical region to which the country belongs, at the time of conquest or colonization or the establishment of present state boundaries and who, irrespective of their legal status, retain, or wish to retain, some or all of their own social, economic, spiritual, cultural and political characteristics and institutions.

A fundamental principle established by ILO 169 is that: Self-identification as indigenous or tribal shall be regarded as a fundamental criterion for determining the groups to which the provisions of this convention apply.

This principle is upheld by all indigenous groups, who, as the Final Statement of the Consultation on Indigenous Peoples' Knowledge and Intellectual Property Rights, Suva, April 1995, says: We assert our inherent right to define who we are. We do not approve of any other definition.

Indigenous Peoples insist that they be recognized as 'peoples', not 'people'. The 's' distinction is very important, because it symbolizes not just the basic human rights to which all individuals are entitled, but also land, territorial and collective rights, subsumed under the right to self-determination. In contrast, the use of terms like 'people', 'populations' and 'minorities' implicitly denies self-determination (Posey 1996).

The term 'traditional' is also problematic and, according to the Four Directions Council (1996) of Canada should not to be used to restrict local innovation and cultural change:

"What is 'traditional' about traditional knowledge is not its antiquity, but the way it is acquired and used. In other words, the social process of learning and sharing knowledge, which is unique to each Indigenous culture, lies at the very heart of its 'traditionality'. Much of this knowledge is actually quite new, but it has a social meaning, and legal character, entirely unlike other knowledge."

Traditional livelihood systems, therefore, are constantly adapting to changing social, economic, and environmental conditions. They are dynamic, but – no matter the changes – embrace principles of sustainability (Bierhorst, 1994; Callicott, 1989; Johannes & Ruddle, 1993 Clarkson et al, 1992; Posey and Dutfield 1997). These principles cannot be regarded as universal, but generally emphasize the following values:

– cooperation;

– family bonding and cross-generational communication, including links with ancestors;

– concern for the well-being of future generations;

– local-scale, self-sufficiency, and reliance on locally available natural resources;

– rights to lands, territories and resources which tend to be collective and inalienable rather than individual and alienable;

– restraint in resource exploitation and respect for nature, especially for sacred sites.

The sacred balance

Although conservation and management practices are highly pragmatic, indigenous and traditional peoples generally view this knowledge as emanating from a spiritual base. All Creation is sacred, and the sacred and secular are inseparable. Spirituality is the highest form of consciousness, and spiritual consciousness is the highest form of awareness. In this sense, a dimension of traditional knowledge is not local knowledge, but knowledge of the universal as expressed in the local. In indigenous and local cultures, experts exist who are peculiarly aware of Nature's organizing principles, sometimes described as entities, spirits, or natural law. Thus, knowledge of the forests depends not only on the relationship between humans and Nature, but also between the visible world and the invisible spirit world. According to Opoku (1978), the distinctive feature of traditional African religion is that it is:

„A way of life, [with] the purpose of... order[ing] our relationship with our fellow men and with our environment, both spiritual and physical. At the root of it is a quest for harmony between man, the spirit world, nature, and society. Thus, the unseen is as much a part of reality as that which is seen – the spiritual is as much a part of reality as the material. In fact, there is a complementary relationship between the two, with the spiritual being more powerful than the material. The community is of the dead as well as the living. And in nature, behind visible objects lie essences, or powers, which constitute the true nature of those objects."

Indigenous and traditional peoples frequently view themselves as guardians and stewards of forests. Harmony and equilibrium among components of the Cosmos are central concepts in most cosmologies. Agriculture, for example, can provide 'balance for well-being' through relationships not only among people, but also nature and deities. In this concept, the blessing of a new field represents not mere spectacle, but an inseparable part of life where the highest value is harmony with the Earth. Most traditions recognize linkages between health, diet, properties of different foods and medicinal plants, and horticultural/natural resource management practices – all within a highly articulated cosmological/social context (e.g., Hugh-Jones, 1998).

Local knowledge embraces information about location, movements, and other factors explaining spatial patterns and timing in the ecosystem, including sequences of events, cycles, and trends. Direct links with the land are fundamental and obligations to maintain those connections form the core of individual and group identity. Chief Oren Lyons (1998) also emphasizes how these relationships and obligations are not to some external objects that possess life, but rather to kin and relatives. Biodiversity for his Haudenosaunee people are family and "all our relations".

Suzuki (1998) calls the links between life, land, and society the "Sacred Balance". Science with its quantum mechanics methods, he says, can never address the universe as a whole. And it certainly can never adequately describe the holism of Indigenous knowledge and belief.

In fact, science is far behind in the environmental movement. It still sees nature as objects ("components" of biodiversity is the term used in the Convention on Biological Diversity) for human use and exploitation. Technology has used the banner of scientific "objectivity" to mask the moral and ethical issues that emerge from such a functionalist, anthropocentric philosophy. Strathern (1996) makes this clear when discussing the ethical dilemmas raised (or avoided) when human embryos are "decontextualized" as human beings to become "objects" of scientific research.

Science and technology seldom embrace the values of local knowledge and traditions, and very rarely employ the language of rights and local control over access to resources. Meanwhile, economists would have us believe that markets provide "level playing fields" that do not moralize globalization and, therefore, work more efficiently to advance the causes of environmental conservation.

With such philosophies and policies, there can be little surprise that indigenous, traditional and local communities are hostile to the rhetoric of "partnerships" and "sustainable development" – indeed, to the very tenets of "biodiversity" and "conservation". The dominant scientific and economic forces assume that traditional communities must change to meet "modern" standards, but indigenous and traditional peoples feel the opposite must occur: science and industry must begin to respect local diversity and the "Sacred Balance".

Dealing with the problems

It is obvious that not all human impact on the environment is positive. Indeed, the massive, unprecedented destruction of all types of forests, entire environmental systems, extinctions of species, and pollution of waters and the atmosphere is due to the greed of human societies out of control. Population growth, over-consumption, wastefulness, and just plain arrogance can all be named as reasons for this situation. And although most of this rampant devastation results from industrialized societies competing for global markets, an increasing number of indigenous, peasant and local communities are abandoning sustainable traditions in order to adopt destructive activities.

Some scientists express skepticism that the subsistence and resource management practices of traditional peoples are – and never have been – guided by a "conservation ethic" (e.g., Hames 1991; Kalland 1994a). Some argue that mass extinctions of North American megafauna during the Pleistocene era were not caused by climate changes, but by reckless over-hunting by humans colonizing the continent from Siberia (Martin 1984). Likewise, the extinction of wildlife on such islands and archipelagos as New Zealand, Madagascar and Australia have been blamed upon the ancestors of today's traditional peoples (Martin and Klein 1984; Diamond 1994, 1997; Flannery 1996). Yet, many megafauna species persisted in Africa and Eurasia despite human habitation (Flannery 1996; Diamond 1997); East Africa, where Homo sapiens evolved, has retained many of its original megafauna species up to the present day.

Ellen (1986) notes that small scale and isolated traditional societies are most often regarded as being oriented towards conservation. He argues that it is because these societies are small that they impact minimally on the environment. Thus, dependence upon a broad spectrum of useful species is a rational subsistence strategy, but not a conscious means to protect species for future generations. Redford and Stearman (1993) are also skeptical that traditional peoples are natural conservationists. They feel it is inappropriate to generalize about traditional communities and make broadly applicable assertions about their environmental values (Stearman 1992). Furthermore, present-day traditional societies are to a large extent part of the global economy and have lost many of their traditional cultural values. It is therefore unfair to expect traditional peoples to continue using traditional, low-impact subsistence technologies and strategies (Redford 1991; Kalland 1994b).

Nonetheless, many anthropologists defend the idea that indigenous and traditional peoples have a profound a wareness of conservation (e.g. Bodley 1976; Martin 1978; Clad 1984; Posey, 1997; Reichel-Dolmatoff 1976). And most everyone agrees that local communities are more likely to employ environmentally sustainable practices when they enjoy territorial security and local autonomy (Gadgil and Berkes 1991; Bierhorst 1994; Kalland 1994a; Redford and Stearman 1993; Alcorn 1994; Posey and Dutfield 1997).

It is to no one's benefit to romanticize about indigenous and traditional peoples – even those groups that do still live close to the Earth. For it is just as easy for us to find unsustainable practices within their societies as it is for us to have invented the "ecologically noble savage" who lives in "harmony and balance with nature". All human societies – even the most traditional – are enmeshed in change, and always have been. Human evolution is about adaptation and change, and as cultures and environmental conditions adapt to different conditions, there will inevitably be practices and customs that become unadaptive and must be modified to fit the new ambiance.

Indigenous Peoples themselves reject an "ecologically noble savage" approach that romanticizes their relationship with nature. Two Native American scientists (Pierotti and Wildcat, 1998) warn that:

"Those wanting to embrace the comfortable and romantic image of the Rousseauian "noble savage" will be disappointed. Living with nature has little to do with the often voiced "love of nature", "closeness to nature", or desire "to commune with nature" one hears today. Living with nature is very different than "conservation" of nature. Those who wish to "conserve" nature still feel that they are in control of nature, and that nature should be conserved only insofar as it benefits humans, either economically or spiritually. It is crucial to realize that nature exists on its own terms, and that non-humans have their own reasons for existence, independent of human interpretation (see below, and Taylor 1992). Those that desire to dance with wolves, must first learn to live with wolves."

Pierotti and Wildcat (ibid) also point out that the concepts of biodiversity and conservation are not indigenous, and, indeed, are alien to Indigenous Peoples. This does NOT mean they do not respect and foster living things, but rather that nature is an extension of society. Thus, biodiversity is not an object to be conserved. It is an integral part of human existence, in which utilization is part of the celebration of life.

Finn Lynge (In Golliher 1998) emphasizes that one of the basic differences between traditional hunters and urban conservationists is that the latter fear, not love, nature. As he points out, "good nature management" depends upon "the recognition of the interdependent wholeness of humanity", which, in turn, is based upon a respect for life that must be taken to preserve lives.

The problem then is not if Indigenous and traditional peoples are or are not "natural conservationists or foresters", but rather who and how are we (non-Indians) to judge? Different worldviews make such judgments tenuous at best. And, besides, whose scientific measuring stick is to be used to make the judgments? There are, for example, no universal, nor even standardized, indicators of sustainable forest management, nor universal agreement on how to define, measure, or monitor forest biodiversity. And, what are the criteria for environmental health? And healthy environments and forests for whom? Never mind the moral question of: who are we to judge, who provoked the biodiversity crisis in the first place?

Two major points remove us from this relativism and judgmentalism, placing scientists, conservationists and indigenous/traditional peoples alike onto the hard facts of observation and experience. One is the unequivocal influence of indigenous and local communities in the formation and maintenance of modern forest ecosystems. The other are the formidable number of cases studies showing how traditional ecological knowledge and practices serve to effectively manage and conserve forest mountain, agricultural, dry land, highland, aquatic and other ecosystems (See Posey & Dutfield, 1997; Prain, Fujisaka and Warren, forthcoming; Warren, Slikkerveer and Brokensha 1995).

Recognizing indigenous and local communities

Western science may have invented the words "nature", "biodiversity", and "sustainability", but it certainly did not initiate the concepts. Indigenous, traditional and local communities have sustainably utilized and conserved a vast diversity of plants, animals, and ecosystems since the dawn of Homo sapiens. Furthermore, human beings have molded environments through their conscious and unconscious activities for millennia – to the extent that it is often impossible to separate nature from culture.

Some recently 'discovered' cultural landscapes include those of Aboriginal peoples, who 100,000 years before the term 'sustainable development' was coined, were trading seeds, dividing tubers, and propagating domesticated and non-domesticated plant species. Sacred sites act as conservation areas for vital water sources and individual species by restricting access and behavior. Traditional technologies, including fire use, were part of extremely sophisticated systems that shaped and maintained the balance of vegetation and wildlife. Decline of fire management and loss of sacred sites when Aboriginal people were centralized into settlements, led to rapid decline of mammals throughout the arid regions (Sultan, Craig and Ross 1997).

Another example of 'cultural landscapes' is the 'forest islands' (apete) of the Kayapó Indians of Brazil (Posey 1985; 1990; 1997). Kayapó practices of planting and transplanting within and between many ecological zones indicate the degree to which indigenous presence has modified Amazonia. Extensive plantations of fruit and nut trees, as well as 'forest islands' (apete) created in savanna, force scientists to re-evaluate what have often hastily and erroneously been considered 'natural' Amazonian landscapes. The Kayapó techniques of constructing apete in savanna show the degree to which this Amazon group can create and manipulate micro-environments within and between ecozones to actually increase biological diversity. Such ecological engineering requires a detailed knowledge of soil fertility, micro-climatic properties and plant varietal qualities, as well as interrelationships between components of a human-modified ecological community. Successful apete are dependent not just on knowledge of the immediate properties, but also of long-term successional relationships that change as the forest islands mature and grow. Since many plants are specifically grown to attract useful animals, the complexity of the management problem greatly increases: apete are managed both as agroforestry units and game reserves. Kayapó knowledge of apete formation and succession offers invaluable insights into processes of forestation in savanna and reforestation in denuded areas.

The Kagore Shona people of Zimbabwe have sacred sites, burial grounds, and other sites of special historical significance deeply embedded in the landscape (Matowanyika 1997). Outsiders often cannot recognize them during land use planning exercises. In societies with no written language or edifices, hills, mountains and valleys become the libraries and cathedrals that reflect cultural achievement. Chapter 13 on forest management provides additional evidence that presumed "wild" forests are actually managed landscapes. Forests are more often peoples' back yards, not the "wildernesses" assumed by outsiders.

A failure to recognize anthropogenic (human-modified) landscapes has blinded outsiders to the management practices of Indigenous Peoples and local communities (Deneven, 1992; Gomez-Pompa and Kaus 1992). Many so-called 'pristine' landscapes are in fact cultural landscapes, either created by humans or modified by human activity (such as natural forest management, cultivation, and the use of fire).

This is more than semantics. "Wild" and "wilderness" imply that these landscapes and resources are the result of "nature" and, as such, have no owners they are the "common heritage of all humankind". This has come to mean that local communities have no tenurial or ownership rights, and, thus, their lands, territories, and resources are "free" to others just for the taking. This is why Indigenous Peoples have come to oppose the use of "wilderness" and "wild" to refer to the regions in which they now or once lived.

This is poignantly expressed in an Aboriginal Resolution from the 1995 Ecopolitics IX Conference, Darwin, Australia: (Northern Land Council 1996):

The term 'wilderness' as it is popularly used, and related concepts as 'wild resources', 'wild foods', etc., [are unacceptable]. These terms have connotations of terra nullius [empty or unowned land and resources] and, as such, all concerned people and organizations should look for alternative terminology which does not exclude Indigenous history and meaning (Northern Land Council 1996).

Cultural landscapes and their links to conservation of biological diversity are now recognized under the 1972 UNESCO Convention Concerning the Protection of the World Cultural and Natural Heritage ('The World Heritage Convention'). A new category of World Heritage Site, the 'Cultural Landscape', recognizes 'the complex interrelationships between man and nature in the construction, formation and evolution of landscapes' (UNESCO/WHC/2/Revised/1995). The first cultural landscape World Heritage Site was Tongariro National Park, a sacred region for the Maori people of New Zealand (Rössler 1993) that was included in the World Heritage List because of its importance in Maori beliefs. Hay-Edie (1998) reports that UNESCO is also now developing new projects to help local communities conserve and protect sacred places, including sacred groves and forests.

The Convention on Biological Diversity (CBD) is one of the major international forces in recognizing the role of indigenous and local communities *in situ* conservation. The Preamble recognizes the:

Close and traditional dependence of many indigenous and local communities embodying traditional lifestyles on biological resources, and the desirability of sharing equitably benefits arising from the use of traditional knowledge, innovations and practices relevant to the conservation of biological diversity and the sustainable use of its components.

Article 8 (j) of the Convention on Biological Diversity (CBD) spells out specific obligations of Signatories to:

Subject to its national legislation, respect, preserve and maintain knowledge, innovations and practices of indigenous and local communities embodying traditional lifestyles relevant for the conservation and sustainable use of biological diversity and promote the wider application with the approval and involvement of the holders of such knowledge, innovations and practices and encourage the equitable sharing of the benefits arising from the utilization of such knowledge, innovations and practices

The CBD also enshrines the importance of customary practice in biodiversity conservation and calls for protection of and equitable benefit-sharing from the use and application of "traditional technologies" (Articles 10.c and 18.4). Glowka and Burhenne-Guilmin (1994) warn that 'traditional' can imply restriction of the CBD only to those embodying traditional lifestyles, keeping in mind that the concept can easily be misinterpreted to mean "frozen in time". But Pereira and Gupta (1993) claim 'it is the traditional methods of research and application, not just particular pieces of knowledge that persist in a 'tradition of invention and innovation'. Technological changes do not simply lead to modernization and loss of traditional practice, but rather provide additional inputs into vibrant, adaptive and adapting, holistic systems of management and conservation.

'Traditional knowledge, innovations and practices' are often referred to by scientists as Traditional Ecological Knowledge (TEK). TEK is far more than a simple compilation of facts (Gadgil et al, 1993; Johnson, 1992). It is the basis for local-level decision-making in areas of contemporary life, including natural resource management, nutrition, food preparation, health, education, and community and social organization (Warren et al 1995). TEK is holistic, inherently dynamic, constantly evolving through experimentation and innovation, fresh insight, and external stimuli (Suzuki and Knudson 1992).

TEK is built upon traditional varieties of crop and forest plants and gathered foods (often known as NDRs – non-domesticated resources-or NTFPs – non-timber forest products) that serve to stimulate biodiversity conservation, not destroy or homogenize it as most agro-forest management systems do (Thrupp 1997). Indeed "modern" forestry and agriculture have become major threats to indigenous and local communities, as well as biodiversity, healthy ecosystems – and even food security (Mann & Lawrence 1998).

Another important area in which local knowledge plays a major role is in forest medicines and traditional health systems (Akerele et al. 1991; Bodeker 1998). Alternative medical systems are dependent upon and closely tied to healthy forests and biodiversity conservation. It is important to remember that the distinctions between medicine, food, and health are western distinctions. For many indigenous and traditional peoples, foods are medicines and vice versa; in fact, the western division of the two makes little sense to many traditional peoples (Hugh-Jones 1998). And, above all, healthy forests are critical to healthy societies and individuals, because humanity and nature are one, not in opposition to each other.

Equity and rights

Recognition by the CBD of the contributions of indigenous and traditional peoples to maintaining biological diversity may be a major political advance. But there are major dangers. Once TEK or genetic materials leave the societies in which they are embedded, there is little national protection and virtually no international laws to protect community "knowledge, innovations, and practices". Many countries do not even recognize the basic right of indigenous peoples to exist – let alone grant them self-determination, land ownership, or control over their traditional resources (Gray, 1998).

"Farmers' Rights", developed by the Food and Agricultural Organization (FAO) over the last two decades, is one of the few international attempts to recognize the contributions of traditional and indigenous peoples – in this case to global food security. But its legal basis is weak and even meager guarantees are resisted by some powerful countries. The global fund established to insure forms of compensation for local farmers remains inoperative. FAO is undertaking a revision of its International Undertaking on Plant Genetic Resources (IUPGR) with the view of strengthening or expanding Farmers' Rights, but the political road to such improvements is rocky and uncertain (GRAIN 1995; Posey 1996; Plenderleith 1998).

The International Labour Organization (ILO) Convention 169 is the only legally-binding international instrument specifically intended to protect indigenous and tribal peoples. ILO 169 supports community ownership and local control of lands and resources. It does not, however, cover the numerous traditional and peasant groups that are also critical in conservation of the diversity of agricultural, medicinal, and non-domesticated resources. To date the Convention has only 10 national signatories and provides little more than a base line for debates on indigenous rights (Barsh 1990).

The same bleak news comes from an analysis of Intellectual Property Rights (IPRs) laws. IPRs were established to protect individual inventions and inventors, not the collective, ancient folklore and TEK of indigenous and local communities. Even if IPRs were secured for communities, differential access to patents, copyright, know-how, and trade secret laws and lawyers would generally price them out of any effective registry, monitoring or litigation using such instruments (Posey and Dutfield, 1996). Box 1 summarizes how IPRs are considered inadequate and inappropriate for protecting the collective resources of indigenous and traditional peoples.

Box 1: inadequacies of intellectual property rights

Intellectual Property Rights are inadequate and inappropriate for protection of traditional ecological knowledge and community resources because they:

- recognize individual, not collective rights;
- require a specific act of "invention";
- simplify ownership regimes;
- stimulate commercialization;
- recognize only market values;
- are subject to economic powers and manipulation;
- are difficult to monitor and enforce;
- are expensive, complicated, time-consuming.

The World Trade Organization's General Agreement on Tariff and Trade (WTO/GATT) contains no explicit reference to the knowledge and genetic resources of traditional peoples, although it does provide for States to develop *sui generis* (specially generated) systems for plant protection (Trade Related Aspects of Intellectual Property Rights (TRIPs) Article 27.c) (Dutfield 1997). Considerable intellectual energy is now being poured by governments, non-government and peoples' organizations into defining what new, alternative models of protection would include (SEE Leskien & Flitner, 1997). There is skepticism, however, that this *sui generis* option will be adequate to provide any significant alternatives to existing IPRs (Montecinos 1996).

One glimmer of hope comes from the CBD's decision to implement an "intersessional process" to evaluate the inadequacies of IPRs and develop guidelines and principles for governments seeking advice on access and transfer legislation to protect traditional communities (UNEP 1997).

This provides exciting opportunities for many countries and peoples to engage in an historic debate. Up to now, United Nations agencies have been reluctant to discuss „integrated systems of rights" that link environment, trade, and human rights. However, agreements between the CBD, FAO and WTO now guarantee broad consultations on *sui generis* systems and community intellectual property rights (CIPRs) between the World Intellectual Property Organization (WIPO), United Nations Education and Scientific Organization (UNESCO), United Nations Environment Programme (UNEP), United Nations Development Programme (UNDP), United Nations Commission on Trade and Development (UNCTAD), International Labour Organization (ILO), the Geneva Human Rights Centre, and others. It will take the creative and imaginative input of all these groups – and many more – to solve the complicated challenge of devising new systems of national and international laws that support and enhance cultural and biological diversity.

Many of the principles of *sui generis* systems of rights have already been established in international Conventions like the CBD and ILO 169, as well as major human rights agreements such as the International Covenant on Civil and Political Rights (ICCPR), the International Covenant on Economic, Social and Cultural Rights (ICESCR), and, of course, the Universal Declaration of Human Rights (UDHR) (Greaves 1994; van der Vlist 1994, Posey & Dutfield 1996; Posey 1996).

For indigenous peoples, the Draft Declaration of Rights of Indigenous Peoples (DDRIP) is the most important statement of basic requirements for adequate rights and protection. DDRIP took nearly two decades to develop by hundreds of indigenous representatives to the UN Working Group on Indigenous Populations of the Geneva Human Rights Centre. It is broad-ranging, thorough, and reflects one of the most transparent and democratic processes yet to be seen in the United Nations. The process itself and many of the principles established will undoubtedly serve as models for traditional societies and local communities seeking greater recognition of rights. [Box 2 provides some of the principles affirmed by the DDRIP. The complete text is provided in Appendix 1].

Box 2: some principal rights affirmed by the draft declaration on the rights of indigenous peoples

- Right to self-determination, representation and full participation.
- Recognition of existing treaty arrangements with indigenous peoples.
- Right to determine own citizenry and obligations of citizenship.
- Right to collective, as well as individual, human rights.
- Right to live in freedom, peace, and security without military intervention of involvement.
- Right to religious freedom and protection of sacred sites and objects, including ecosystems, plants, and animals.
- Right to restitution and redress for cultural, intellectual, religious or spiritual property that is taken or used without authorization.
- Right to free and informed consent (prior informed consent).
- Right to control access and exert ownership over plants, animals and minerals vital to their cultures.
- Right to own, develop, control and use the lands and territories, including the total environment of the lands, air, waters, coastal seas, sea-ice, flora and fauna and other resources which they have traditionally owned or otherwise occupied or used.
- Right to special measures to control, develop and protect their sciences, technologies and cultural manifestations, including human and other genetic resources, seeds, medicines, knowledge of the properties of fauna and flora, oral traditions, literatures, designs and visual and performing arts.
- Right to just and fair compensation for any such activities that have adverse environmental, economic, social, cultural or spiritual impact.

The global balance sheet

Although international efforts to recognize indigenous, traditional and local communities are welcome and positive, they are pitted against enormous economic and market forces that propel globalization of trade. Critiques of globalization are numerous (e.g. Korten 1995), and point to at least two major short-comings: (i) value is imputed to information and resources only when they enter external markets; and (ii) expenditures do not reflect actual environmental and social costs. This means that existing values recognized by local communities are ignored, despite knowledge that local forest biodiversity provides essential elements for survival (food, shelter, medicine, etc.). It also means that the knowledge and managed resources of indigenous and traditional peoples are ascribed no value and assumed to be free for the taking. This has been called "intellectual terra nullius" after the concept (empty land) that allowed colonial powers to expropriate "discovered" land for their empires. Corporations and states still defend this morally vacuous concept because it facilitates the "biopiracy" of traditional medicines and useful NDR/NTFP species.

Even scientists have been accomplices to such raids by publishing data they know will be catapulted into the public domain and gleaned by "bioprospectors" seeking new products. They have also perpetuated the "intellectual terra nullius" concept by declaring useful local plants as "wild" and entire forest and other ecosystems as "wildernesses", often despite knowing that these have been molded, managed, and protected by human populations for millennia. It is also common for scientists to declare areas and resources "wild" through ignorance – or negligence – without even basic investigations into archaeological or historical records, or to actual human management practices. The result is to declare the biodiversity of a site as "natural", thereby transferring it to the public domain. Once public, communities are stripped of all rights to their traditional resources.

It is little wonder then, that indigenous groups in the Pacific region have declared a moratorium on all scientific research until protection of traditional knowledge and genetic resources can be guaranteed to local communities by scientists. The "moratorium movement" began with the 1993 Mataatua Declaration (Clause 2.8) Posey & Dutfield 1996, p.205):

A moratorium on any further commercialization of indigenous medicinal plants and human genetic materials must be declared until indigenous communities have developed appropriate protection mechanisms.

The Mataatua Declaration, in turn, influenced the Final Statement of the 1995 Consultation on Indigenous Peoples' Knowledge and Intellectual Property Rights in Suva, Fiji (PCRC 1995):

Call for a moratorium on bioprospecting in the Pacific and urge indigenous peoples not to co-operate in bioprospecting activities until appropriate protection mechanisms are in place:

– Bioprospecting as a term needs to be clearly defined to exclude indigenous peoples' customary harvesting practices.

– Assert that *in situ* conservation by indigenous peoples is the best method to conserve and protect biological diversity and indigenous knowledge, and encourage its implementation by indigenous communities and all relevant bodies.

– Encourage indigenous peoples to maintain and expand our knowledge of local biological resources.

To allay these deep concerns, many scientific and professional organizations are developing their own Codes of Conduct and Standards of Practice to guide research, health, educational, and conservation projects with indigenous and local communities (a summary of some of these can be found in Cunningham 1993, Posey 1995 and Posey &, Dutfield 1996).

One of the most extensive is that of the International Society for Ethnobiology, that undertook a 10-year consultation with indigenous and traditional peoples – as well as its extensive international membership – to establish "principles for equitable partnerships". The main objective of the process was to establish terms under which collaboration and joint research between ethnobiologists and communities could proceed based upon trust, transparency, and mutual concerns. A list of these principles can be found in Box 3.

Box 3: principles for "equitable partnerships" established by the international society for ethnobiology

Principle of Self-Determination: This principle recognizes that indigenous peoples have a right to self determination (or local determination for traditional and local communities) and that researchers shall as appropriate acknowledge and respect such rights. Culture and language are intrinsically connected to land and territory, and cultural and linguistic diversity are inextricably linked to biological diversity; therefore, the principle of self-determination includes: (i) The right to control land and territory; (ii) the right to sacred places; (iii) the right (to own / determine the use of / accreditation, protection and compensation for) knowledge; (iv) the right of access to traditional resources; (v) the right to preserve and protect local language, symbols and modes of expression (vi) and the right to self-definition.

Principle of Inalienability: This principle recognizes that the inalienable rights of indigenous peoples and local communities in relation to their traditional lands, territories, forests, fisheries and other natural resources. These rights are both individual and collective, with local peoples determining which ownership regimes are appropriate.

Principle of Minimum Impact: This principle recognizes the duty of scientists and researchers to ensure that their research and activities have minimum impact on local communities.

Principle of Full Disclosure: This principle recognizes that it is important for the indigenous & traditional peoples & local communities to have disclosed to them (in a manner that they can comprehend), the manner in which the research is to be undertaken, how information is to be gathered and the ultimate purpose for which such information is to be used and by whom it is to be used.

Principle of Prior Informed Consent & Veto: This principle recognizes that the prior informed consent of all peoples and their communities must be obtained before any research is undertaken. Indigenous peoples, traditional societies and local communities have the right to veto any program, project, or study that affects them.

Principle of Confidentiality: This principle recognizes that indigenous peoples, traditional societies, and local communities, at their sole discretion, have the right to exclude from publication and/or to be kept confidential any information concerning their culture, traditions, mythologies or spiritual beliefs and that such confidentiality will be observed by researchers and other potential users. Indigenous and traditional peoples also have the right to privacy and anonymity.

Principle of Active Participation: This principle recognizes the critical importance of communities to be active participants in all phases of the project from inception to completion.

Principle of Respect: This principle recognizes the necessity for western researchers to respect the integrity of the culture, traditions and relationship of indigenous and traditional peoples with their natural world and to avoid the application of ethnocentric conceptions and standards.

Principle of Active Protection: This principle recognizes the importance of researchers taking active measures to protect and enhance the relationship of communities with their environment and thereby promote the maintenance of cultural and biological diversity.

Principle of Good Faith: This principle recognizes that researchers and others having access to knowledge of indigenous peoples, traditional societies and local communities will at all times conduct themselves with the utmost good faith.

Principle of Compensation: This principle recognizes that communities should be fairly, appropriately, and adequately remunerated or compensated for access and use of their knowledge and information.

Principle of Restitution: This principle recognizes that where as a result of research being undertaken, there are adverse consequences and disruptions to local communities, those responsible for all undertaking of research will make appropriate restitution and compensation.

Principle of Reciprocity: This principle recognizes the inherent value to western science and humankind in general from gaining access to knowledge of indigenous peoples, traditional societies, and local communities and the desirability of reciprocating that contribution.

Principle of Equitable Sharing: This principle recognizes the right of communities to share in the benefits from products or publications developed from access to and use of their knowledge and the duty of scientists and researchers to equitably share these benefits with indigenous peoples.

Similar principles have been elaborated by environmental philosophers, ethicists, and eco-theologians (Golliher, 1998). Unfortunately much of their efforts have been couched in such rarefied discourses that they have had little impact on the practice of science or on public policy.

There are some important exceptions to this, notably "deep ecology" (Naess 1985, 1989; Devall 1988, Fox 1990, Sessions 1995), which has inspired a militant "Earth First" movement aimed at extinguishing the anthropocentric view that humans have the right to do as they wish to other life forms. For deep ecologists, "the hubris in asking people 'to take responsibility' for the environment is replaced by an invitation to realize the depth of existing ecological relationships" (Golliher, ibid). Ingold (1988) has long argued for a discourse that avoids anthropocentrism and ethnocentrism, in favor of an "ontological equality". To a large extent, this requires shifting priorities from instrumental values (how is biodiversity useful to humans) to intrinsic values (all life is valuable whether it is of use to humans) – not an easy task in a world dominated by economics and global trade.

"Ecofeminism" has also been instrumental in pointing out how unequal gender and power relations have operated to separate "nature" from "spirit", thereby catalyzing disrespect for biodiversity and destruction of ecosystems (Ruether 1992, 1998; Adams 1993; Mies and Shiva 1993; Plaskow and Chirst 1989; Primavesi 1991). This emphasis on "spirit" provides a much-needed bridge between cultures, since „cosmovisions" are the organizing spiritual and conceptual models used by indigenous and traditional peoples to integrate their society with the world. These cosmovisions are based on the „sacred balance" of cosmic forces that unite human beings (males and females equally) with all life (again, equally shared).

Many people in industrialized countries are trying to re-integrate the concept of "sacred balance" into a practical "ethic" of land, biodiversity, and environment. This movement takes its inspiration from Aldo Leopold's (1949) ideas of "land ethic" and "environmental citizenship". Callicott (1998) argues for the need of a global ethic formulated around respect for the diversity of cultures and ecosystems. It may be that the "need" is not just the artifact of human psychology and moral reflection, but rather spiritually and psychologically grounded. Roszak (1992) believes that the environmental crisis is rooted in the extreme "disturbance" of the web of life that is a part of human consciousness.

Indeed, a basic precept of ecology itself is that disturbance of one element of an environmental systems affects all other elements, as well as the whole (Capra, 1998). It may be conjecture as to how Homo sapiens is psychologically affected by the overall loss of biological and cultural diversity, but certainly indigenous, traditional and local communities are aware of the negative local affects – and they express their profound concerns in cultural and spiritual terms precisely because they recognize the deep rootedness of the disturbance.

The worrisome lesson from all of this is that the global environmental crisis cannot be solved by technological tampering ("quick fixes") or superficial political measures. The Native American leader Black Elk puts it:

It is the story of all life that is holy and is good to tell, and of us two-leggeds sharing in it with the four-leggeds and the wings of the air and all green things; for these are children of one mother and their father is one spirit. (Neihardt, 1959; Suzuki 1998).

For industrialized society to reverse the devastating cycles it has imposed on the Planet, it will have to invent an "ecology" powerful enough to offset deforestation, soil erosion, species extinction, and pollution; and, "sustainable practices" that can harmonize with growth of trade and increased consumption; and, of course, a "global environmental ethic" that is not subverted by economically powerful institutions. That may be an impossible task – but there are some viable paths.

One of the best is to relearn the ecological knowledge and sustainable principles that our society has lost. This can come through listening to the peoples of the Planet who still know when birds nest, fish migrate, ants swarm, tadpoles develop legs, soils erode, and rare plants seed and whose cosmovisions manifest the ecologies and ethics of sustainability. As the Bepkororoti Paiakan, a Kayapo Chief (Brazil), puts it: We are trying to save the knowledge that the forests and this Planet are alive – to give it back to you who have lost the understanding.

But listening is not enough: we must uphold their basic rights to land, territory, knowledge, and traditional resources. And we must discover how the balance sheet of economic and utilitarian policies can be countered by the "sacred balance" expressed by indigenous and traditional peoples.

Appendix 1: UN Draft Declaration on the Rights of Indigenous Peoples

(as agreed upon by members of the Working Group on Indigenous Populations at its 11th session, 1993)

Affirming that indigenous peoples are equal in dignity and rights to all other peoples, while recognizing the right of all peoples to be different, to consider themselves different, and to be respected as such,

Affirming also that all peoples contribute to the diversity and richness of civilizations and cultures, which constitute the common heritage of humankind,

Affirming further that all doctrines, policies and practices based on or advocating superiority of peoples or individuals on the basis of national origin, racial, religious, ethnic or cultural differences are racist, scientifically false, legally invalid, morally condemnable and socially unjust,

Reaffirming also that indigenous peoples, in the exercise of their rights, should be free from discrimination of any kind,

Concerned that indigenous peoples have been deprived of their human rights and fundamental freedoms, resulting, inter alia, in their colonization and dispossession of their lands, territories and resources, thus preventing them from exercising, in particular, their right to development in accordance with their own needs and interests,

Recognizing the urgent need to respect and promote the inherent rights and characteristics of indigenous peoples, especially their rights to their lands, territories and resources, which derive from their political, economic and social structures, and from their cultures, spiritual traditions, histories and philosophies,

Welcoming the fact that indigenous peoples are organizing themselves for political, economic, social and cultural enhancement and in order to bring an end to all forms of discrimination and oppression wherever they occur,

Convinced that control by indigenous peoples over developments affecting them and their lands, territories and resources will enable them to maintain and strengthen their institutions, cultures and traditions, and to promote their development in accordance with their institutions, cultures and traditions, and to promote their development in accordance with their aspirations and needs,

Recognizing also that respect for indigenous knowledge, cultures and traditional practices contributes to sustainable and equitable development and proper management of the environment,

Emphasizing the need for demilitarization of the lands and territories of indigenous peoples, which will contribute to peace, economic and social progress and development, understanding and friendly relations among the nations and peoples of the world,

Recognizing in particular the right of indigenous families and communities to retain shared responsibility for the upbringing, training, education and well-being of their children,

Recognizing also that indigenous peoples have the right freely to determine their relationships with States in a spirit of coexistence, mutual benefit and full respect,

Considering that treaties, agreements and other arrangements between States and indigenous peoples are properly matters of international concern and responsibility,

Acknowledging that the Charter of the United Nations, the International Covenant on Economic, Social and Cultural Rights and the International Covenant on Civil and Political Rights affirm the fundamental importance of the right of self-determination of all peoples, by virtue of which they freely determine their political status and freely pursue their economic, social and cultural development,

Bearing in mind that nothing in this Declaration may be used to deny any peoples their right of self-determination,

Encouraging States to comply with and effectively implement all international instruments, in particular those related to human rights, as they apply to indigenous peoples, in consultation and cooperation with the peoples concerned,

Emphasizing that the United Nations has an important and continuing role to play in promoting and protecting the rights of indigenous peoples,

Believing that this Declaration is a further important step forward for the recognition, promotion and protection of the rights and freedoms of indigenous peoples and in the development of relevant activities of the United Nations system in this field,

Solemnly proclaims the following United Nations Declaration on the Rights of Indigenous Peoples:

Articles

Part I

1. Indigenous peoples have the right to the full and effective enjoyment of all human rights and fundamental freedoms recognized in the Charter of the United Nations, the Universal Declaration of Human Rights and international human rights law.

2. Indigenous individuals and peoples are free and equal to other individuals and peoples in dignity and rights, and have the right to be free from any kind of adverse discrimination, in particular that based on their indigenous origin or identity.

3. Indigenous peoples have the right of self-determination. By virtue of that right they freely determine their political status and freely pursue their economic, social and cultural development.

4. Indigenous peoples have the right to maintain and strengthen their distinct political, economic, social and cultural characteristics, as well as their legal systems, while retaining their rights to participate fully, if they so choose, in the political, economic, social and cultural life of the State.

5. Every indigenous individual has the right to a nationality.

Part II

6. Indigenous peoples have the collective right to live in freedom, peace and security as distinct peoples and to full guarantees against genocide or any other act of violence, including the removal of indigenous children from their families and communities under any pretext.

In addition, they have the individual rights to life, physical and mental integrity, liberty and security of person.

7. Indigenous peoples have the collective and individual right not to be subjected to ethnocide and cultural genocide, including prevention of and redress for:

(a) Any action which has the aim or effect of depriving them of their integrity as distinct peoples, or of their cultural values or ethnic identities;

(b) Any action which has the aim or effect of dispossessing them of their lands, territories or resources;

(c) Any form of population transfer which has the aim or effect of violating or undermining any of their rights;

(d) Any form of assimilation or integration by other cultures or ways of life imposed on them by legislative, administrative or other measures;

(e) Any form of propaganda directed against them.

8. Indigenous peoples have the collective and individual right to maintain and develop their distinctive identities and characteristics, including the right to identify themselves as indigenous and to be recognized as such.

9. Indigenous peoples and individuals have the right to belong to an indigenous community or nation, in accordance with the traditions and customs of the community or nation concerned. No disadvantage of any kind may arise from the exercise of such a right.

10. Indigenous peoples shall not be forcibly removed from their lands or territories. No relocation shall take place without the free and informed consent of the indigenous peoples concerned and after agreement on just and fair compensation and, where possible, with the option of return.

11. Indigenous peoples have the right to special protection and security in periods of armed conflict.

States shall observe international standards, in particular the Fourth Geneva Convention of 1949, for the protection of civilian populations in circumstances of emergency and armed conflict, and shall not:

(a) Recruit indigenous individuals against their will into the armed forces and, in particular, for use against other indigenous peoples;

(b) Recruit indigenous children into the armed forces under any circumstances;

(c) Force indigenous individuals to abandon their lands, territories or means of subsistence, or relocate them in special centres for military purposes;

(d) Force indigenous individuals to work for military purposes under any discriminatory purposes.

Part III

12. Indigenous peoples have the right to practice and revitalize their cultural traditions and customs. This includes the right to maintain, protect and develop the past, present and future manifestations of their cultures, such as archaeological and historical sites, artifacts, designs, ceremonies, technologies and visual and performing arts and literature, as well as the right to the restitution of cultural, intellectual, religious and spiritual property taken without their free and informed consent or in violation of their laws, traditions and customs.

13. Indigenous peoples have the right to manifest, practice, develop and teach their spiritual and religious traditions, customs and ceremonies; the right to maintain, protect, and have access in privacy to their religious and cultural sites; the right to the use and control of ceremonial objects; and the right to the repatriation of human remains.

States shall take effective measures, in conjunction with the indigenous peoples concerned, to ensure that indigenous sacred places, including burial sites, be preserved, respected and protected.

14. Indigenous peoples have the right to revitalize, use, develop and transmit to future generation their histories, languages, oral traditions, philosophies, writing systems and literatures, and to designate and retain their own names for communities, places and persons.

States shall take effective measures, whenever any right of indigenous peoples may be threatened, to ensure this right is protected and also to ensure that they can understand and be understood in political, legal and administrative proceedings, where necessary through the provision of interpretation or by any other appropriate means.

Part IV

15. Indigenous children have the right to all levels and forms of education of the State. All indigenous peoples also have this right and the right to establish and control their educational systems and institutions providing education in their own languages, in a manner appropriate to their cultural methods of teaching and learning.

Indigenous children living outside their communities have the right to be provided access to education in their own culture and language.

States shall take effective measures to provide appropriate resources for these purposes.

16. Indigenous peoples have the right to have the dignity and diversity of their cultures, traditions, histories and aspirations appropriately reflected in all forms of education and public information.

States shall take effective measure, in consultation with the indigenous peoples concerned, to eliminate prejudice and discrimination and to promote tolerance, understanding and good relations among indigenous peoples and all segments of society.

17. Indigenous peoples have the right to establish their own media in their own languages. They also have the right to equal access to all forms of non-indigenous media.

States shall take effective measures to ensure that State-owned media duly reflect indigenous cultural diversity.

18. Indigenous peoples have the right to enjoy fully all rights established under international labour law and national labour legislation.

Indigenous peoples have the right not to be subjected to any discriminatory conditions of labour, employment or salary.

Part V

19. Indigenous peoples have the right to participate fully, if they so choose, at all levels of decision-making in matters which may affect their rights, lives and destinies through representatives chosen by themselves in accordance with their own procedures, as well as to maintain and develop their own indigenous decision-making institutions.

20. Indigenous peoples have the right to participate fully, if they so choose, through procedures determined by them, in devising legislative or administrative measures that may affect them.

States shall obtain the free and informed consent of the peoples concerned before adopting and implementing such measures.

21. Indigenous peoples have the right to maintain and develop their political, economic and social systems, to be secure in the enjoyment of their own means of subsistence and development, and to engage freely in all their traditional and other economic activities. Indigenous peoples who have been deprived of their means of subsistence and development are entitled to just and fair compensation.

22. Indigenous peoples have the right to special measures for the immediate, effective and continuing improvement of their economic and social conditions, including in the areas of employment, vocational training and retraining, housing, sanitation, health and social security.

Particular attention shall be paid to the rights and special needs of indigenous elders, women, youth, children and disabled persons.

23. Indigenous peoples have the right to determine and develop priorities and strategies for exercising their right to development. In particular, indigenous peoples have the right to determine and develop all health, housing and other economic and social programs affecting them and, as far as possible, to administer such programs through their own institutions.

24. Indigenous peoples have the right to their traditional medicines and health practices, including the right to the protection of vital medicinal plants, animals and minerals.

They also have the right to access, without any discrimination, to all medical institutions, health services and medical care.

Part VI

25. Indigenous peoples have the right to maintain and strengthen their distinctive spiritual and material relationships with the lands, territories, waters and coastal seas and other resources which they have traditionally owned or otherwise occupied or used, and to uphold their responsibilities to future generations in this regard.

26. Indigenous peoples have the right to own, develop, control and use the lands and territories, including the total environment of the lands, air, waters, coastal seas, sea-ice, flora and fauna and other resources which they have traditionally owned or otherwise occupied or used. This includes the right to the full recognition of their laws, traditions and customs, land-tenure systems and institutions for the development and management of resources, and the right to effective measures by States to prevent any interference with, alienation of or encroachment upon these rights.

27. Indigenous peoples have the right to the restitution of the lands, territories and resources which they have traditionally owned or otherwise occupied or used; and which have been confiscated, occupied, used or damaged without their free and informed consent. Where this is not possible, they have the right to just and fair compensation. Unless otherwise freely agreed upon by the peoples concerned, compensation shall take the form of lands, territories and resources equal in quality, size and legal status.

28. Indigenous peoples have the right to the conservation, restoration and protection of the total environment and the productive capacity of their lands, territories and resources, as well as to assistance for this purpose from States and through international cooperation. Military activities shall not take place in the lands and territories of indigenous peoples, unless otherwise freely agreed upon by the peoples concerned.

States shall take effective measures to ensure that no storage of hazardous materials shall take place in the lands and territories of indigenous peoples.

States shall also take effective measures to ensure, as needed, that programs for monitoring, maintaining and restoring the health of indigenous peoples, as developed and implemented by the peoples affected by such materials, are duly implemented.

29. Indigenous peoples are entitled to the recognition of the full ownership, control and protection of their cultural and intellectual property.

They have the right to special measures to control, develop and protect their sciences, technologies and cultural manifestations, including human and other genetic resources, seeds, medicines, knowledge of the properties of fauna and flora, oral traditions, literatures, designs and visual and performing arts.

30. Indigenous peoples have the right to determine and develop priorities and strategies for the development or use of their lands, territories and other resources, including the right to require that States obtain their free and informed consent prior to the approval of any project affecting their lands, territories and other resources, particularly in connection with the development, utilization or exploitation of mineral, water or other resources. Pursuant to agreement with the indigenous peoples concerned, just and fair compensation shall be provided for any such activities and measures taken to mitigate adverse environmental, economic, social, cultural or spiritual impact.

Part VII

31. Indigenous peoples, as a specific form of exercising their right to self-determination, have the right to autonomy or self-government in matters relating to their internal and local affairs, including culture, religion, education, information, media, health, housing, employment, social welfare, economic activities, land and resources management, environment and entry by non-members, as well as ways and means for financing these autonomous functions.

32. Indigenous peoples have the collective right to determine their own citizenship in accordance with their customs and traditions. Indigenous citizenship does not impair the right of indigenous individuals to obtain citizenship of the States in which they live.

Indigenous peoples have the right to determine the structures and to select the membership of their institutions in accordance with their own procedures.

33. Indigenous peoples have the right to promote, develop and maintain their institutional structures and their distinctive juridical customs, traditions, procedures and practices, in accordance with internationally recognized human rights standards.

34. Indigenous peoples have the collective right to determine the responsibilities of individuals to their communities.

35. Indigenous peoples, in particular those divided by international borders, have the right to maintain and develop contacts, relations and cooperation, including activities for spiritual, cultural, political, economic and social purposes, with other peoples across borders.

States shall take effective measures to ensure the exercise and implementation of this right.

36. Indigenous peoples have the right to the recognition, observance and enforcement of treaties, agreements and other constructive arrangements concluded with States or their successors, according to their original spirit and intent, and to have States honor and respect such treaties, agreements and other constructive arrangements. Conflicts and disputes which cannot otherwise be settled should be submitted to competent international bodies agreed to by all parties concerned.

Part VIII

37. States shall take effective and appropriate measures, in consultation with the indigenous peoples concerned, to give full effect to the provisions of this Declaration. The rights recognized herein shall be adopted and included in national legislation in such a manner that indigenous peoples can avail themselves of such rights in practice.

38. Indigenous peoples have the right to have access to adequate financial and technical assistance, from States and through international cooperation, to pursue freely their political, economic, social, cultural and spiritual development and for the enjoyment of the rights and freedoms recognized in this Declaration.

39. Indigenous peoples have the right to have access to and prompt decision through mutually acceptable and fair procedures for the resolution of conflicts and disputes with States, as well as to effective remedies for all infringements of their individual and collective rights. Such a decision shall take into consideration the customs, traditions, rules and legal systems of the indigenous peoples concerned.

40. The organs and specialized agencies of the United Nations system and other intergovernmental organizations shall contribute to the full realization of the provisions of this Declaration through the mobilization, *inter alia,* of financial cooperation and technical assistance. Ways and means of ensuring participation of indigenous peoples on issues affecting them shall be established.

41. The United Nations shall take the necessary steps to ensure the implementation of this Declaration including the creation of a body at the highest level with special competence in this field and with the direct participation of indigenous peoples. All United Nations bodies shall promote respect for and full application of the provisions of this Declaration.

Part IX

42. The rights recognized herein constitute the minimum standards for the survival, dignity and well-being of the indigenous peoples of the world.

43. All the rights and freedoms recognized herein are equally guaranteed to male and female indigenous individuals.

44. Nothing in this Declaration may be construed as diminishing or extinguishing existing or future rights indigenous peoples may have or acquire.

45. Nothing in this Declaration may be interpreted as implying for any State, group or person any right to engage in any activity or to perform any act contrary to the Charter of the United Nations.

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Language: A Resource for Nature*

Luisa Maffi

Abstract

Several international instruments concerned with biodiversity conservation in particular, the Convention on Biological Diversity (CBD) – have begun to acknowledge the intrinsic link between biological and cultural diversity. Efforts are underway to enshrine the preservation and protection of traditional ecological knowledge in the documents now being drafted to implement the CBD. Another aspect of the diversity of life, linguistic diversity, must also be given attention and be protected in this context. Local languages are the repositories of traditional knowledge, yet they are vanishing fast under the pressure of global forces that are also threatening biological and cultural diversity. For the sake of continuity of the diversity of life on earth, we must recognize the role of language in the creation, transmission and perpetuation of local knowledge and cultural behaviors, and accord indigenous and minority languages the same protection and chances for survival as are beginning to be granted to the traditional cultures they sustain.

Biocultural diversity and international processes

The concept of biocultural diversity is becoming increasingly familiar in environmental conservation circles internationally, especially since finding its way into international instruments such as the Convention on Biological Diversity (CBD) after the 1992 Rio Summit (UN Conference on Environment and Development). Article 8(j) of the CBD is specifically concerned with indigenous peoples, traditional knowledge and related rights. It states that each Contracting Party must: Subject to its national legislation, respect, preserve and maintain knowledge, innovations and practices of indigenous and local communities embodying traditional lifestyles relevant for the conservation and sustainable use of biological diversity and promote their wider application with the approval and involvement of the holders of such knowledge, innovations and practices and encourage the equitable sharing of the benefits arising from the utilization of such knowledge, innovations and practices.

Indigenous organizations have been very active vis-à-vis the implementation of Article 8(j) at the meetings of the Conference of the Parties (COP) to the CBD. At the latest meeting (COP IV, May 4-15, 1998, Bratislava, Slovakia), they succeeded in passing a decision that calls for the creation of a continuous working group in charge of advising on the measures necessary to protect indigenous peoples' knowledge, innovations and practices. In spite of persisting concerns about being actually enabled to participate in the working group and affect its recommendations, indigenous organizations consider this decision a success on the road to full recognition of the importance of their environmental knowledge and practices for the conservation and sustainable use of biological diversity.

While the processes surrounding the CBD have been in the spotlight, it is perhaps less well known that the first international document to incorporate an integrated notion of biocultural diversity was the Declaration of Belém of the International Society of Ethnobiology, elaborated in 1988 at the 1st International Congress of Ethnobiology in Belém, Brazil. Aware of the simultaneous extinction threats facing tropical and other fragile ecosystems on the one hand, and indigenous peoples on the other, ethnobiologists stressed indigenous peoples' stewardship over the world's biological resources and affirmed the existence of an "inextricable link" between cultural and biological diversity on earth.

Linguistic diversity and biodiversity

Threats to linguistic diversity. Interestingly, at about the same time linguists were beginning to voice widespread concern about the status of the world's languages and to warn of another impending extinction crisis, of a magnitude and pace comparable to, if not greater than, that affecting biodiversity: one that would dramatically reduce linguistic diversity through the disappearance of most of the numerically small languages spoken by indigenous and minority peoples. In linguists' calls to action vis-à-vis this crisis, a parallel was often drawn with the loss of biodiversity, as a way of suggesting comparable damage to humanity's heritage. However, in these initial pronouncements, no significant attempt was made to go beyond such parallels and ask whether there might be more than a metaphorical relationship between these phenomena. It is only recently that this question has been explicitly asked and the idea proposed that, along with cultural diversity, linguistic diversity should also be seen as inextricably linked to biodiversity.

Defining and measuring linguistic diversity. In order to address this issue, let us begin by defining linguistic diversity. As with biodiversity, there are various definitions of linguistic diversity. Most commonly, however, the number of different languages spoken on earth is used as a proxy for global linguistic diversity. There are an estimated 5,000 to 7,000 languages spoken today on the five continents, of which 32% in Asia, 30% in Africa, 19% in the Pacific, 15% in the Americas, and 3% in Europe. Of these languages, statistics indicate that about half are spoken by communities of 10,000 speakers or less; half of these, in turn, are spoken by communities of 1,000 or fewer speakers (Tab. 1). Overall, languages with up to 10,000 speakers total about 8 million people, less than 0.2% of an estimated world population of 5.3 billion.

On the other hand, of the remaining half of the world's languages, a small group of less than 300 (such as Chinese, English, Spanish, Arabic, Hindi, and so forth) are spoken by communities of 1 million speakers or more, accounting for a total of over 5 billion speakers, or close to 95% of the world's population. The top ten of these alone actually comprise almost half of this global population (Tab. 2).

Indigenous and minority languages at risk. Taken together, these figures show that, while more than nine out of ten people in the world are native speakers of one or other of only about 300 languages, most of the world's linguistic diversity is carried by very small communities of indig-

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Tab. 1: Size classification of world's languages by number of mother-tongue speakers and proportion of living languages (n=6526) (after Harmon 1995).

Number of mothertongue speakers per language	Number of languages	Proportion of world's living languages (%)
1–100	553	8.4
101–1000	1143	17.4
1001–10 000	1710	26.2
10 001–100 000	1436	22.0
100 001–1 000 000	660	10.1
> 1 000 000	288	4.4
Extinct	234	
No total given	723	11.0
Auxiliary only	13	< 0.1

Tab. 2: Languages with the most mother-tongue speakers: proportion of world population (after Harmon 1995).

Language	Proportion of world population (%)
Mandarin Chinese	16
English	8
Spanish	5
Arabic (all varieties)	4
Hindi	3
Portuguese	3
Bengali	3
Russian	3
Japanese	2
French	2
All other	51

enous and minority people. These are the languages that have been and continue to be under threat, due to the ever-growing assimilation pressures that promote incorporation of their speakers into "mainstream" society and the collective abandonment of the native languages in favor of majority languages (a phenomenon known as "language shift"). Virtually all languages with 1,000 speakers or less are threatened in this sense, although even more widely spoken languages are fully susceptible to the same pressures. Many of these smaller languages are already at risk of disappearing due to a drastic reduction in the number of their speakers, with younger generations decreasingly or no longer learning their language of heritage. Many more have reached a stage of near extinction, with only a few elderly speakers left. Statistics about "nearly extinct" languages range between 6% and 11% of the currently spoken languages. In some projections, as many as 90% of the world's languages may disappear during the course of the next century. These figures portray a threat to linguistic diversity that may be far greater and more imminent than the threat facing biodiversity.

It is a historical fact that languages, like biological species, have undergone extinction before. Informed guesses suggest that the peak of linguistic diversity on earth may have occurred at the beginning of the Neolithic (10,000 years b.p.), at which time more than twice the current number of languages may have been spoken. Population movements and political and economic expansion have long contributed to reducing linguistic diversity everywhere in the world, even well before the era of colonization and empire building. As with biodiversity, however, what is unprecedented is an extinction crisis of the present magnitude and pace. It has been estimated that there may already be 15% fewer languages now than 500 years ago, when the era of European colonization began.[4] Losses have been especially marked in the Americas and Australia, and the trend is now accelerating throughout the world, with Australia and the Americas (especially the U.S.A.) still in the lead.

Causes of language loss. By and large, the main waves of colonial and imperial expansion in human history (both European and of other major civilizations) have come not only to the detriment of local peoples' sovereignty and control over their ancestral territories, resources, and cultural traditions, but also to the detriment of their ancestral languages. Whenever assimilation into the dominant culture has been the goal (as it has been in most cases), this assimilation has been effected crucially by way of linguistic assimilation, through the imposition of the dominant language in schooling, the media, government affairs, and most other public contexts – and, in parallel, through the denigration of the local languages (and the cultures they embody) as defective, primitive, unfit for the "modern world", as well as through the severe restriction of their contexts of use and even the explicit prohibition of and punishment for their use. Awareness of the political implications of linguistic assimilation was perhaps never better expressed than by the 15th century Spanish grammarian Antonio de Nebrija. In 1492, presenting Queen Isabella of Spain with his grammar of Spanish (the first grammar of any modern European language), Nebrija so explained its purposes in his introduction: "Language has always been the consort of empire."[5]

The "curse of Babel" exposed. We may well feel sorry for the speakers of these smaller languages who have lost or are losing their ancestral tongues. But is it not the case that this linguistic assimilation is ultimately just an inevitable consequence of the in turn inevitable process of globalization the world is witnessing? Is this not, after all, a small price to pay for intercommunication and world stability? At long last, a widespread attitude has it, humanity will be freed of the burden laid on it by the "curse of Babel": the multiplicity of languages. With fewer different languages in use, this line of reasoning goes, it will be easier to communicate with people elsewhere in the world; once marginalized populations will be able to develop and prosper; ethnic conflict will decrease; national unity will no longer be threatened; and we will finally be moving toward the globalized cosmopolitan world that is the ultimate destiny of humanity.

However – whatever we may think about the inevitability of globalization and the ultimate destiny of humanity – none of these arguments is supportable. Firstly, they are mostly expounded by speakers of languages that are comfortably not at risk of going extinct. Secondly, and very importantly, the learning of other languages does not have to occur at the cost of losing one's own language (in technical terms, it doesn't have to be subtractive); it can be additive, leading to a situation of stable multilingualism in one's mother tongue and one or more other languages. Again, it is rare for indigenous or minority groups to abandon their languages in favor of a majority one without direct or indirect pressures from governments and other outside forces. Faced with the challenges of modernity, indigenous and minority language speakers may or may not wish to preserve their own languages and cultural traditions, but should not have to find themselves systematically pressured into the latter choice. Indeed, one may seriously question whether choice under such pressure can be called choice at all.

Furthermore, marginalized ethnic groups who opt for or are forced into assimilation into a linguistic and cultural majority often do not succeed in overcoming their marginalization but end up among the dispossessed within "mainstream" society. As for the issue of ethnic conflict and national security, specialized studies show that ethnic differences (whether identified with language, culture, religion, or any aspects of social organization) do not normally constitute the source of conflict, although they may be seized upon and attributed special meaning as a basis for mobilization when conflict arises. In particular, there is no evidence to suggest that the use of different languages by neighboring populations may constitute per se a cause of conflict; nor, for that matter, does monolingualism within or between countries seem to be a guarantee for peace. When populations of speakers of different languages coexisting in adjacent or the same territory do come into conflict, the causes of such conflict reside more commonly in socioeconomic and political inequality and competition over land and resources, as well as in the denial (rather than the granting) of linguistic and cultural rights.[6]

The idea of Babel as a "curse" is a widespread interpretation of this element of the Judaeo-Christian religious tradition, yet not necessarily a valid one. It is perhaps more accurate to see the divine intervention that brings about a multiplicity of languages as a way of curbing the arrogance and single-mindedness of monolingual empire builders. Other religious traditions suggest that a diversity of languages (and cultures) is a good thing. To cite just one example, according to the Acoma Pueblo Indians of New Mexico the mother goddess Iatiku causes people to speak different languages so that it will not be as easy for them to quarrel.

Multilingualism and linguistic ecologies. Above all, these arguments completely ignore that – for most of human history, and even today in many parts of the world – high concentrations of different languages have coexisted side by side in the same areas. Over 800 different languages are still spoken in the island of New Guinea – the main hotspot of linguistic diversity. There and elsewhere, complex networks of multilingualism in several local languages and pidgins or lingua francas have been a commonplace way of dealing with cross-language communication in situations of contact. This extensive multilingualism has been a key factor in the maintenance of linguistic diversity historically, countering the increasing effects of linguistic assimilation.

Linguists are only beginning to realize that there may be structure to such linguistic diversity. The functional relationships that develop in space and time among linguistic communities that communicate across language barriers have been referred to as "linguistic ecologies". An ecological theory of language takes as its focus the diversity of languages per se, and investigates the functions of such diversity in the history of humanity. It seeks to identify the mechanisms that sustain a language ecology over time – which are, in fact the very same mechanisms that will be required to build a genuine multilingual and multicultural society in today's global world. Furthermore, the study of traditional linguistic ecologies reveals that they encompass not only the linguistic and social environment, but also the physical environment, within a worldview in which physical reality and the description of that reality are not seen as separate phenomena, but instead as interrelated parts of a whole.

Language and the environment: The inextricable link

Overlap of linguistic and biological diversity. To understand how language and the environment may be seen as parts of the same whole, let us first consider some striking correlations between linguistic and biological diversity.[8] The majority of the smaller languages (which, as we have seen, account for most of the world's linguistic diversity) can be labeled as "endemic", in that they are spoken exclusively within this or that country's borders. Comparing a list of countries by number of endemic languages with the IUCN list of "megadiversity" countries, one finds that ten out of the top 12 megadiversity countries (or 83%) also figure among the top 25 countries for endemic languages (Tabl. 3).

A global cross-mapping of endemic languages and higher vertebrate species brings out the remarkable overlap between linguistic and biological diversity throughout the world (Fig. 1). Similar results can be obtained by cross-mapping endemic languages and flowering plant species.

Language, knowledge, and human-environment coevolution. What may account for these correlations? Several geographical and environmental factors have been suggested that may comparably affect both biological and linguistic diversity, and especially endemism: 1) Extensive land masses with a variety of terrains, climates, and ecosystems (e.g., Mexico, USA, Brazil, India, China); 2) Island territories, especially with internal geophysical barriers (such as Indonesia, Australia, New Guinea, the Philippines); 3) Tropical climates, fostering higher numbers and densities of species (e.g., Cameroon, Zaire). All these factors are thought to increase linguistic diversity by increasing mutual isolation between

Table 3: Megadiversity Countries: Concurrence with Endemic Languages (Countries in top 25 for endemic languages in bold).

Country listed alphabetically;
(endemic language rank in parentheses)

Australia	(5)
Brazil	(8)
China	(17)
Colombia	(23)
Ecuador	(—)
India	(4)
Indonesia	(2)
Madagascar	(—)
Malaysia	(15)
Mexico	(6)
Peru	(18)
Zaire	(9)

CONCURRENCE: 10 of 12 (83%)

NOTES: Modified from Harmon (in press). "Megadiversity countries' have been identified as those likely to contain a large percentage of global species richness. The twelve listed were identified on the basis of species lists for vertebrates, swallowtail butterflies, and higher plants. Source: McNeely et al. 1990.

human populations and thus favoring linguistic diversification. In addition, an ecological phenomenon has also been proposed as possibly accounting for biodiversity-linguistic diversity correlations: a process of coevolution of small-scale human groups with their local ecosystems, in which over time humans interacted closely with the environment, modifying it as they adapted to it, and acquiring intimate knowledge of it. This knowledge was encoded and transmitted through the local languages, which thus became in turn molded by and specifically adapted to their socioecological environments. As one linguist puts it: "Life in a particular human environment is dependent on people's ability to talk about it."[9]

This may sound like a truism worthy of little note, but it is not so. That remark embodies one of the most basic functions that language performs for humans, and in its deceptive simplicity reveals where the "inextricable link" between language and the environment is to be found. At the local level, linguistic and cultural distinctiveness has often developed even among human groups defined as belonging to the same cultural area or whose languages are considered to be historically related, and who live within the same bioregion. As local groups have adapted to life in specific ecological niches, they have developed specialized knowledge of them, and specialized ways of talking about them, to convey this vital knowledge and ways of acting upon it for individual and group survival. What has been said of Australian Aboriginal tribes could be said in hundreds of other cases of local peoples around the world: "Coincidences of tribal boundaries to local ecology are not uncommon and imply that a given group of people may achieve stability by becoming the most efficient users of a given area and understanding its potentialities."[10]

Linguistically anthropogenic landscapes. In this light, then, it becomes possible to suggest that landscapes are anthropogenic (human-made) not only in the sense that they are physically modified by human intervention – as ethnobiologists and ethnoecologists have shown contra the myth of pristine wildernesses – but also because they are symbolically brought into the sphere of human communication by language: by the words, expressions, stories, legends, songs that encode and convey human relationships with the environment and that inscribe the history of those relationships onto the land.

Traditional place-naming also both occurs in an ecological context and carries high cultural significance for indigenous peoples, "as a framework for cultural transmission and moral instruction, as a symbolic link to their land, and as a ground for their identity". Named landmarks convey and evoke knowledge both about the physical environment and about daily human activities, historical events, social relations, ritual, and moral conduct: "wisdom sits in places".[11] Landscapes are networks of such places of knowledge and wisdom and thus, in this sense also, anthropogenic.

Losing the link

The extinction of experience. It is this inextricable link between language and the environment that is lost when external forces begin to undermine traditional cultures, pushing them into the "mainstream". Whether this process is propelled by dispossessing local peoples of their sovereignty over land and resources, trampling their cultural traditions, or promoting linguistic assimilation (generally, all three phenomena occur at once and are mutually reinforcing), the end result is the same. Local peoples lose control over, and contact with, their natural and cultural environments. As they are removed from their lands, or subsist in highly degraded ecosystems, and are absorbed into a market economy in which there normally is little room for traditional subsistence practices and resource use, local ecological knowledge and beliefs and the wisdom about human-environment relationships begin to lose their relevance to people's lives.

This phenomenon has been called the "extinction of experience", the radical loss of direct contact and hands-on interaction with the surrounding environment.[12] In turn, local languages lose their crucial function of communicating and upholding such knowledge, beliefs and wisdom that are increasingly less significant and intelligible to younger generations. Furthermore, local knowledge does not "translate" easily into the majority language to which minority language speakers switch; and along with the dominant language usually comes a dominant cultural framework that begins to take over and displace the traditional one. Because in most cases indigenous knowledge is only carried by oral tradition, when shift toward "modernization" and dominant languages occurs and oral tradition in the native languages is not kept up, local knowledge is lost. Due to its place-specific and subsistence-related nature, local ecological knowledge is at especially high risk of disappearing.

Knowledge loss. The patterns and factors of erosion of languages and linguistically-encoded environmental knowledge are beginning to be systematically identified and quantified. For example, among the Piaroa Indians of Venezuela the persistence of ethnobotanical knowledge has been found to negatively correlate with age, bilingualism and schooling. Younger, more acculturated Piaroa show dramatically lower levels of competence than their older, less acculturated counterparts in identifying local plants by their Piaroa names and the cultural uses of those same plant species (Fig. 2–5).

Often, the loss of traditional languages and cultures may be hastened by environmental degradation – such as for logging, mining, agribusiness, cattle-raising, and so forth – by creating a negative feedback loop. In the Yoem pueblo of the Yaqui people of the Sonoran Desert in Arizona, the performance of Yoeme ritual is hampered by the disappearance from the local environment of many plant species that were traditionally employed in religious ceremonies. Ritual is one of the main contexts for the teaching of the Yoeme Truth, and in particular of the intimate spiritual and physical connection with and respect for nature. "Yaquis have always believed that a close communication exists among all the inhabitants of the Sonoran desert world in which they live: plants, animals, birds, fishes, even rocks and springs. All of these come together as a part of one living community which Yaquis call the huya ania, the wilderness world. [...] Yaquis regard song [as a part of ritual] as a special language of this community, a kind of 'lingua franca of the intelligent universe'." The Yoeme elders' inability to correctly perform ritual due to environmental degradation thus contributes to precipitating language and knowledge loss, and creates a vicious circle that in turn affects the local ecosystem.[13]

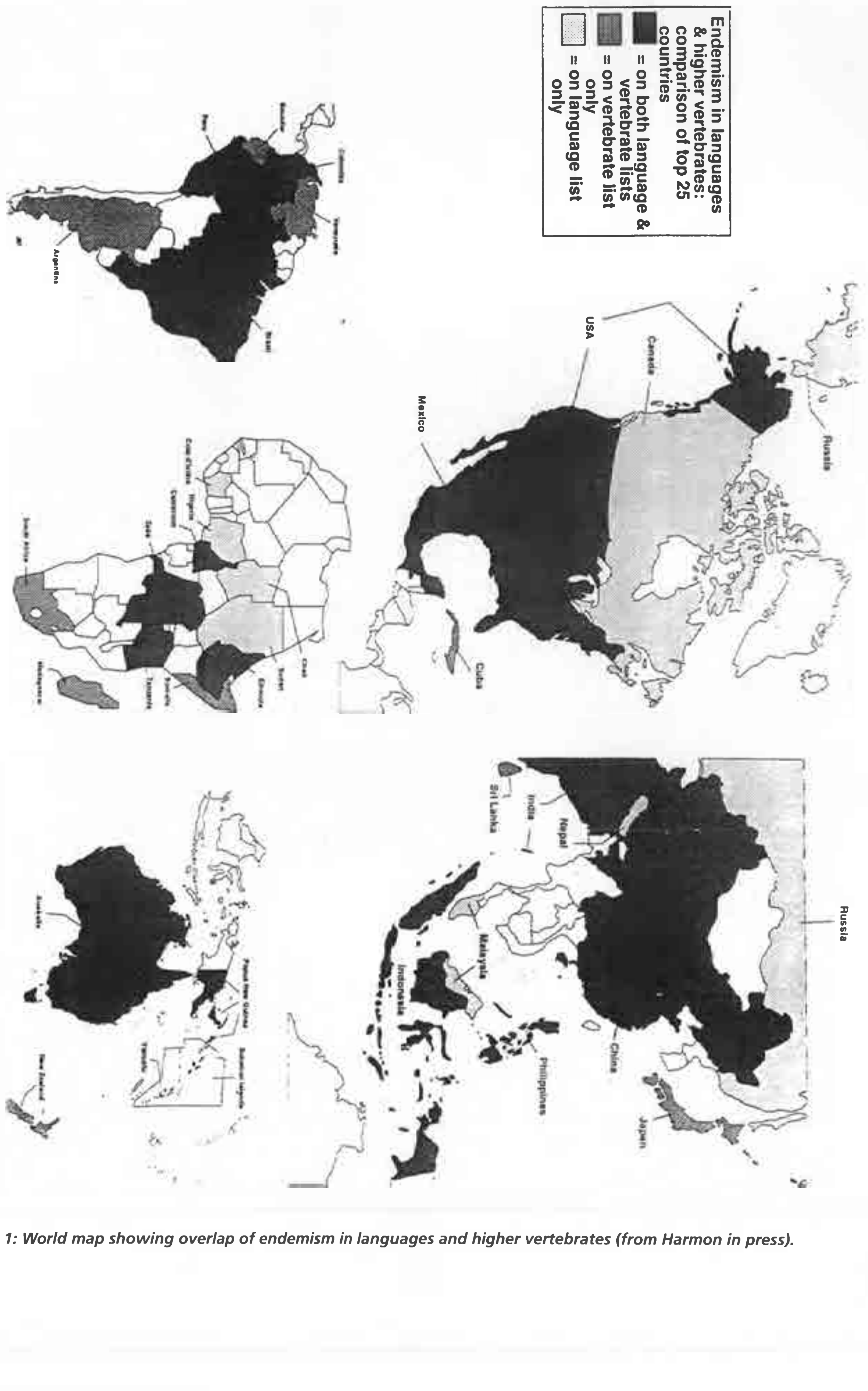

Figure 1: World map showing overlap of endemism in languages and higher vertebrates (from Harmon in press).

Preserving and restoring language, culture, and land

Community efforts. The Yoeme example clearly shows how, for local peoples, the struggle for maintaining or restoring the integrity of their cultures, languages, and environments configures itself as one interrelated goal. This holistic approach is increasingly evident in the grassroots efforts that are being made around the world. As an example, Native Californians are engaging in integrated biocultural conservation efforts. The linguistic and cultural revival activities in which they are involved go hand in hand with advocacy for environmental restoration on their lands and the renewed use of native plants for traditional handicrafts, such as basketweaving, and for other purposes.

On the other hand, if acculturation has such measurably negative effects on traditional knowledge and languages, as in the case of the Piaroa, should local peoples reject the framework of modernity altogether, including the Western schooling that brings about dominant languages and cultural patterns – or, for that matter, the biomedical care that undermines the prestige of traditional medicine, and other similar cultural change? Some indigenous groups, such as certain Amazonian tribes, have made this choice, taking refuge deeper into the forest. Others have chosen to integrate aspects of the two worlds, for instance by combining formal schooling with curricula based on their own cultural traditions and formulated in their native languages. The Hawaiians and Maori have been at the forefront of the latter kind of approach. In still other cases, educational efforts have been aimed at marking the distinction between formal, Western-type learning and traditional, informal learning. In Australia, several Aboriginal groups use an approach whereby they separate "white knowledge" (literacy, numeracy, etc.), taught by monolingual English-speakers, with White Australian content and structure, from their own Aboriginal knowledge. Their own knowledge is rather "lived" than taught in schools.[14]

The need for choices. Whatever choices local peoples may make – and as we have seen, they make a variety of them – what matters is that there be choices. As in the case of language learning (acquisition of a majority language does not have to be subtractive; it can and should be additive), here too it does not have to be a matter of either-or between different cultural frameworks (as it is far too often purported to be by dominant cultures). Local peoples must simply remain free to consciously choose if and how much of either framework – the traditional and the exogenous – they may wish to maintain or adopt. Some groups, as in the Amazonian case, may indeed choose isolation. But others, perhaps most, will probably choose some form of integration between, or parallel adoption of, frameworks. And in so doing, after all, they will not be doing anything different – if done in freedom and not under pressure – from what humans throughout history have done in situations of contact: mixing and matching, which has contributed to so much of the cultural and linguistic diversity that we know today.

Language as a resource

Linguistic diversity and the human potential. Questions about the consequences of loss of linguistic and cultural diversity have been raised mostly in terms of ethics and social justice, and of maintaining the human heritage from the past – and rightly so. However, when we consider the interrelationships between linguistic, cultural, and biological diversity, we may begin to ask these questions also as questions about the future – as related to the continued viability of humanity on earth. We may ask whether linguistic and cultural diversity and diversification may not share substantive characteristics with biological diversity and diversification, characteristics that are ultimately those of all life on earth.

The relevant issues relate to the adaptive nature of variation in humans (as well as other species), and to the role of language and culture as providers of diversity in humans. Human culture is a powerful adaptation tool, and language at one and the same time enables and conveys much cultural behavior. While not all knowledge, beliefs, and values may be linguistically encoded, language represents the main instrument for humans to elaborate, maintain, develop, and transmit such ideas. "Linguistic diversity ... is at least the correlate of (though not the cause of) diversity of adaptational ideas." Therefore, it is possible to suggest that "any reduction of language diversity diminishes the adaptational strength of our species because it lowers the pool of knowledge from which we can draw."[15] It is true that diversity characterizes languages (and cultures) not just with respect to one another, but also internally, with patterns of variation by geographical location, age grade, gender, social status, and a host of other variables. This internal variation combines with the variation ensuing from historical contact among human populations in propelling language and culture change and all manners of innovation. However, as more and more languages and cultural traditions are overwhelmed by more dominant ones and increasing homogenization ensues, one of the two main motors of change and innovation – the observation of linguistic and cultural difference – breaks down, or is seriously damaged. The end result is a global loss of diversity.

Avoiding "cultural blind spots". From this perspective, issues of linguistic and cultural diversity preservation may then be formulated in the same terms that have been proposed for biodiversity conservation: as a matter of "keeping options alive" and of preventing "monocultures of the mind".[16] It has been argued that convergence toward majority cultural models increases the likelihood that more and more people will encounter the same "cultural blind spots" – undetected instances in which the prevailing cultural model fails to provide adequate solutions to societal problems. Instead, "[i]t is by pooling the resources of many understandings that more reliable knowledge can arise"; and "access to these perspectives is best gained through a diversity of languages." Or simply stated: "Ecology shows that a variety of forms is a prerequisite for biological survival. Monocultures are vulnerable and easily destroyed. Plurality in human ecology functions in the same way."[17]

Supporting linguistic, cultural, and biological diversity: The role of scientists

Benefit for the many or for the few? Pronouncements about the importance of diversity often conclude on some universalistic note. Yet it is time to go beyond these general (and generic) statements, true as they may be. That we need diversity – cultural, linguistic, biological – for the benefit of humanity is undoubtedly true. But far too often, as local peoples are the first to know, the hailed "benefit

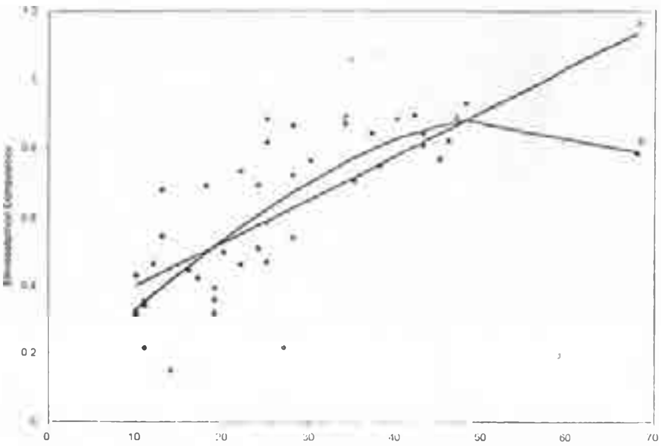

Figure 2: Regression of age and ethnobotanical competence among the Piaroa of Venezuela (from Zent in press). The regression lines drawn represent: a) a linear or binominal model (r^2 = .539; y = .2739 + .0126x); and b) a curvilinear or polynomial model (r^2 = .625; y = 8.3118 + .4465x – 3.359$\sqrt{x}$ – 15.7723x^2 – .0023x^3).

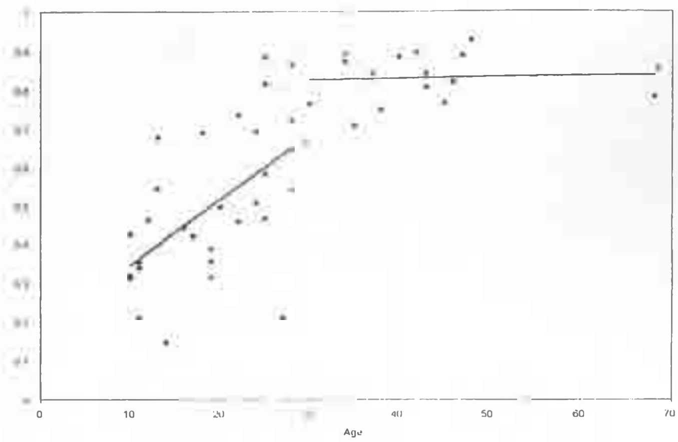

Figure 3: Regression of age and ethnobotanical competence according to age subgroups among the Piaroa of Venezuela (from Zent in press). The regression lines drawn represent: (a) a linear model for 30 and above age group (r^2 = .002; y = .8176 + .00032x); and (b) a linear model for below 30 age group (r^2 = .296; y = .1786 + .017x).

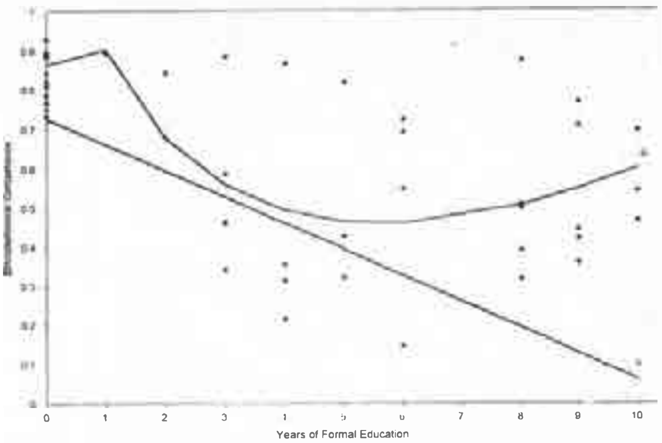

Figure 4: Regression of formal education and ethnobotanical competence among the Piaroa of Venezuela (from Zent in press). The regression lines drawn represent: (a) a linear or binomial model (r^2 = .22; y = .7471 – .0307x); and (b) a curvilinear or polynomial model (r^2 = .415; y = 1.7739 + .2311x – 1.1022$\sqrt{x}$ – .0009/x).

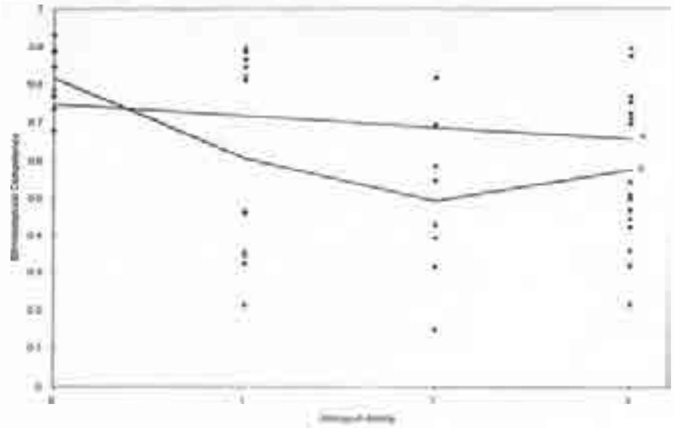

Figure 5: Regression of billingual ability and ethnobotanical competence among the Piaroa of Venezuela (from Zent in press). The regression lines drawn represent: (a) a linear or binomial model (r^2 = .113; y = .727 – .0667x); and (b) a curvilinear or polynomial model (r^2 = .209; y = .8154 - .226x + .0162x^3).

for humanity" has actually meant the benefit (and specifically the economic benefit) of a very small, privileged subset of said humanity, one that does not include that vast majority of humans in which most of this diversity resides. Ethnoscientists have realized to their dismay that they may have been even too successful in affirming the validity of traditional ethnobiological and ethnomedical knowledge – thus unwittingly attracting droves of unscrupulous bioprospectors to the lands of the indigenous peoples whose knowledge they have painstakingly documented. Supporters of cultural diversity balk at the thought that someone may now be earning millions selling multicultural T-shirts in the places where cultural diversity least abounds. And if we are good enough explicating and advocating for the role of language in the diversity equation, the time may not be far away when someone will begin to devise ways to make a business out of linguistic diversity – and not to the advantage of those who hold most of it.

Terralingua. As we work for the maintenance of cultural, linguistic, and biological diversity, we must be constantly aware of these risks. And this is why research, applied work, and advocacy must go hand in hand today. This is not to say that basic research is no longer needed, but it is to say that it can no longer proceed in a vacuum, and that scientists need to educate themselves and others as to the nature and implications of what they do. It also means that scientists must become much better at listening to what indigenous and other local peoples around the world have to say about what they want and need, and be more prepared to ask if and how they can help. With these thoughts in mind, in 1996 an international and multicultural group of scientists created the NGO Terralingua: Partnerships for Linguistic and Biological Diversity, which is devoted to a mixture of research, information, applied work and advocacy concerning the world's linguistic diversity and its relationships with biodiversity.

Among the basic principles guiding Terralingua's work are:

- That the diversity of languages and their variant forms is a vital part of the world's cultural diversity;
- That biological diversity and cultural diversity (of which linguistic diversity is a major component) are not only related, but often inseparable, perhaps causally connected through coevolution;
- That, like biological diversity, linguistic diversity (represented mostly by indigenous languages) is facing rapidly increasing threats that are causing a drastic loss of both languages and the knowledge of which they are carriers, including knowledge about the environment and sustainable resource use;
- That the continued loss of linguistic, cultural and biological diversity will have dangerous consequences for humans and the Earth; and
- That, therefore, the fate of the lands, languages and cultures of indigenous peoples is decisive for the maintenance of biodiversity and linguistic and cultural diversity.[18]

Acknowledging the link. Over the past two years, Terralingua has been striving to promote this perspective both locally and globally in support of indigenous as well as minority communities' struggle to holistically preserve and protect their linguistic, cultural, and natural environments through self-determination (or local determination in the case of local communities). It is apparent that these concerted efforts are beginning to make a difference, and that recognition of the inextricable link between linguistic and biological diversity is beginning to emerge internationally. The International Society of Ethnobiology has enshrined this perspective in its Draft Code of Ethics,[19] which states that: "Culture and language are intrinsically connected to land and territory, and cultural and linguistic diversity are inextricably linked to biological diversity", and upholds the right to preserve and protect local languages as a part of the principle of self-determination. International bodies such as UNESCO, UNEP, and the UN Centre for Human Rights are turning their attention to issues of indigenous languages within the framework of biocultural diversity preservation and the protection of the rights of indigenous peoples. It is likely that in the near future the notion of linguistic diversity will become as familiar as that of cultural diversity in the debates surrounding international instruments concerned with biodiversity, like the Convention on Biological Diversity.

As this process unfolds, we are coming full circle to a holistic view of language, culture and land that may have once characterized localized human communities throughout the world, and that indigenous peoples today are holding up for the rest of humanity to see.

Notes and References:

1. This article draws in part on my contribution to the chapter „Language Diversity", cowritten with T. Skutnabb-Kangas and J. Andrianarivo, to appear in: Posey, D. (ed.) forthcoming, Cultural and Spiritual Values of Biodiversity. Leiden, The Netherlands, Leiden University/Intermediate Technologies/United Nations Environment Programme.

2. On language endangerment, see especially: Krauss, M. 1992. The world's languages in crisis. Language 68(1): 4-10. An integrated perspective on linguistic, cultural and biological diversity was developed in particular at the international interdisciplinary working conference "Endangered Languages, Endangered Knowledge, Endangered Environments" (Berkeley, California, October 25-27, 1996). See: (a) Maffi, L. 1997. Language, knowledge and the environment: Threats to the world's biocultural diversity. Anthropology Newsletter 38(2): 11; (b) Maffi, L. (ed.) forthcoming. Language, Knowledge and the Environment: The Interdependence of Biological and Cultural Diversity. In preparation for Oxford University Press.

3. For the most comprehensive catalogue of the world's languages, see: Grimes, B. (ed.) 1996. Ethnologue: Languages of the World. 13th ed. Available on the World Wide Web at http://www.sil.org/ethnologue/. Summer Institute of Linguistics, Dallas. The mentioned figures do not include sign languages, that may be almost as numerous as oral languages. The data on classification of languages by number of mother-tongue speakers and relative size are from: Harmon, D. 1995. The status of the world's languages as reported in the Ethnologue. Southwest Journal of Linguistics 14: 1-33. Table 1-2 are reproduced from Harmon (1995) with the author's permission.

4. The statistics about "nearly extinct" languages are from: Harmon (1995). The estimate about the possible magnitude of impending linguistic diversity loss is from: Krauss (1992). On hypotheses about the historical peak of linguistic diversity, see: Hill, J.H. 1997. The meaning of linguistic diversity: Knowable or unknowable? Anthropology Newsletter 38(1): 9-10. On estimates of linguistic diversity loss since the colonial era, see: Bernard, R. 1992. Preserving language diversity. Human Organization 51(1): 82-89.

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6. The issue of additive vs. subtractive bilingualism is treated extensively in: Skutnabb-Kangas, T. 1984. Bilingualism or Not: The Education of Minorities. Multilingual Matters, Clevedon, UK. On ethnic groups, marginalization, and ethnic conflict, see: (a) Bodley, J.H. 1990. Victims of Progress. Mayfield Publishing Co., Mountain View, CA. (b) Pattanayak, D.P. 1988. Monolingual myopia and the petals of the Indian lotus: Do many languages divide or unite a nation? In Skutnabb-Kangas, T. and Cummins, J. (eds.), Minority Education: From Shame to Struggle, pp. 379-389. Multilingual Matters, Clevedon, UK. (c) Stavenhagen, R. 1990. The Ethnic Question: Conflicts, Development:, and Human Rights. United Nations University Press, Tokyo.

7. The concept of "linguistic ecology" described here is due to Peter Mühlhäusler, building on earlier work by Einar Haugen. See: (a) Mühlhäusler, P. 1996. Linguistic Ecology: Language Change and Linguistic Imperialism in the Pacific Rim. Routledge, London. (b) Haugen, E. 1972. The Ecology of Language. Stanford: Stanford University Press.

8. The correlations reported here are from: Harmon, D. in press. Losing species, losing languages: Connections between biological and linguistic diversity. Southwest Journal of Linguistics. Figure 1 and Table 3 are reproduced from Harmon (in press) with the author's permission.

Tabl. 4: Statement of Purpose. Terralingua: Partnerships for Linguistic and Biological Diversity.

Terralingua: Partnerships for Linguistic and Biological Diversity is an international organization dedicated to:

1. Preserving the world's linguistic diversity. and
2. Exploring connections between cultural and biological diversity.

STATEMENT OF PURPOSE

A. Terralingua recognizes:

1. That the diversity of languages and their variant forms is a vital part of the world's cultural diversity;
2. That cultural diversity and biological diversity are not only related, but often inseparable; and
3. That, like biological species, many languages and their variant forms around the world are now faced with an extinction crisis whose magnitude may well prove very large.

B. Terralingua declares:

4. That every language, along with its variant forms, is inherently valuable and therefore worthy of being preserved and perpetuated, regardless of its political, demographic, or linguistic status;
5. That deciding which language to use, and for what purposes, is a basic human right inhering to members of the community of speakers now using the language or whose ancestors traditionally used it; and
6. That such usage decisions should be freely made in an atmosphere of tolerance and reciprocal respect for cultural distinctiveness—a condition that is a prerequisite for increased mutual understanding among the world's peoples and a recognition of our common humanity.

C. Therefore, Terralingua sets forth the following goals:

7. To help preserve and perpetuate the world's linguistic diversity in all its variant forms (languages, dialects, pidgins, creoles, sign languages, languages used in rituals, etc.) through research, programs of public education, advocacy, and community support.
8. To learn about languages and the knowledge they embody from the communities of speakers themselves, to encourage partnerships between community-based language/cultural groups and scientific/professional organizations who are interested in preserving cultural and biological diversity, and to support the right of communities of speakers to language self-determination.
9. To illuminate the connections between cultural and biological diversity by establishing working relationships with scientific/professional organizations and individuals who are interested in preserving cultural diversity (such as linguists, educators, anthropologists, ethnologists, cultural workers, native advocates, cultural geographers, sociologists, and so on) and those who are interested in preserving biological diversity (such as biologists, botanists, ecologists, zoologists, physical geographers, ethnobiologists, ethnoecologists, conservationists, environmental advocates, natural resource managers, and so on), thus promoting the joint preservation and perpetuation of cultural and biological diversity.
10. To work with all appropriate entities in both the public and private sectors, and at all levels from the local to the international, to accomplish the foregoing.

9. The discussion of factors of linguistic diversity-biodiversity correlations is from: Harmon (in press). The quote is from p. 155 of: Mühlhäusler, P. 1995. The interdependence of linguistic and biological diversity. In Myers, D. (ed.), The Politics of Mulitculturalism in the Asia/Pacific, pp. 154-161. Northern Territory University Press, Darwin, Australia.

10. Quoted from p. 133 of: Tindale, N.B. 1974. Aboriginal Tribes of Australia. University of California Press, Berkeley.

11. The quote on place names is from p. 4 of: Hunn, E.S. 1996. Columbia Plateau place names: What can they teach us? Journal of Linguistic Anthropology 6(1): 3-26. The expression "wisdom sits in places" is derived from: Basso, K.H. 1996. Wisdom Sits in Places: Landscape and Language among the Western Apache. University of New Mexico Press, Albuquerque.

12. See: Nabhan, G.P. and St. Antoine, S. 1993. The loss of floral and faunal story: The extinction of experience. In Kellert, S.R. and Wilson, E.O., The Biophilia Hypothesis. 229-250. Island Press, Washington, D.C.

13. For the Piaroa study, see: Zent, S. in press. The quandary of conserving ethnoecological knowledge: A Piaroa example. In Blount, B.G. and Gragson. T.S. (eds.), Ethnoecology: Knowledge. Resources and Rights Georgia University Press. The Yoeme case is described in: Molina, F.S. 1998. Wa huya ania ama vutti yo'oriwa – the wilderness world is respected greatly: The Yoeme (Yaqui) truth from the Yoeme communities of Arizona and Sonora, Mexico. In Maffi, L., (ed.), forthcoming, Language, Knowledge and the Environment: The Interdependence

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14. On Native Californians, see: Manriquez, L.F. 1998. Silent no more: California Indians reclaim their culture – and they invite you to listen. In Maffi, L. (ed.), forthcoming. Language, Knowledge and the Environment: The Interdependence of Biological and Cultural Diversity. In preparation for Oxford University Press. On Hawaiians, see: Kamana, K. and Wilson, W.H. 1996. Hawaiian language programs. In Cantoni, G. (ed.), Stabilizing Indigenous Languages. 153-156. Center for Excellence in Education, Northern Arizona University, Flagstaff, AZ. On Australian Aborigines, see: Harris, S. 1990. Two-way Aboriginal Schooling. Education and Cultural Survival. Aboriginal Studies Press, Canberra.

15. For a review of commonly proposed reasons for preserving languages, see: Thieberger, N. 1990. Language maintenance: Why bother? Multilingua 9(4): 333-358. The quotes are from p. 82 of Bernard (1992). See also: Diamond, J. 1993. Speaking with a single tongue. Discover 14(2): 78-85.

16. See: (a) Reid, W.V. and Miller, K.R. 1993. Keeping Options Alive: The Scientific Basis for Conserving Biodiversity. World Resources Institute, Washington, D.C. (b) Shiva, V. 1993. Monocultures of the Mind: Perspectives on Biodiversity and Biotechnology. Zed Books, London/Atlantic Heights, NJ.

17. The two quotes are: (a) from p. 160 of Mühlhäusler (1995; (b) from p. 380 of Pattanayak (1988).

18. Terralingua can be reached by email at: <gws@mail.portup.com>, or on the World Wide Web at: http://cougar.ucdavis.edu/nas/terrallin/home.html.

19. To be submitted for approval by the membership at the 6th International Congress of Ethnobiology. Whakatane, Aotearoa/New Zealand, 23-28 November 1998.

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Traditional Ecological Knowledge: Peoples, Forests and Plants

L. Jan Slikkerveer

Abstract

Embarking on a short overview of the development of cognitive anthropology and ethnoscience into the new field of Traditional Ecological Knowledge (TEK), the theoretical significance of the indigenous knowledge systems' perspective for biodiversity conservation and management, as well as the practical implications for environmental policy planning and implementation targeted at indigenous and traditional communities in the tropics is indicated. Since these communities - particularly in the tropical forest areas - are increasingly facing erosion or loss of their own traditional knowledge and local authority due to globalization and policies that undermine their societies, remedial action to reverse their own practices and revitalize or modify traditional conservation strategies has recently brought various important issues into the international debate.

Current efforts from among several disciplines are focused on establishing a comprehensive body of knowledge on 'indigenous knowledge and development' that on the theoretical and methodological level is obviously in need of a theorem that goes beyond the mere accumulation of data from case studies and narratives on the subject. This kind of collaborative action-research has recently introduced important issues of natural and intellectual property rights, empowerment and joint grassroots movements into the arena.

In this process, the particular significance of TEK for further conservation of both bio- and cultural diversity is emerging from a growing number of practical case studies indicating its value for new bio-ecological insight, environmental assessment, and alternative forms of conservation practices all of which are intertwined with respect and protection of indigenous peoples and their traditional knowledge systems. Several accounts also highlight the critical role of local philosophies, cosmologies and worldviews in the management of forestry and agricultural and natural resources against the background of the current international debate on the interface between 'global' and 'indigenous' knowledge systems.

The assessment of the current threat of indigenous peoples in the tropical forests and their knowledge systems has also introduced the controversy between political economy and political ecology of biodiversity, leading up to the conclusion that empowerment is among the major pre-requisites of ultimate syncretization of both knowledge systems that pertains to the concept of power-sharing with indigenous and traditional peoples around the globe.

Ethnoscience and Indigenous Knowledge Systems

Since most indigenous knowledge systems are based on the sustainable use and since pre-colonial times, traditional peoples' beliefs, knowledge and practices have been largely ignored if not humiliated by the West as 'folk', 'primitive', 'native' and 'backward'. Their wisdom has often been ridiculed as 'superstitious', and as such marginalized, and in some cases even wiped out completely. The subjugated position of these largely oppressed but persistent indigenous knowledge systems have lasted until after World War II, when the emergence of the new independent states in the developing world allowed for a growing academic interest to study local ideas, taxonomies and classifications from the participant's own point of view.

Although earlier ethnologists such as Franz Boas and Bronislaw Malinowski – supported by a few natural historians, missionaries and travelers in the field –

had already stressed the importance of the 'native point of view' for human survival in the tropics, the development of 'ethnoscience' out of cognitive anthropology did not occur until the 1950s. Then, a group of anthropologists including Harold Conklin (1957), Ward Goodenough (1956) and Paul Kay (1966) began to study local communities from the viewpoint of the members themselves. The new field of ethnoscience, soon subdivided into various sub-sets such as ethnoecology, ethnobotany, ethnolinguistics, ethnohistory, ethnomedicine, ethnobiology, etc. focused on the study of how traditional communities perceive and organize their own cultures, and which principles are underlying the behaviour of its members.

Relevant information on the participants' perceptions of their place in nature was largely collected by the use of the local language itself, often with the help of interpreters that provided a deeper insight in the structures of culture and language. However, as specifically designed ethnoscience research methods themselves soon became more important than the object of study, the interrelations between these data and the community as a whole were not further elaborated. Hence, explanations of such conceptions as the worldview or cosmology of the participants and their relevance for peoples' daily life were largely left open, leaving local perceptions of the relationship between humans and their natural and the spiritual world largely to speculation. Moreover, most ethnoscientists were less interested in the practical relevance of these perceptions, and concentrated on the construction of cognitive delineations based on local taxonomies and classifications of plants, soils, diseases etc. Despite certain successful research in such sub-fields as ethnobotany, ethnomedicine, ethnolinguistics and ethnopsychiatry, by the late 1970s, the ethnoscientific studies – often labeled to as 'static' – had virtually ran into an academic 'cul-de-sac'.

Meanwhile, however, the locus of most of these ethnoscientific studies – the developing world itself – was confronted with increasingly complex problems of development and change. In the practical setting of the age-long processes of interaction and acculturation between the peoples and cultures of the non-Western and Western world, it were the post-World War II theories of modernization and change concerning the socio-economic development process of the new nations in the tropics that supported the design of several models of transfer and diffusion of knowledge and technology. The rather dominant Western-oriented Transfer-Of-Technology (TOT) model used in international 'development aid' was mainly constructed on the basis of the Western concept of knowledge systems to represent a process of creation, exchange and utilization of knowledge.

Often, this process was thought of as evolving from research institutes, laboratories and universities in 'developed' countries, and subsequently transferred onto 'under-developed' countries of the Third World in a unilinear mode (cf. Beal, Dissanayake and Konoshima 1986). Although this strategy initially fostered high hopes for socio-economic development and growth, an increasing number of disappointing development programs and projects in health care, agriculture and forestry – mainly introduced by outsiders who continued to ignore local experience and wisdom – eventually called for alternative solutions.

Then, in 1980, the pioneering work on Indigenous Knowledge Systems and Development by Brokensha, Warren and Werner embarked on a 'new' ethnoscience in terms of the study and analysis of traditional knowledge systems in a more dynamic perspective of the actual development process. Their approach was rather focused on the dynamic context of processes of interaction and interface between non-Western and Western systems of knowledge and technology, and provided a basis for development 'from below' instead of 'from the top'. Following the publication of this comprehensive study in which various forms of indigenous and global knowledge were perceived as interacting systems, an increasing number of applied-oriented studies from several disciplines started to highlight the crucial role that some of these 'traditional' knowledge systems have been playing in the arena of rural extension projects and programs.

In general, Indigenous Knowledge Systems (IKS) refer to specific systems of knowledge and practice evolved over generations in a particular field of anthropological study, and as such unique to a specific culture or region. Sometimes referred to as systems of 'local knowledge' or 'traditional knowledge', these systems have mainly developed outside – or in contrast with – Western-oriented, 'scientific, or 'modern' systems of knowledge and technology generated through universities, research institutes and industries. Indigenous Knowledge forms the basis for local-level decision-making in major sectors of the society such as human and animal health, agriculture and food production, forestry, fisheries and natural resources management (cf. Warren, Slikkerveer and Titilola 1989; Warren, Slikkerveer and Brokensha 1995).

In the course of the 1980s, after the initial acknowledgment and integration of traditional medical knowledge and practice in the new strategy of 'Primary Health Care' adopted by the WHO Conference in Alma Ata (1978), the potentiality of such dynamic orientation on indigenous systems for participatory development started to emerge also in other sectors such as the management of agricultural and natural resources. As a consequence of on the one hand, the growing frustration with disappointing results of largely Western-oriented development programs in the Third World, and on the other hand, the decrease of a long-lasting 'Post-Colonial Syndrome' among some administrators, development experts and extension agents working within donor organizations, a gradual process of revaluation of indigenous peoples and their knowledge systems took successively place in several sectors of the developing nations (cf. Jiggins 1989; Slikkerveer 1989; Warren 1989). Such reorientation not only occurred in relation to the specific problems in those particular sectors, but also reflected the socio-political context of the entire society at the time.

Since then, various studies from both natural and social scientists from among disciplines such as anthropology, botany, agronomy, forestry, ecology, medicine and biology have documented the adaptability and viability of many local systems for the international development process (cf. Posey 1985; Richards 1985; Chambers, Pacey and Thrupp 1989; Warren 1989; Mazur, and Titilola 1992; Fairhead 1992; Slikkerveer 1991; Leakey and Slikkerveer 1991; Mathias Mundy 1990; Warren, Slikkerveer and Brokensha 1995). In most of these studies, the empirical value of the new perspective is being expressed in its multidisciplinary orientation to problem-solving activities that tend to cross conventional boundaries of disciplines and sub-disciplines. Moreover, it is being well demonstrated, that Indigenous Knowledge Systems are often sustainable, participatory and particularly functional on a small-scale level.

Following the strategies of Primary Health Care and 'Health for All by the Year 2000' of WHO (1978, 1980) that allowed for the integration of traditional medicine for comprehensive health care coverage of the entire population, the growing environmental movement around the globe during the 1980s created new space for traditional peoples and their less exploitative philosophies of nature and the environment. So, when the 'Agricultural Crisis' occurred towards the mid 1980s, with its implications for serious food shortage in Sub-Saharan Africa, international agencies started to acknowledge the potential contribution of indigenous knowledge and technology as a sustainable, non-technical solution to the alarming situation in which the ecological dimension obviously played a crucial role. Indeed, partly as a result of prolonged High External Input Agriculture (HEIA) for the support of cash crops that rely heavily on costly imported hybrid seeds and chemical fertilizers, pesticides, fungicides and herbicides, not only the financial problems increased, but particularly the environment became seriously under threat.

In this context, specific agricultural knowledge and practice of local and traditional peoples, also referred to as Indigenous Agricultural Knowledge Systems (INDAKS) refer to a particular body of indigenous knowledge in the field of agricultural resources management by local communities that – according to some authors – go beyond just 'knowledge' and 'information' to include both intellectual and material components of the agro-ecological sector of society, such as perceptions, beliefs, cosmologies, attitudes, practices, technologies, artifacts, seeds, plants, crops, and institutions, procedures and processes (cf. Slikkerveer 1994).

From Ethnoecology to Traditional Ecological Knowledge (TEK)

Since most indigenous knowledge systems are based on the sustainable use and management of local resources over many generations, they link up with the concept of 'sustainability' that has been promoted by the Brundtland Report (1987). This concept that recently was elaborated into the strategy of 'Sustainable Agriculture and Rural Development' (SARD) refers to the use of natural resources to satisfy the changing human needs while maintaining or enhancing the quality of the environment (TAC/CCIAR 1988). A broader definition of 'Sustainability' accepts agriculture to be sustainable only if it complies with the following five criteria: ecologically sound, economically viable, socially just, humane and adaptable (cf. Gips 1986).

Indeed, in the international debate on 'development and environment' provoked by the World Commission on Environment and Development (1987), the role of indigenous knowledge systems in natural resources management could also no longer be ignored. Alternative development paradigms were designed to replace the dominant 'Transfer-of-Technology' model that continued to prolong exploitation and depletion of scarce resources in the tropics that historically are the domain of indigenous communities. The attention for 'grass roots' movements of indigenous peoples and their knowledge systems has further posed a challenge to the 'TOT' model, giving way to the adoption of a more realistic model as proposed by Chambers, Pacey and Thrupp (1989). In their 'Farmer First' orientation they use indigenous practices as a starting point for sustainable agricultural development from below. As a result, alternative programs of Low External Input Agriculture (LEIA) were linking up with the new orientation, and re-introduced the application of traditional agricultural methods and techniques successfully, albeit largely on a small-scale base (cf. Reijntjes, Haverkort and Waters-Bayer 1992). Similarly, the concept of agroecology was introduced as a practical instrument to combine traditional and modern agriculture with specific attention for the preservation of resources and the environment (Altieri 1987).

Meanwhile, general ecology – the study of the relationship between a species and its environment – had developed into the promising field of human ecology that seeks to understand the complex relationships between people and their total environment including all other organic and inorganic components of the earth. Further specialization in this field led to the sub-disciplines of cultural ecology - the study of the way in which a specific culture is adapted to the environment and to other cultures – and social ecology – the study of the way in which the social structure of a human group reflects its entire environment (Campbell 1983).

Within ethnoscience, one of the separate sub-fields that initially developed during the 1950s has been labeled 'ethnoecology' which seeks to understand how local communities perceive their interaction with their environment in terms of animals, plants, forests, soils, spirits etc. Hardesty (1977) defined this field as: 'the study of systems of knowledge developed by a given culture to classify objects, activities, and events of its universe'. Thus, ethnoecology focuses primarily on the ideas, perceptions and classifications of the environmental relationships of members of a particular community or culture. In this way, an emic view on representation from within – as opposed to the etic view from outside – on the environment is constructed as it is perceived by the members of the community themselves. It includes the study of folk classifications and taxonomies of nature and the environment – including plants, animals, diseases etc. – which provides certain clues to the way in which the community is coping with its ecological problems. Here, one of the interesting themes also involves the role of the people's cosmology as it is regulating their interactions with their environment.

Concurrently, the anthropological study of the relationships between non-Western human cultures and their environment evolved into a new sub-discipline of anthropology: ecological anthropology. After an initial stage of cultural evolutionism during the sixties, followed by a second stage of neo-evolutionism and neo-functionalism during the seventies, it was during the eighties that a third stage emerged in this field of processual approaches to the diachronic study of long-term interactions between human populations in the tropics and their environment.

The latter work in ecological anthropology stresses the importance of diachronic studies by its focus on historical processes of transformation and change (cf. Orlove 1980). The environment has always played a major role in anthropology in order to explain both cultural origins and diversity, and today, ecological – or environmental – anthropology is among the most popular sub-fields in the discipline. While ecological anthropology seeks to study and analyze the relationship between humans and their environment in an 'objective', i.e. from the observer's point of view, the ethnoecological approach involves the study of such ecological relationships largely from the participant's point of view.

In conjunction with the above mentioned 'new' ethnoscience orientation on Indigenous Knowledge Systems of the early 1980s, a number of anthropologists have engaged in the study of the interaction among different – Western and non-Western – systems of knowledge and practice which humans have developed over many generations in order to adapt and survive in their environment. Such renewed attention for the dynamic context on interaction between traditional ecological knowledge and Western ecology, 'Indigenous Ecological Knowledge' is also referred to as Traditional Ecological Knowledge (TEK) (cf. Slikkerveer in press). Although Traditional Ecological Knowledge – that primarily encompasses local peoples' knowledge of natural elements such as plants, animals, soils etc. – became widespread in the course of the 1980's, Johannes (1989) and Inglis (1993) point to the age-long experience and wisdom of human interactions with their environment that go back to the earliest hunter-gatherer groups in history. The ultimate objective of this new approach, which embarks on a multi-disciplinary basis to seek answers from among different local and global knowledge systems in order to contribute to the solution of current problems, is essentially based on the comparative study of human's place in nature from prehistory to the present (cf. Leakey and Slikkerveer 1993).

A working definition of Traditional Ecological Knowledge has been presented by Berkes (1993: 3): 'TEK is a cumulative body of knowledge and beliefs, handed down through generations by cultural transmission, about the relationship of living beings (including humans) with one another and with their environment.' In addition to the accumulating body of such applied-oriented environmental knowledge and practice, TEK also refers in a broader sense to the complex – and for so many development experts invisible - socio-cultural context of the knowledge system. Was the emphasis initially placed on the practical value of TEK that only gradually was accepted by development experts as much more effective in various disappointing, often virtually failing or disrupting international development projects, we are now witnessing – and contributing to – a 'struggle' to draw the international attention to the important theoretical, philosophical and spiritual dimensions of TEK. By implication, these dimensions are bringing the legal issues of property rights and the political arguments of equal share and empowerment into the arena.

In line with the above mentioned definition of Indigenous Agricultural Knowledge Systems (INDAKS) , an equally holistic definition has recently been proposed that – in addition to the basic aspects of knowledge and experience – also seeks to accommodate the material spiritual aspects of indigenous ecological knowledge systems. In such an approach, TEK refers to a particular body of indigenous knowledge to include both intellectual and material components of the environment of the society, such as:

- concepts, perceptions, beliefs, cosmologies,
- attitudes,
- practices, experiences, skills, technologies,
- artifacts,
- seeds, plants, crops, trees,
- institutions, procedures and processes,

used by a particular group, community or society in relation to their natural and spiritual environment. (Slikkerveer 1996).

In such a broader perspective, the indigenous conceptualization of human's place within the natural and spiritual world has recently attracted renewed attention, particularly in agriculture where farmers experiment and accumulate experience under influence of their cosmology, or 'cosmovision' – a concept recently introduced by Van den Berg (1991) and the PRATEC Project (1991) in Peru. Cosmovision refers specifically to the way in which the members of a particular culture perceive their world, cosmos or universe. It represents a view of the world as a living being, i.e. in its totality to include natural elements such as plants, animals, and humans, but also spiritual elements such as spirits, ancestors and future generations. In this view, nature does not belong to humans, but humans to nature. As the concept of cosmovision includes the relationships between humans, nature and spiritual world, it describes the principles, roles and processes of the forces of nature, often intertwined with local belief systems (cf. Haverkort 1995). As a result, several accounts of anthropological research indicate that the study of cosmovisions held by particular communities requires a special research methodology as visions also tend include 'extra-scientific' factors and variables, which are often 'invisible' for outsiders in the first instance (cf. Van den Breemer et al. 1991).

The Challenge of Bio-Cultural Diversity

The dynamic newly-developing field of theory and practice of 'Indigenous Ecological Knowledge Systems' encompasses a rather holistic approach to the comparative study of complex interaction processes among human populations vis à vis their environments through time and space. By the end of the 1980s, the breakthrough in the international acknowledgment of indigenous peoples' knowledge on their environment – TEK – occurred in conjunction with the increasing world-wide attention for the conservation and management of biodiversity, now under serious threat of extinction. In line with such reorientation on the international level, the Convention on Biological Diversity (CBD, Article 8.j 1992) called for: 'the wider application of knowledge, innovations and practices of indigenous and local communities embodying traditional lifestyles.'

Other international organizations followed soon to point at the positive contribution of indigenous peoples to sustainable biodiversity conservation and management (Rio Declaration on Environment and Development 1992; Agenda 21 1992; WRI/IUCN/UNEP 1992). In 1993, the United Nations officially declared that the 'Year of the World's Indigenous Peoples' and since then, various recommendations have been formulated concerning the indigenous peoples' political rights, economic rights, the rights to self-determination, and the protection of their cultural, scientific and intellectual property (Voices of the Earth Congress 1993). Moreover, as Posey (in press) emphasizes, international attention is given to the call for respect for indigenous knowledge, practice and experience, as well as for actions to sharing the benefits from their use and application, which leads to full recognition of basic rights of indigenous peoples, traditional societies, and local communities.

In the process to attain a global movement of conservation and management of biodiversity, one of the key issues is directly related to the age-long debate on 'Human's Place within – and not above – Nature' (Leakey and Slikkerveer 1993). While most Western ecological theories have tended to portray humans a 'stewards of the earth' that enabled them full control over and exploitation of natural resources, most indigenous ecological principles are largely concerned with common experience, sustainability and prediction in relation to human subsistence and survival. These principles include values, norms and beliefs regarding the maintenance of the 'balance of nature' which have evolved over generations, and – as an intrinsic part of the local culture – encapsulate specific conservation methods and practices of animal and plant species among many cultures in the tropics. In contrast with the dominant Western economic philosophy of nature and the environment that is based on ever-increasing resource use and production, as described by Max Weber in his Protestant Ethic and the Spirit of Capitalism (1904), most indigenous and local communities tend to give priority to sustainable life-style and the maintenance of resources for future generations above exploitation of natural resources on the short term.

In this context, it is also important to note that cultural diversity is closely linked to biodiversity in several respects, especially in the comparison of cultural diversity in terms of different systems of local, regional and global knowledge vis-à-vis biodiversity in terms of different genes, species and ecosystems (cf. Brush 1989; Warren 1995; Slikkerveer 1996; Posey in press). Recently, the complementarity between cultural and biological diversity was further underscored by a group of ethnobiologists who established the Declaration of Belém of the First International Congress of Ethnobiology (1988) acknowledging the crucial role of indigenous peoples in global environmental planning (cf. Posey and Dutfield 1996).

The complex relationship and the presupposed differences between 'scientific' ecology and TEK, and their different objectives, has often been expressed in binary oppositions. Berkes (1993) lists nine general ways in which TEK tend to differ from scientific ecological knowledge, including the following oppositions: qualitative versus quantitative; intuitive versus rational; holistic versus reductionist, relation of mind and matter versus separation of the two; moral versus value-free; spiritual versus mechanistic, empirical versus systemic; data from resource users versus data from researchers, and diachronic data versus synchronic data.

Moreover, Berkes (1993) points to the significant social context of TEK, in which he observes the following three dimensions: a) symbolic meaning through oral history, place names and spiritual relationships; b) distinct cosmology or worldview being a conceptualization of the environment which differs from Western science of which ecology is a part; c) relations based on reciprocity and obligations towards both community members and other beings and resource management institutions based on shared knowledge and meaning.

With regard to the position of the indigenous and local communities in the tropical rain forests, the socio-cultural context of TEK is particular important as it has served over many generations as a framework for survival. In view of the recent external threats of the indigenous peoples and their habitats as a result of processes of acculturation and globalisation, further documentation, understanding, acknowledgment and respect for these underlying cosmologies and worldviews of nature is crucial as it would provide a base for syncretisation of Western and non-Western philosophies of nature and the environment. Such research efforts would also contribute to the current international debate on the interface between 'global' and 'indigenous' knowledge systems (cf. IK&D Monitor 1995/96).

Paradoxically, however, conventional scientific research methods and techniques to study and analyse these cosmologies and belief systems as part of the local culture have so far been unable to fully understand and analyse these cultural and spiritual values that underlie behaviour, such as the conservation and management of biodiversity (cf. Posey in press).

In the next paragraph, an elaboration of the recently developed 'ethnosystems methodology' will be presented in the context of the indigenous peoples' spiritual values related to biodiversity in the tropical forests, including sacred forests and groves.

TEK, Forests and Plants

Both the theoretical and practical significance of Traditional Ecological Knowledge for the study of biodiversity in the tropical forests of the world are essentially related to a better understanding of the often non-written expressions of indigenous wisdom and experience with the sustainable use and management of the forestry resources by the indigenous peoples. Clearly justifying the preservation of TEK for social and cultural reasons, Berkes (1993) presents various arguments of the practical significance of TEK over 'scientific' knowledge:

- its value for new 'scientific' biological and ecological insight;
- its relevance for contemporary resource management (local 'rules of thumb');
- its effectiveness for local conservation education;
- its use for realistic development planning that involves local people;
- its contribution to environmental impact assessment.

In addition, the theoretical significance of TEK can be further substantiated by the following considerations:

– its contribution to the advancement of a new, synthesized system of indigenous and 'scientific' ecological knowledge and technology;

– its value for the development of an alternative philosophy of nature and the environment;

– its role in the development of a specific research methodology that goes beyond the study of empirical data to include also the 'spiritual' dimension of TEK into the final analysis;

– its input to foster and support respect and protection of the position and health of indigenous peoples and their traditional knowledge systems.

The last consideration links up with Hrenchuk's (1993) assumption that a newly found awareness of TEK could strengthen Western appreciation of the cultures that are holding such indigenous knowledge system.

The specific significance of TEK for the conservation and management of the world's forest biodiversity is emerging from the analysis of rather sustainable practices and use of forest resources by indigenous peoples that is based on their subsistence life-style and underlying cosmovision. Several studies highlight various forms of sustainable indigenous biodiversity management and conservation of agricultural, forestry and natural resources in the tropics such as in Latin America (Alcorn 1989), Nepal (Rusten and Gold 1995; Messerschmidt 1995), Sri Lanka (Everett 1995), Indonesia (Sayer 1991; Aumeerruddy 1995; Padoch and Peluso 1996; Adimihardja in press), West Africa (Falconer 1990), East Africa (Stigter 1995), and Kenya (Slikkerveer 1995; Maundu 1995).

In addition to important research data that are recently being collected by various disciplines engaged in the 'scientific' study of forest biodiversity, specifically in the tropics, such as botany, biology, forestry, entomology and zoology, the further documentation and analysis of Traditional Ecological Knowledge of the indigenous and local communities of the tropical rainforest can contribute substantially to our understanding of related local perceptions, values, practices and experience that have formed the base of sustainable use and management of the rich forest biodiversity in the tropics over many generations. It is clear that such endeavour can only be successful, if it is carried out according to well-considered protocols that would include at least three main aspects: a) as teamwork, b) in agreement and full participation with the local people involved, and c) according to sound ethnoecological research methodology.

Teamwork. While anthropologists document and study the prevailing indigenous ecological knowledge and practice in conjunction with 'scientific knowledge systems, ecologists generally collect data of the environment in terms of soils, landscapes, vegetation, ecozones, climates etc., and biologists provide information on animal and wildlife populations. Similarly, linguists describe local terms and classifications, often in collaboration with botanist who collect and identify plant and tree species. Although in principle, these six main disciplines are more or less involved in the multi-disciplinary endeavour to study and analyze particular aspects of traditional ecological knowledge systems, generally anthropologists are by definition entrusted with the overall research activities.

Local participation. In indigenous forestry research, Alcorn (1995) and Messerschmidt (1995) point to the potentially rich sources of local knowledge. They found that in addition to the obvious need for a special research methodology, extensive participation of villagers has shown to be highly effective for a better understanding of the complex forestry systems in developing countries. Similarly, Aumeeruddy (1994) analysed the situation of forestry in relation to a national park under pressure in Sumatra, Indonesia and found that recognition and involvement of local people is a prerequisite for an adequate decision-making process for forestry research and development. As Posey (in press) notes, this aspect is closely related to the recognition and protection of the indigenous peoples' intellectual and natural property rights.

Research methodology. A participatory, so-called 'ethnosystems' approach has recently been developed at Leiden University based on three methodological principles: 'Participant's View' (V), 'Field of Ethnological Study' (FES), and 'Historical Perspective' (HP) (cf. Leakey and Slikkerveer 1991). With regard to TEK, as well as to indigenous knowledge and practice in adjacent sectors, the understanding of the cosmovision of a particular community or culture is a key requirement for cooperation and participation in development-oriented activities. The special techniques to study, analyze and explain the various aspects of cosmologies which tend to vary along gender lines, forms an important part of the 'ethnosystems' methodology, in which it has gained a prominent position in the study of the indigenous peoples' perspective.

In this context, it is interesting to note, that while most non-academic institutions and organizations in the field seek to evade such 'soft', often 'invisible' factors of spiritual and symbolic meaning and cosmovision, IUCN/UNEP/WWF (1991) recently included some of these dimensions in their publication on Caring for the Earth: A Strategy for Sustainable Living.

The assessment of the current threat of both the indigenous peoples and their knowledge systems, as well as the biodiversity in their tropical forests habitat has recently provoked the controversy between political economy and political ecology of biodiversity, leading up to the conclusion that empowerment is among the major pre-requisites of ultimate syncretization of both knowledge systems that pertains to the concept of power-sharing with indigenous and traditional peoples around the globe.

As Agrawal (in press) points out, the current international debate on the supposedly 'critical difference' between indigenous and scientific knowledge – which he recently initiated in the Indigenous Knowledge and Development Monitor (1995-1996) – left the essential relationship between the knowledge systems and the related power structures largely unexplored. In his view, the value and usefulness of indigenous knowledge lies ultimately in the empowerment of the local communities which have currently come under serious threat.

The ultimate question in the debate on indigenous vis-à-vis global ecological knowledge is then no longer what is the value and usefulness of Traditional Ecological Knowledge for the sustainable use and conservation of the forests' biodiversity, but rather how can it be functionalised to insure an equitable benefit sharing of the rich resources with the indigenous communities.

Conclusion

Embarking on the view that TEK embodies a important area that can provide a major contribution to the sustainable use, management and conservation of biodiversity in the world's forests, the following points summarize the conclusions of this presentation:

- The human resp. indigenous peoples' dimension in the conservation of forest biodiversity should be further acknowledged, substantiated and operationalized, as recognized by the Convention of Biological Diversity (CBD Art. 8-j, 10-c), FAO and other international organizations;
- In addition to the 'ecodiversity-geodiversity-biodiversity' model presented during the opening session of this conference, cultural diversity should be included in terms of different peoples, their various knowledge systems and languages;
- Instead of further differentiation in dichotomies between TEK and 'Scientific Ecological Knowledge', the search for common ground, complementarity, collaboration and synergism of these subsystems should be pursued since both are

part of the same human endeavour to create order out of disorder.

■ The identification of who precisely are 'indigenous peoples' should principally be left with the peoples and communities themselves to decide, as guaranteed by the U.N. Working Group on Indigenous Peoples, ILO etc.

■ The definition of TEK should be holistic as to encapsulate intellectual, cultural, spiritual behavioural and material elements transferred over generations concerning the relationship of human beings with their natural and spiritual environment, such as:

- perceptions, beliefs, cosmologies,
- attitudes, opinions,
- practices, experiences, skills, technologies,
- traditions, innovations,
- artifacts, tools,
- trees, seeds, plants, crops, animals,
- institutions,
- procedures, processes and local authority structure,

used by a indigenous and traditional communities in the tropics in relation to the use and management of natural resources

■ The TEK approach should specifically focus on the philosophies and cosmovisions on which indigenous peoples base their perceptions and practices relating to the management and conservation of biodiversity in order to assess alternative philosophies of nature and the environment.

■ In the analysis of the role of TEK in biodiversity conservation and management, research methodologies should be designed and refined for comparative purposes as to extrapolate 'subjective' factors at the individual level to 'objective' variables at the system level.

■ Truly participatory R&D programs begin with involvement of indigenous peoples in the research process, acknowledges their intellectual and natural resource rights and is based on equitable sharing of benefits.

■ We should provide indigenous peoples with support of their alliances and with networking facilities.

■ The relevance of TEK for bio-cultural diversity conservation and management of forest resources includes:

– Provision of new opportunities for collaborative R&D

– provision of alternatives for sustainable use

– Provision of indigenous environmental assessment

– Provision of alternative conservation methods and practices

– contribution to the development of alternative philosophies of nature and the environment

– contribution to the policy planning and implementation process at various levels.

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Statement

Miguel Hilario

For several centuries, we the indigenous peoples and our knowledge of conservation have been despised and ignored. We have been seen only as inhabitants of the forest; therefore our value has been as objects of study along with natural species. However, at the end of this century, people in the west have to be awaken to realise that our traditional ecological knowledge indeed are important for the conservation and protection of biodiversity. Therefore, we demand that conservation NGOs and government policy makers include us in the discussion of the conservation of biodiversity.

Our ecological philosophy is very simple, a man and his soul is connected to the earth and vice versa. Without the land and its resources the Indian man would disappear as well as the rest of the humanity. In addition, the forest is not only the source of provision for our physical subsistence. But it is where our medicinal and spiritual knowledge is based. However, our spiritual connection with the earth has often been ignored by natural scientists and government policy makers. This has been and still is a major problem for us the indigenous peoples. It is essential that people in the west understand our modus vivendi with biodiversity because for thousands of years we have nurtured and preserved it through our practices, skills and integral knowledge of the environment.

We the indigenous peoples denounce individuals, governments and pharmaceutical companies who use the native peoples as resources to obtain and commercialise our knowledge without our consent and benefit sharing agreements. Our objection of the use of our knowledge does not mean that we are self centred peoples, but rather our objection means that we are tired of being disrespected and exploited in our knowledge, culture and territories. Therefore, we demand that individuals, governments and pharmaceutical companies and conservationist do take into account our concerns, which is the respect of our knowledge and lands as we are all pursuing the protection of biodiversity. Indeed, we have selflessly and in good faith shared our traditional knowledge with the outsiders for the benefit of human kind. But unfortunately, they have not follow the guidelines of international agreements.

We the indigenous peoples demand of active participation in the conservation of biodiversity because we have a close and direct relationship with it. So the plundering, contamination and destruction of the forest resources is a methodical extermination of our knowledge of plants, herbs, trees and conservation techniques. When the plants are gone, our knowledge will be gone, when our knowledge is gone our soul will be gone, when our soul is gone then we as peoples will cease to exist. A failure to understand this indigenous equation, it will cause the failure of all the human and capital investment in the preservation of the forests and its biodiversity.

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Thailand: Hilltribe's Way of Life and Changes

Kittisak Ruttanakrajangsri

Introduction

The kingdom of Thailand is the home of many different ethnic groups, namely the Karen, Hmong, Lahu, Mien, Akha, H'tin, Lisu, Lua, Khamu and Mlabri.

In 1995, there were 790,369 hilltribe people and other ethnic minorities from 150,111 households in 3,512 villages in Thailand (1). This figure accounted for 1.3% of the country's total population but did not include ethnic and minority groups in other regions of Thailand, especially those from the northeast and south. These nearly 800,000 tribal people are residents in 20 of the nation's 76 provinces, including: 14 provinces in the north, 5 in the west and central plains and 1 in the northeast. The province with the greatest tribal population is Chiang Mai, with 28.36% of the total hill tribe population. The Karen population is standing at the highest of 402,095 or 51% of the total ethnic population and Mlabri is the smallest group, they have only a population of 173 or 0.02% of the total population. Individual populations of the various highland ethnic groups are shown in the table below.

In the hilltribe community which has been descended from many generations, it is obviously seen that their way of life is related closely to their surrounding environments and biodiversity as a source of food, medicine, clothing, and living areas. They learnt and practiced how to live in harmony and balance with nature. This knowledge has been accumulated, developed and passed down from generation to generation which led to a sustainable society and economy over hundreds of years.

Structure and Living Pattern of the Hilltribe Peoples

Typically, village structure and living pattern of the hilltribe peoples is classified into five series (3):

- Settlement areas (Village/Community)
- Community forest
- Sacred Forests
- Farming areas (Wet-rice field/Dry-rice field)
- Village boundary and dense jungle areas (for hunting and gathering)

The structure mentioned above is in harmony with the highlander's way of life in every step and conformity with the forest and biodiversity as follows:

Settlement Areas

Almost all hilltribe communities are located on highland areas. They can be divided into two groups according to their geographic distribution. Some groups live at the low hill and high valleys e.g. Karen, Lua, H'tin, Khamu, and some groups live at higher altitudes e.g. Hmong, Mien, Lisu, Lahu and Akha. The latter groups adopted opium cultivation as a cash crop in the past, otherwise known as the opium cultivator. However, the opium cultivation no longer exists in Thailand since the introduction of substitution crops by both government and international development agencies.

In 1960s, during the country insurgency (conflict between communist party and Thai government), the government relocated some villages living in the buffer zone down to lowland areas. Apparently, there are some hilltribe villages to be found at the lowland. Yet, a majority still settle on the highland areas which is declared as protected areas.

Community Forest

Surrounding the community is the community forest. It has been called in different languages of each tribe, for example, Mien calls it 'Ho Bei San' or 'Ching Gam', Karen calls it 'Gawketaw', Akha calls 'Mi Zang Law', etc.

Community forest is very important and useful for the villagers for many reasons :

- Keeping the village shady and cool in the dry season and protection from strong winds in the rainy season;
- The playground and training areas for living skills, acknowledgment of nature in childhood before growing up and adventure in the deep forest as their ancestors have done;
- A source of food and medicine: medicinal plants, mushroom, bamboo shoots, wild fruits, banana flower, etc.;
- Supplying resources for living, like firewood, wood for household construction, fencing, etc.;
- Animal raising areas e.g. pigs, chicken, horse, cattle, elephant;
- Inhabitation of small animals e.g. birds, squirrels, rodents, moles, snakes, insects, etc.;
- A natural fire boundary to prevent wildfire to the village;
- A source of water supply.

This area is not allowed for farming in any case due to the reasons mentioned above and in other words to avoid the conflict between villagers. If you have a farming area near the community, it is easy to be destroyed by the household animals.

Tab. 1: Highland ethnic populations of Thailand (2), Note: Ethnic group includes: own name (Thai name).

Ethnic Group/Tribe	Population	% of total
1. Pga-Geu-Nyaw (Karen)	402 095	50.87
2. Hmong (Meo)	126 147	15.96
3. Lahu (Musser)	78 842	9.98
4. Mien (Yao)	47 305	5.98
5. Akha (Egaw)	45 300	5.73
6. H'tin (H'tin)	32 565	4.12
7. Lisu (Lisaw)	31 536	3.99
8. La weu (Lua)	11 210	1.42
9. Khamu (Khamu)	8 738	1.11
10. Mlabri (Pee-Tong-Lueang)	173	0.02
Other minority groups	6 458	0.82
Total	**790 369**	**100**

Sacred Forests Areas

Sacred forests are preserved forests. These areas are designed for use in particular circumstances such as ceremonial site, water catchment area, graveyard, etc. and people are not allowed to cut the trees or do any activities which may be harmful to these places. Moreover, they have to perform a ceremony to the spirit of the mother earth every year.

For example, when a baby is born, Karen people bring the umbilical cords and tie it on a tree and by doing so this tree becomes a sacred tree because they believe that the soul of the baby resides there. If any activities harm this tree, it may cause an illness to the baby. Doo ta' is another place which they believe that the spirit of the land reside there, so this area is protected. Akha people have several sacred places e.g. graveyard, 'Mi zang Law' area – the worshipping area for mother earth, 'E Saw Law Koh' – a sacred water area, 'Loh Khong'- village gate. Mien people have a place called 'Uam Yuan' or watershed area, at this place they believe that a strong spirit resides there.

Farming Areas

There are two types of highland cultivation; first, terrace-paddy field or wet-rice fields. This mode of production is widely adopted by the Karen, Lua, H'tin and Khamu and some other groups. The wet-rice field is quite limited due to the geographical area and the population growth. Second type is shifting cultivation, also known as slash-and-burn cultivation or cyclical cultivation.

The shifting cultivation is practiced in various farms dynamically. Each farm is cultivated about 1-2 years and left fallow for 5-10 years. Then, the farmers will come back and grow their crops again. In the period of fallow, soil condition and ecological condition of the forest will produce to their fertility to be ready for planting again.

However, this type of agriculture has been widely debated whether it is a form of sustainable agriculture or a cause of deforestation.

These mode of production is most similar among hilltribe peoples. Few differences base on distinctive ethnic way of life, especially, wet-rice cultivation practiced by the Lua and the Karen people and the adoption of opium poppy as a cash crop practiced by the other groups mentioned above.

Village Boundary and Dense Jungle Areas

Away from the farming, the area is generally used as a village boundary between each community as well as hunting and gathering. This area is furthermost from the village. It is a deep jungle.

Regarding the hunting, they also have traditional rules which control the balance of animal and nature. For instance, Mien people believe that medium and large animals e.g. porcupine, civet, monkey, barking deer, bear, boar, deer, bison, wild buffalo and so on, have its guardian spirits to protect and take care. Whenever they hunt it they have to perform a ceremonial offering to its guardian and each of them is not allowed to hunt more than 4 animals per year, otherwise they would face unforeseen situations which affect their lives or their families such as having an accident or other unforeseen things.

The rules of hunting also vary from each ethnic groups. For instance with the Karen people, some animals are forbidden for hunting such as apt and hornbill. They believe that the death of these animals may cause the problem of imbalance of the environment. They have proverbs which reflected to these concept e.g. 'The death of an apt, seven forests would be lonesome'; 'The death of one hornbill, seven banyan trees would be desolate'. Moreover, their traditional rule disallows the hunt of more than one large animal per year.

Changes

Recently, this balance with nature has begun to change as a result of inroads by the economic prosperity and technological advances of the larger Thai society as well as the introduction of modern education. This was aided by development efforts on the part of government agencies and international agencies.

Highland development and the promotion of cash crops has had considerable impact on traditional farming practices. Economic mono-crops are not appropriate for indigenous agricultural systems, particularly the previous rotational cultivation of diverse crops. In fact, the introduction of "modern" agriculture has been destructive of indigenous patterns and lifestyles which are based on direct and wide response to family needs. The production of subsistence rice and food security have both suffered. Cash crops, e.g. cabbage, tomatoes, coffee, necessitated the use of toxic chemicals to fight insects and disease, posing proven dangers to farmers and consumers alike. Both the capital investment and recurring costs of supporting new technologies have been high, incurring increasing debt and financial dependence. Besides, the market-oriented agriculture requires a larger piece of land which lead to the encroachment of forest.

Government legal restrictions on land use have also been destructive of traditional rotational farming systems which require long fallow periods for soil regeneration and insect control. The security of indigenous farming, which fosters national interests, is continually threatened by reforestation, plantations, and mining. Government policy on permanent agriculture demands the repeated use of a single plot of land, which resulted in soil depletion and reduced yields. The outcome is migration to other areas in search of other employment which brings a host of new problems, such as being taken advantage of by employers, loss of identity and culture, prostitution, HIV/AIDS and drug addiction, all of which show signs of escalation in many areas.

One of the major problems faced by highland peoples is the inability to gain legal rights to residential and farm lands. This is especially difficult as they are required to produce more and more as demanded by both the economy and ecology. The right to maintain traditional farming practices respected by the local communities are of little interest to outsiders. The Forestry Department claims ownership of these lands in the name of the Thai government and reforests areas left fallow by villagers.

Furthermore, modern education provided by the government as a fundamental development is not associated with the way of life in the highland. For example, the curricula can not address the real and distinct problems arising in the community and is biased towards industrialization and has no provision for the retention of traditional knowledge.

These problems with the existing curriculum have led to community children becoming alienated from the local wisdom and values. In some communities there are large gaps between parents and their children in terms of what is held as valuable and what is considered unworthy. Such gaps feed the unsustainability of the communities.

Community Struggle Land Rights

There have been movements and requests for the rights of local communities to manage highland resources and hold land rights since the first Chuan government in 1995 in the name of Northern Farmers Network (NFN) and the Assembly of the Poor (4, 5). For example, the demand for a Community Forestry Bill- calling for the state to recognize traditional forest management and participation in resource preservation and demand for demarcation of community area and farming areas out of the protected areas.

Currently, all hilltribe communities have been settled in the protected areas which were declared by the government after the settlement of the village. In this case the King of Thailand had also expressed his concern that :

"In forests designated and delineated by the authorities as reserved or restricted, there were people there already at the time of the delineation. It seems rather odd for us to enforce the reserved forest law on the people in the forest which became reserved only subsequently by the mere drawing of lines on pieces of paper. The problem arises in as much as, with the delineation done, these people became violators of the law. From the viewpoint of law, it is a violation, because the law was duly enacted; but according to natural law, the violator of the law is the one who drew the lines, because the people who had been in the forests previously possessed the human rights, meaning that the authorities had encroached upon individuals and not individuals transgressing the law of the land".

The big campaign was carried on by Assembly of the Poor during 25 January-2 May 1997. The issue of negotiation covers 6 main problems of the poor:

1. Land and forests;
2. Dams;
3. Government development projects;
4. Slums;
5. Work-related disabilities and environment; and
6. Alternative agriculture networks.

On 19 April 1997, the government, led by General Chavalit Youngchaiyuth, passed a Cabinet resolution calling for the solution of all problems for all groups.

Regarding the problem of land and forests, the government agreed with the recommendations proposed by NFN (see annex 1). However, the implementation was delayed due to the lack of financial support and nothing had been done until the government had resigned and changed to the new government led by Chuan Leekphai as a second term.

Unfortunately, this Cabinet resolution was reviewed and revoked by the current National Forestry Policy Committee (NFPC) on 10 June 1998 (6). Therefore the solution for this problem is still uncertain. At the same time, the villagers have also improved their potential so that they are able to live in co-existence with the forest in a sustainable way.

Education

There was a joint project initiated by the village leaders, NGO and government agency trying to develop and implement a local curricula, to be taught along side the Thai curricula (7). This local curricula includes traditional knowledge emphasizing on forest preservation and cultural values in the society. This project aims to link schools into the life of the community, to make it a valuable and relevant part of the community's life. The project is due to be completed by the year 2000.

Conclusion

Nature and highlanders' way of life are interconnected through mutual relationship portraying the cycle of the ecological system. This system has been maintained within traditional rules, beliefs, and rituals collected and descended, as well as, adjusted into traditional knowledge to manipulate the balance of nature.

Means on forest preservation among distinctive tribal highlanders associated with traditional beliefs, rituals and process of production.

Beliefs and rituals are systems created by our ancestors through experience that descended from generation to generation. Also, they have been developed into traditional rules, and ethnic customs and traditions, in a way, that not only assist the highlanders to survive in society but also preserve nature involved with righteousness and moral values among human-beings, man and animal and man and the forest.

These beliefs and rituals finally become traditional laws which control, force and maintain ecological balance for forest and wild life. All villagers have to practice and follow these rules seriously, otherwise, punishments will be enforced to them, by natural.

The mode of productions which is practiced by them are subsistence and sustainable to the ecology and environment.

However, today, tribal lifestyles, cultures, and agricultural practices are disappearing at an increasing rate in response to changes in Thai and western culture. Expanded communications, government and NGO initiated development, and technological advances have all elicited alterations in tribal society. Highland communities have had to give up subsistence farming and animal raising practices for intensely economic-related agriculture, including: large areas of monocrops, use of toxic chemicals, and planting of pine and eucalyptus forests. This has caused a continuing reduction in the size of crop lands, soil depletion, environmental and ecological imbalances, reduction of natural forests, destruction of water resources, and eradication of highland food sources. The ensuing migration has given rise to the erosion of culture and local wisdom.

The conflict over resource management is increasing especially from the different school of thoughts, one believes that man and forest should be separated and one believe that humans and forest should co-exist.

This issue is quite complicated. The only thing is every group should respect each other and find out a collective solution to conserve this fragile forest and biodiversity for the future generation.

Annex 1: Actions to be taken :

■ Immediate abolition of the government policy of relocation of current forest villages from forest areas;

■ Surveys and proof of residence of villagers prior to the establishment of national parks, wildlife refuges and Class 1A watersheds. If prior residence is proved, the Forestry Department and other responsible agencies will void all regulations prohibiting residence and farming and affirm residential and agricultural rights in accordance with the law;

■ Investigation and proof of rights and affirmation of rights;

■ A committee will be established with responsibility for the investigation and affirmation of rights. This committee will comprise representatives of concerned government agencies and the people affected in equal numbers; Persons being investigated must be those who are true residents of the areas under question; Criteria for investigation and affirmation include compliance with at least one of the following;

– Evidence of fruitful use of the land;

– Man-made structures, fruit trees or perennial trees;

■ Confirmation of status by a member of the community; Official documentation, including SK1, PBT 5, house registration, etc. which shows prior residence or fruitful use of the land; Criteria for the affirmation of rights. The responsible agency will affirm the residents rights as follows:

– For residents with sufficient evidence to warrant the issuance of official documentation in accordance with the laws governing land, e.g. SK1, the Land Department will issue the appropriate document as quickly as possible; For residents without sufficient documentation of land ownership, an SPK.4-01 should be issued as quickly possible;

■ With respect to existing community forests that the villagers have maintained in a sustainable manner, the communities rights to these forests and their use will be officially acknowledged. There should be no arrests, threats or encroachments on these lands by the authorities. When the Community Forestry Bill is passed, conservation forest status will be withdrawn and status as community forests will be legalized;

■ During the process of correction of the forestry problem the villagers will be allowed to continue residence and farming on their traditional lands without threats, arrest or encroachment by officials. At the same time, they will be allowed to develop public facilities such as home construction and improvement of roads, water systems and electricity.

■ A committee will be appointed and made responsible for over sight of correction of the situation in accordance with the results of negotiations. The Prime Minister or delegated Minister will serve as committee chair, with representatives of concerned government agencies and affected villagers serving as committee members in equal number.

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Community Use of Woodland Resources at Aliseni Village, Ulumba Mountain, Southern Malawi*

Rachel Bone

Abstract

A participatory rural appraisal of woodland resource use was conducted at Aliseni village in southern Malawi. The village, which consists of about 25 households is surrounded by government owned Eucalyptus plantations. These plantations were established on land which belonged the community and which had previously supported Miombo woodland. The purpose of the study was i) to determine how woodland resource collection from the plantation compared to that from areas of naturally regenerating Miombo woodland close to the village ii) to gain an impression of the demand for and availability of woodland products in the area and iii) to document the views of the villagers with regard to a) the impact of the plantations on their lives and b) the proposed hand over of the plantations to local control.

Semi structured interviews were conducted with men's groups, women's groups, a school children's group, and with the community as a whole. These groups participated in the construction of visual aids including maps, product flow diagrams and seasonal calendars in order to assist in the exchange of information. A transect walk was conducted by members of the community and of the research team during which different resource units were observed and discussed.

* Adapted from FRIM Report No. 97002 Bone R. and Khofi C. (1997) Community use of Eucalyptus plantation and regenerating Miombo woodland resources at Aliseni village, Ulumba mountain, southern Malawi. Forestry Research Institute of Malawi, P.O. Box 270, Zomba, Malawi

The results showed that the community collected a much greater variety of products from the small areas of naturally regenerating woodland than they did from the plantation. Important nutritional products such as fruit and mushrooms were less abundant than before the plantation was established. Products made from mature trees, such as mortars and pestles had to be purchased from a market 25 kilometres away. Prices of products imported to the villages were generally higher than for those exported. Scarcity of the Miombo species had forced the villagers to substitute their preferred species with those which were less suitable but more abundant. In the eyes of the villagers the overall effect of the plantation at Aliseni had been a negative one.

The prospect of owning and managing the plantations was welcomed by the men, but not by the women. The study highlighted the problem of insufficient communication between the current BCFP management and the villagers. An urgent need for education and training of the villagers on the subjects of plantation and landscape management was identified. This is necessary in order that they can develop the capacity to manage the resources in accordance with their needs.

Introduction

Miombo woodland, characterised by the genera *Brachystegia and Julbernardia* is the dominant woodland type in Malawi. For centuries these woodlands have provided the country's population with a wide range of resources. In many rural areas, woodlands and farm trees provide critical support to agricultural production through the protection of water catchment areas and the maintenance and improvement of soil conditions. Woodlands are valuable graze resource for livestock. Important supplements for human nutrition are obtained from Miombo woodland in the form of fruits, mushrooms, and edible wild vegetables. Woodlands also provide people with the opportunity to earn a cash income. A variety of woodland products including fruits, mushrooms, fuelwood and poles are marketed throughout the country.

The rapid increase in the human population, particularly during the latter part of the twentieth century, has put enormous pressure on this important national resource. The resulting deforestation has been variously estimated at between 1% and 3.5% per annum for the country as a whole, (Ministry of Natural Resources 1995, 1996) and is most severe in the Southern Region, where a World Bank estimate put it at 11% per annum (World Bank 1994). In many areas of the Southern and Central Regions there is a critical shortage of woodland products. The World Bank's estimate of Malawi's wood deficit in 1990 was 2.8 million m^3 per annum, with a predicted rise to 3.8 million m^3 per annum by 1995 (World Bank 1994). Estimates are not yet available for the deficit in non wood forest products such as fruits and medicinal plants, or for the cost of the loss of non tangible benefits, such as watershed protection, that Miombo formerly provided. However this does not mean that such resources and services are any less important. Those who are most directly dependant on woodland resources, and therefore worst affected by deforestation, are the poorest rural dwellers (Sambo 1995).

Efforts to address the problems resulting from this rapid deforestation have mainly taken the form of donor assisted government afforestation schemes geared toward meeting the demand for fuelwood, poles and timber in the rapidly expanding urban areas. In 1995 there were 13 035 ha of fuelwood and pole plantations and 8 033 ha of timber plantations in the southern region of Malawi (BCFP 1995). The main species planted are Eucalyptus species, particularly *camaldulensis* on lowland sites, and conifers, mainly *Pinus patula* on the hills and plateaux. This study was carried out within the plantations established by one such afforestation project, the Blantyre City Fuelwood Project.

Exotic plantation forestry species do not supply the multitude of products that have traditionally been derived from Miombo species. The prospect of finding cost effective methods of restoring native forest on degraded land is of therefore of great interest and potential importance to forestry researchers and land managers in Malawi. Recent research from a number of other tropical countries has demonstrated that, under favourable conditions, the establishment of plantations (of either indigenous or exotic species) on degraded land can serve to accelerate recolonisation of this land by native and naturalised forest species. This effect of the plantations has been attributed to their influence on understorey micro-climate and soil fertility, the suppression of dominant grasses and the provision of habitat for seed dispersers (Pande et al., 1988; Parrotta, 1993; Parrotta, 1995a&b; Mitra and Sheldon, 1993). In 1995, an 18 month international exploratory analysis entitled "The Catalytic Effect of Tree Planting on the Rehabilitation of Native Forest Biodiversity on Degraded Tropical Lands" was launched. The purpose of this work was to gain a better understanding of the factors which govern the rate of native forest regeneration in the understorey of plantations in a number of degraded ecosystems throughout the tropics. This study involved researchers in seven tropical countries investigating a number of core hypotheses (see Appendix 1). The Forestry Research Institute of Malawi, with funding from the British Overseas Development Administration took part in this project and examined the feasibility of this approach to Miombo woodland restoration in the BCFP area in Zomba District, Southern Malawi (Bone et al. 1997). In contrast to the findings of the other 6 countries involved in the study (see Forest Ecology and Management Vol. 99 Nos 1,2 for results of the international study) the results of the work in Malawi showed that plantation establishment had not served to accelerate rehabilitation of degraded forest and that this was better achieved by site protection.

To compliment the findings of this botanical study, and to allow interpretation of the results in the context of demand for and use of resources by villagers living in the plantation area, a woodland use study was conducted at Aliseni village. The woodland use study is the subject of this report. The purpose of this study was to determine how the results of the vegetation survey related to woodland resource use by local community and how the lives of the community had been affected by BCFP. The objectives were as follows:

1) To determine how the collection of woodland products varied between the plantation sites and the unplanted control.

2) To gain an impression of the demand for and availability of woodland products in the area.

3) To document a) the villagers' perceptions with regard to the impact of the

BCFP on their lives and b) their reaction to the Forestry Department's decision to hand over ownership and management of the plantations to the local community.

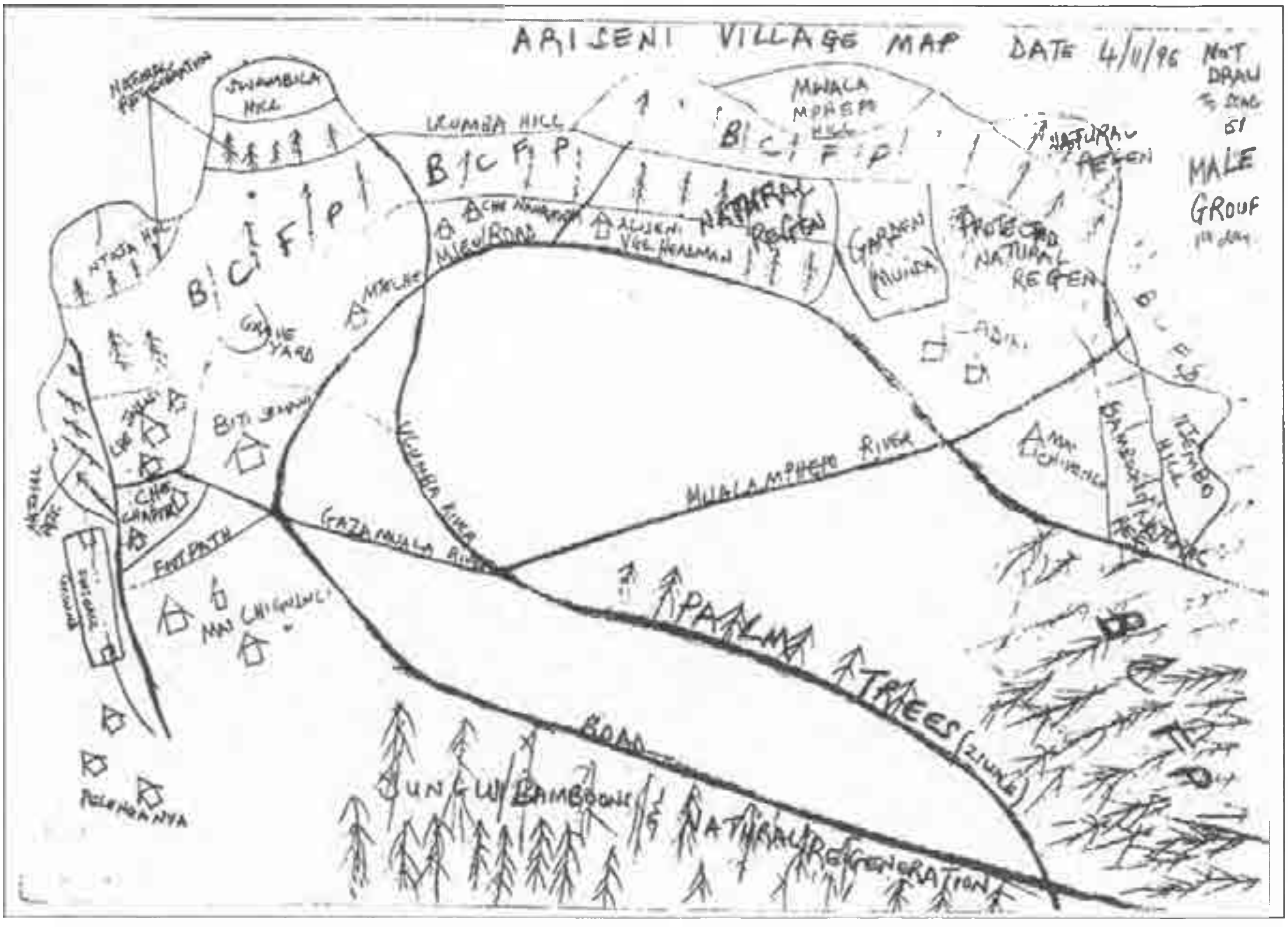
Study area

Ulumba Mountain is located in Southern Malawi at 15° 27' S and 35° 19' E within Traditional Authority Chikowi. Mean minimum and maximum temperatures in the area are 16-18 ° C and 26-28 ° C respectively (Department of Surveys, 1983). Mean annual rainfall between 1991 and 1995 was 780 mm (BCFP, 1995). The plantations at Ulumba cover an altitudinal range of 800 m to 1200 m. Much of the land is steeply inclined, with many compartments on slope of 20 degrees or more. Ninety percent of the 560 hectare plantation is *Eucalyptus camaldulensis,* the other ten percent is *E. tereticornis* and *E. grandis.*

The hillside on which the vegetation composition study was conducted had a mean slope of 25 degrees and a north easterly aspect. The study site included an eight year old first rotation *Eucalyptus camaldulensis* stand, a one year old second rotation *E. camaldulensis* coppice site and an unplanted control site. Both Eucalyptus sites were planted in 1988. The control site had been cleared for planting at the same time as the plantation sites but had been left unplanted and had since been protected from fire. The results of the vegetation study revealed that floral diversity in the understorey of the mature plantation stand did not differ significantly from that of the unplanted control. The coppice site supported a floral community significantly more diverse than that of the plantation stand and the control site. The basal area of indigenous trees and shrubs was significantly higher on the control than on either of the plantation sites. (Bone et al. 1997)

There are a number of villages within the plantation area, the majority of which are situated in the valleys, where soils are deeper, with the Eucalyptus trees on the slopes above (see map). According to the older men in the village the area was first settled sometime between 1915 and the early 1920's by people from the Phalombe plain to the south east of Ulumba mountain. This information is supported by a historical study of the ethnic groups the Chikowi area (Maluza 1980). Aliseni village, the focus of this study, consists of approximately 25 households. Despite its small size the village is composed of people from three ethnic groupings, Nyanja, Yao and Lomwe who have settled there at different times from different areas in the Southern Region.

The land on which the Eucalyptus trees were planted originally supported Miombo woodland. This woodland became degraded over time due to pressure from an increasing human population. In 1986 the remaining woodland was cleared by the World Bank funded Wood Energy Project in preparation for estab-



Map of Aliseni drawn by the mens' group on the eastern side of the village.

lishment of the Eucalyptus plantations. The primary objective of the Wood Energy Project was to supply fuelwood and poles to Zomba town, approximately 15 kilometres away. After the clearing of the indigenous woodlands, charcoal burners moved into the area and converted what remained to charcoal for sale. The land remains the property of the local chiefs under customary law whilst the Eucalyptus trees are the property of the Malawi Government Forestry Department. Therefore, with the establishment of the plantations the villagers in the area lost usufruct, though not ownership of their land. The villagers at Aliseni were not in favour of the establishment of the plantations, but were powerless to intervene in any major way. They did manage however to prevent the planting (but not the clearing) of a small (0.8 ha) site adjacent to the Village Headman's house and have since protected this site in order that the woodland should re-establish. At the time of the study (eight years since protection had begun) this site supported *Uapaca kirkiana* dominated early woodland regrowth with a canopy height of 2-3 metres. This was the site used as the unplanted control in the species composition study.

Methods

Prior to meeting with the villagers a series of questions relating to woodland resource use and the impact of BCFP were compiled by the research team. These questions, which are presented in Table 1, served as a guideline for directing discussions throughout the course of the fieldwork.

The approach used was designed to assist the villagers in expressing the value of woodland resources available to them within the context of their own perceptions, needs and priorities. To this end a series of interactive activities were under-

Table 1: Questions posed to the villagers of Aliseni, and methods used to obtain the answers.

Questions	Tools used
1. What products are collected from the three different woodland types? a) unplanted control b) 8 yr. eucalypt stand c) 1 yr. eucalypt coppice	Mapping, product flow diagrams, key informant interviews, group discussions and transect walk.
2. What restrictions are placed on the collection of resources from each of the areas by a) BCFP? b) Village Headman? c) other bodies? – please specify.	Mapping, product flow diagrams, key informant interviews, transect walk.
3. What other sources of woodland products are available to the community? How far away are these, and how important are they?	Product flow diagrams, group discussions.
4. What products are marketed by the villagers, where, and for what prices?	Product flow diagrams, key informant interviews.
5. What quantities of products are collected? How frequently are collections made? How much time is spent collecting?	Groups discussions, key informant interviews.
6. How does collection vary throughout the year?	Construction of seasonal calendars.
7. What is the relative importance of the major products to men, women and children?	Discussions with mixed community groups.
8. What species are of greatest importance for each of the major products identified in terms of: a) the most preferred? b) the most frequently used?	Ranking by simple group voting system with mixed community group.
9. How had the BCFP affected the lives of the villagers?	Group discussions and transect walk.
10. What were the community's views about the future management of the eucalyptus plantations following the hand over to local control?	Group discussions, transect walk.

taken. Semi structured interviews were conducted with men's groups, women's groups, a school children's group, and with the community as a whole. Initial interviews focused on the procurement and use of woodland products. In later interviews the impact of BCFP on the lives of the villagers, and the prospect of the transfer of the ownership and management of the plantations to local people were discussed.

The villagers were split into two groups on the instruction of the Village Headman. This division was based on the location of the houses. One group consisted of people from the eastern side of the village, the other from the western side. The group on the eastern side of the village was closer to the sites where the species composition study had been conducted, and included the households of the previous and the current Village Headmen. This group, which consisted of nine men, ten women and five school girls, was interviewed first. The reason for this was that good relations had been formed with a number of its members, particularly the Headman and his family, during the species composition study. The group from the western side of the village comprised seven men, eight women and two school boys. With each of the two household groups the work began with an explanation of the objectives of the exercise during which all the questions to be addressed were presented. The data collection team consisted of four male and two female FRIM staff members. At different times this group divided into teams, dealing with women's, men's and school children's groups separately.

Resource maps were drawn by the men's groups from both sides of the village in order to illustrate their perceptions of major resource close to the village. Discussions held during the construction of the maps focused on the availability of products from different areas. The maps drawn by the men's groups were initially created on a large area of bare ground. The mappers used sticks, stones, and green and dry leaves to mark out the various landscape features. This was later copied on to a large sheet of paper by one member of the group who was familiar with the use of paper and ink, guided by research team members. In each of the groups all members participated in identifying landmarks and locating their own homes, with a few individuals dominating at the beginning. The maps produced proved to be very useful for later exercises and discussions. A map was also produced by the group of school girls from the eastern side of the village. This was drawn directly on to a large sheet of paper, using a marker pen.

The women's groups felt they were unable to represent their surroundings in the form of a map since they had little formal education. The FRIM staff with these groups (one male and one female) devised system a whereby each woman could record the products she collected from each of the vegetation types by means of agreed symbols. This exercise resulted in the production of flow diagrams which showed influx of woodland products to the village from the control site, the coppicing Eucalyptus site, and the eight year old Eucalyptus stand. During the production of the maps and the flow diagrams the restrictions on resource collection from each of the different sites were discussed.

Diagrams which showed the flow of woodland products into and out of the village were constructed by the men's and women's groups with assistance from the research team members. Seasonal calendars were constructed in order to record the variation in the collection of products throughout the year. The majority of the community were familiar with the twelve month calendar. Those who were not indicated seasons in which products were available, rather than months.

Species were ranked in terms of those that were most preferred for a given product, and those that were most frequently used for that product. This was achieved by means of a simple group voting system using cuttings or fruits to represent the different species. The importance of different products to each community group relative to the other community groups was discussed. For specialised collection, production and marketing information, key informants were consulted. Two herbalists were interviewed about the collection and uses of medicinal plants. The herbalists were specialists in traditional medicine respected by the community for their knowledge of the healing properties of plants. In the absence of modern medical facilities rural people are dependant on medicinal plants for the majority of their health care needs (Sitaubi et al. 1995). A craftsman gave information about the manufacture and marketing of products such as tools, wooden beds and woven crafts such as baskets.

A transect walk was made, during which the differences in land use, tenure, vegetation composition, management practices, and resource availability were discussed. Six community members accompanied the research team. The walk began at the Village Headman's house, and ended at the foot of Ulumba hill. The transect passed through agricultural fields, Eucalyptus plantation and natural woodland regeneration.

After all the questions had been posed and discussed using the methods outlined above, a presentation of the information collected was made to a group of people from both sides of village gathered at the Headman's house. This was done in part to express gratitude to the community for their help and co-operation. It also gave the team a chance to verify the information collected, and to pick up on points which had been omitted or misrepresented. Following the completion of data collection at Aliseni a member of the research team spoke to a member of staff at the BCFP Office concerning the following issues; the employment figures at the beginning of the project and at the time of the study, the infrastructure benefits that BCFP brought to the area, the regulations governing the harvesting of products from the BCFP controlled sites, the displacement of people at the beginning of the project, and the steps being taken to prepare communities for ownership and management of the plantations.

Results

Woodland resource collection from planted and unplanted sites

Resource maps drawn by the men's groups identified a number of sites where procurement of different woodland products took place. The map (p. 140) presented was drawn by the men's group on the eastern side of the village. In addition to the plantations and the control site protected by the Village Headman the map shows a number of other areas from which woodland products were collected. These included other areas of natural regeneration, sites where bamboo grew and graveyards. The map drawn by the school girls concentrated on the location of fruit trees in the village area.

The flow diagrams constructed by the women's groups showed the collection of products from the natural regeneration, the mature eucalypts, and the coppicing eucalypts. Figure 1 is a reproduction of the flow diagram made by the women's group from the eastern side of the village. There were ten women in this group, each was asked to indicate what products they collected from each of the three sites by means of agreed symbols.

The map and the flow diagrams clearly illustrate that of the three woodland types, the greatest number of different products came from the natural regeneration. With the exception of termites, no products were collected from the plantation that were not also collected from the regenerating woodland site. Table 2 lists the products derived from each vegetation type using pooled data from all the discussion groups, and from the transect walk.

Restrictions placed on the collection of products from the different resource units varied according to their ownership and purpose. The natural woodland areas from which resources were collected included both those under community control and those under BCFP management control. The control over the natural regeneration directly above the Village Headman's house, (see map p. 140) was stricter than that for other natural woodland sites in the surrounding area. This was the area which had been the control site in the species composition survey. Rules governing resource procurement from this site were made by the community and by the Village Headman. The Headman enforced the rules, and permission to harvest any product from that site had to be obtained from him. Felling of trees for firewood was forbidden.

Permission was sometimes granted to fell trees for other products such as poles, and in these cases branches could be used for firewood. Care was taken that felling was not concentrated in any one area. The species most commonly felled were *Brachystegia* species and *Uapaca kirkiana*, mainly for poles and rope fibre. No fee was paid for the harvesting of products from this site. Collection of products from the graveyards was severely restricted. Only dead wood could be collected from the ground, and only at the time of a funeral. In the areas of natur-

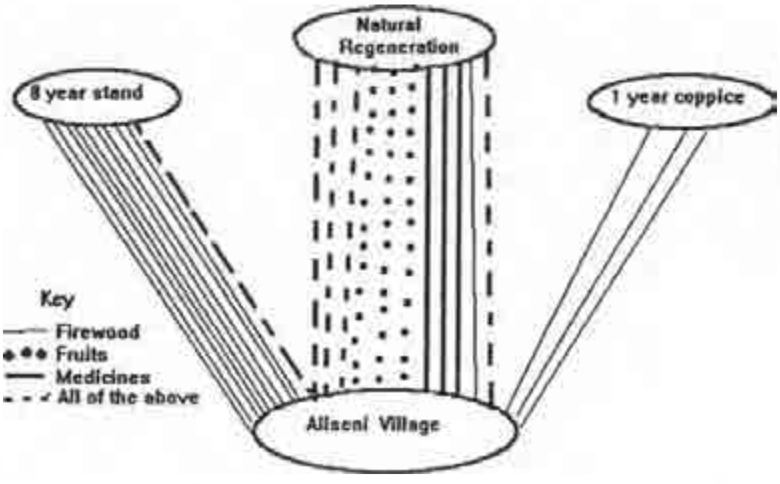


Figure 1. Products collected by women from Eucalyptus plantation and natural regeneration.

Table 2: Products from the three woodland categories at Ulumba.

BCFP 8 year old stand	1 year old second rotation stand	Regenerating woodlands
Bamboo	Bamboo	Bamboo
Firewood	Graze	Graze
Fruits	Firewood	Firewood
Medicine	Fruits	Fruits
Mushrooms	Medicine	Hoe and axe handles
Poles	Rope	Latex
Termites		Medicine
		Mushrooms
		Poles
		Rope fibre
		Rafters
		Thatch grass
		Wild edible vegetables

Figure 2. Flow of Woodland Products into and out of Aliseni Village, showing Distances to Places of Sale/Purchase.

Table 3: Average collection of important woodland products per household, and by tradesmen in Aliseni Village.

PRODUCT	QUANTITY	FREQUENCY	TIME SPENT	COLLECTED BY
Bamboos	1 head load (approx. 20 poles) price MK 0.30 per pole	Once a week	1 hour	Mainly men
Firewood	1 big head load – approx. weight – 18 kgs	Once a week (More frequently during late dry season	4 hours	Women, men and children
Fruits	*Uapaca kirkiana* 1 kg *Ximenia caffra* 2 kg *Multidentia crassa* 1 kg	2 times a week for each, depending on availability bility	2 hours 30 minutes 30 minutes	Women, men and children
Medicine	Dependant on no. of patients requiring treatment and type of illness	As for quantity	As for quantity	Herbalists
Mushrooms	Full pail from indigenous woodland (a std. pail is approx. 25 litres)	Depending on availability every day during early rains (surplus is seasoned future use)	1–2 hours	Women, men and children
Palm poles	4 for a bed, 15 for a granary	2 times a week	1 hour	Craftsmen
Poles	For house construction: approx. 120 poles for a house, 30 for roof alone. For maintenance: depending on need	Once or twice a week during fry season As required	2–4 hours As required	Mainly men Mainly men
Rope fibres	2–5 kg depending on amount of work requiring ropes, e. g. house construction	On average once per month depending on quantity of work requiring ropes	1–3 hours	Women, men and women

al regeneration and bamboo under the control of the BCFP villagers had to pay to collect firewood, at Malawi Kwacha (MK) 0.50 per head load, and bamboo at MK 0.30 per pole. Firewood and small dimension poles collected from the plantations also cost MK 0.50 per head load. At the time of the study MK0.50 was equivalent to US$ 0.03. Statutory minimum daily wage in rural areas at this time was MK 8.50, equivalent to US$ 0.56.

Import and export of woodland products

Figure 2 shows movement of forest products into and out of Aliseni village. This flow diagram, which was constructed using the combined information from all the community groups, illustrates the very important point that the number of types of product imported was far greater than that exported. Villagers bought a range of woodland products from a number of different outside sources, up to 80 km away. Many of these imported products had been obtained from the Miombo close to the village before it was cleared. Prices of products purchased from outside sources were generally much higher than those of products sold by the villagers in nearby markets.

Table 3 is a summary of information gathered from all the different groups

Table 4: Pooled data showing variation in collection of products throughout the year by villagers of Aliseni.

Products	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.
Bamboo poles			X	X				X		XX		
Brooms	XXXXX											
Firewood	X	X	X	X	X	X	X	X	X	XXX	XX	
Flour baskets	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Fruits	XX	XX					XX			X	XX	X
Granaries			XXXX									
Hoe/Axe handles							XX	XXX	X	XXXX		
Medicines	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
Mortars								XX		XXX		
Mushrooms	XXXX	XXX	X								Y	Y
Pestles								XX		XXX		
Poles			X	XXXX				XX		XX	X	
Reed mats		XX							X	XXX		
Rope fibres	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
Thatch grass						XX	XXXX	Y	Y	X		
Wooden spoons	Y	Y	Y	Y	Y	XX	XX	XX	Y	Y	Y	Y

Table 5: Seasonal pattern of fruit collection as expressed by the two adult groups on the western side of Aliseni Village.

Fruits Collected	Months
Annona senegalensis	December
Uapaca kirkiana	December
Strychnoss spinosa	November
Parinari curatellifolia	October–November
Fukula	December–February
Ximenia caffra	March
Mtonogoli	March
Flacourtia indica	March
Zilu	March

regarding the collection of different woodland products from the areas depicted on the maps. As these figures were given during interviews rather than recorded over a period of time they are only intended to be an approximate representation of woodland resource collection by the community. Fresh mushroom were important during the rains, i.e. from November to April. Woodland use studies elsewhere in Malawi have found that fresh "mushrooms are a very important source of nutrition during a time of the year when on-farm food and financial resources are at their lowest" (Kapondela 1995). Fresh mushrooms are also preserved for sale or consumption later in the year.

The villagers stressed that since the clearing of the Miombo many products, particularly mushrooms and fruits had become more scarce, and therefore more time was needed to collect the same quantities. Collection of firewood was estimated to take four hours per week throughout most of the year, more in the late dry season. The estimates of time spent collecting woodland products gives an indication of their importance, and the information on house building and maintenance serves the illustrate the villagers reliance on these resources for their basic needs. It was apparent from the information given during the interviews that the importance of different woodland products varied according to sex and to age group. Table 3 also gives an insight into the division of labour between the sexes. The mixed sex group stated that rope fibres and bamboo were most important to men, as construction work is mainly done by them. Firewood, mortars and wooden spoons were said to be more important to women since they do the majority of food preparation. Fruits were particularly important to children as they provide essential vitamins to supplement their high starch diet and are freely obtained.

The availability of woodland products varies according to season (Tables 4 and 5). Some indigenous trees such as *Parinari curatellifolia and Strychnos spinosa* fruit during the late dry season, others including *Uapaca kirkiana, Annona senegalensis* and Ximenia caffra fruit during the rainy season. Fresh mushrooms are only found during the rainy season, while other products like firewood, rope fibre and medicine are collected throughout the year. Most households collect more firewood between September and November than in other months of the years and store the excess for use during the rainy season. Grass for thatching houses is mostly collected from June to October. It is important to note that collection of resources is not determined purely by availability of products. In the late dry season and early rains priority is given to preparing and planting the fields, so less time is available for woodland resource collection.

Table 6 shows how resource scarcity caused the villagers to substitute preferred species with those which were less suitable, but more abundant. The ranking technique worked well. With minimal prompting many respondents gave detailed reasons for their species preferences for different products.

Eucalyptus was the most commonly used species for firewood and poles, although the villagers claimed it did not burn as well as many of the Miombo spe-

Table 6: Species most preferred most frequently used for various purposes.

Product	Species most preferred	Species most frequently used
Firewood	*Pericopsis angolensis* *Brachystegia boehmii* *Julbernardia globiflora^*	*Eucalyptus species*
Fruits	*Annona senegalensis* *Flacoutia indica** *Parinari curatellifolia** *Strychnos spinosa** *Uapaca kirkiana*	*Annona senegalensis* *Flacoutia indica* *Parinari curatellifolia** *Strychnos spinosa** *Uapaca kirkiana*
Hoe/axe handles	*Annona senegalensis* *Julbernardia globuliflora^*	*Annona senegalensis* *Julbernardia globuliflora*
Mushrooms	*Russula schizoderma*	*Termitomyces eurrhizus*
Poles	*Julbernardia globuliflora* *Pericopsis angolensis** *Terminalia sericea** *Diplorhynchus condylocarpon**	*Eucalyptus species*
Rope fibre	*Brachystegia boehmii* *Julbernardia globiflora*	*Brachystegia boehmii* *Julbernardia globiflora*
Stirring sticks	*Faurea saligna^*	*Cussonia spp.^*
Thatch grass	*Chisukube^*	*Hyparrhenia gazensis^*
Wooden spoons	*Mangifera indica^*	*Cussonia spp.^*

cies and was more susceptible to termite damage. This concurs with the results of a study in the north of the country where women expressed preference for Miombo species for fuelwood over eucalypts, and analysis of basic densities of these woods (an indicator of calorific value) confirmed that the preferred fuelwood species had higher densities than the eucalypts (Lowore et al 1993).

The impact of BCFP on the lives of Aliseni villagers

The clearing of indigenous woodlands by BCFP to replant with Eucalyptus tree species received mixed reactions from the people of Aliseni. The community as a whole felt strongly that indigenous woodland had always been very important in their lives and that these natural resources supported human life at many levels. The overall message was that the impact of the BCFP on the village of Aliseni had been negative. The villagers gave a number of reasons to back up this statement. Firstly, they had to pay for products on land of which they had once had usufruct. Secondly the Eucalyptus plantations did not provide as great a variety of products as did the woodland which had formerly occupied the land on which they were planted. The Eucalyptus wood was inferior to some of the Miombo in terms of susceptibility to termite damage and calorific value. Fruits and mushrooms were less abundant than before the BCFP, hence more time was needed to collect these products and there was less surplus for selling. Certain woodland products were no longer available, for example honey, game and caterpillars. Villagers had previously made bee hives from the bark of mature *Brachystegia* trees, and hung these from trees in the woodland to attract bees. Since the felling this activity had stopped due to the shortage of mature woodland. Small game such as *hyrax,* which had been hunted before the felling of the woodlands were no longer present. Trees such as *Cussonia arborea* which host an edible caterpillar important in the local diet had become scarce since the clearing of the woodlands.

The key information gathered during the transect walk is presented in Table 7. During the walk the villagers revealed the establishment of the plantations and the resultant shortage of land for agriculture had caused the people of a nearby village to leave their homes in search of new land. This was verified by staff at the BCFP office. The streams which were crossed during the walk were seasonal. According to the villagers these had been perennial when the area had been under Miombo woodland. The villagers believed that the Eucalyptus plantations had caused these streams to dry up. One stream, the source of which was in an area of Miombo woodland had remained perennial, and this was given as evidence of the drying effect of the Eucalyptus. Yields from the vegetable gardens in the valley bottoms which used to supplement the produce from the maize fields were decreasing. These gardens previously had moist soils, but since the establishment of the plantations these soils had become increasingly dry.

Despite the above, a number of community members, particularly the men, did recognise that the coming of the project had brought some benefits to the community. The project had brought the opportunity of employment and had the improved the infrastructure of the area through the construction of roads and the installation of a water pump. Journey times were reduced as passing vehicles would often offer transport. Employment was highest at the beginning of the project when a lot of labour was needed for clearing the Miombo, preparing the land, planting, weeding, and road construction. The number of labourers employed to work in the Ulumba and adjacent Ntonya plantations at the start of the project was 1500. At the time of the interviews with the community at Aliseni this had been reduced to 59, none of whom came from that village. The decrease in employment was due both to a reduction in work load, and to less funds being available for wages (BCFP Office, pers. comm.).

The transfer of ownership of the plantations

The issue of the transfer of the plantations to local control arose during a number of group discussions, and was expanded upon during the transect walk. None of the village members spoken to had actually been approached by the current BCFP management about the transfer of the plantations to local control. Those that knew about the plans had heard through word of mouth.

The two groups of women interviewed did not welcome the proposed transfer of ownership. The main reason they gave was that they felt that they did not have the knowledge or capacity to manage the plantations. A number of women stated that they wished the area to return to natural woodland cover, and to this end were in favour of clear felling the entire plantation at once.

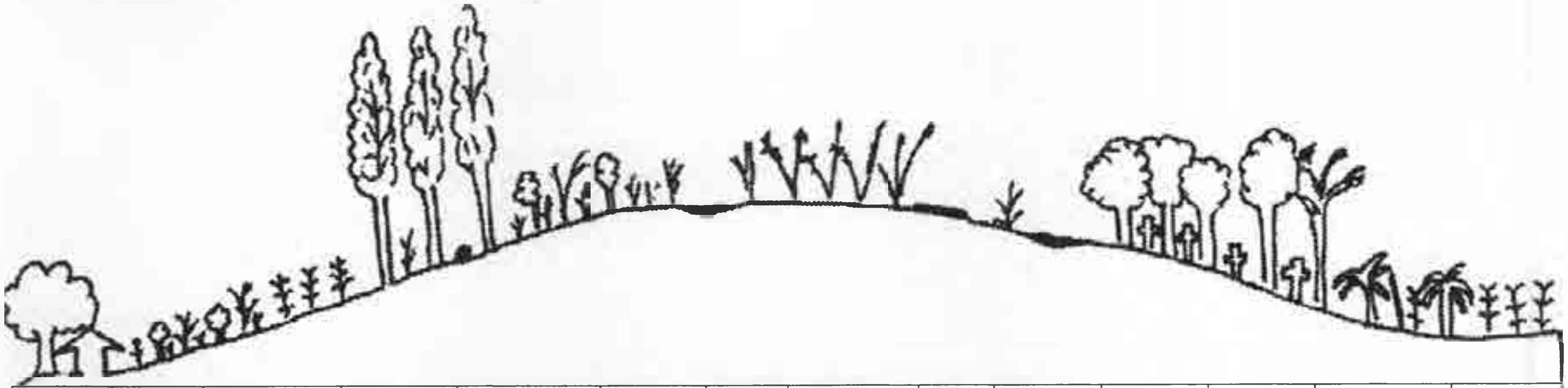
The group of men who had heard about the transfering of ownership of the plantations were more enthusiastic about the prospect. Two of the men who participated in the transect walk made a number of suggestions as to how they wished to manage the plantation following the hand over to local control. These men explained that if the were given control they would discontinue weeding in the plantation. The reason they gave was that weeding destroyed natural regeneration of indigenous tree species and disturbed plant communities which provided multiple products to them. They told the research team they wished to have a dense mixed woodland with a diversity of species, including Eucalyptus. They stated they would continue thinning the Eucalyptus in order to provide poles and firewood, and to create adequate space for the regenerating indigenous tree species.

According to the BCFP office, at the time of the study forestry staff were training rural communities through the establishment of Village Forest Committees which would manage the plantations following the hand over. The hand over was intended to be gradual, no date had been set for the transferral of ownership. The intension was to start with compartments which were due for felling in order that people could reap financial benefits quickly and would therefore remain interested.

Discussion

A major aim of this study was to complement the ecological study, and to allow the interpretation of the results of that study in the context of woodland resource use by the community. In other words, the woodland use study focused on assessing the plantation and control sites not in terms of biodiversity per se, but in terms of "useful" biodiversity. Comparison of the results of the two studies illustrates that

Table 7: Transect of Aliseni Village and Surrounding Area.



Land cover	Village	Natural Regeneration	Fields	Mature *Eucalyptus*	Natural regeneration	Seasonal stream	*Eucalyptus* coppice	Road	Seasonal stream	Grave yard	Grave yard	Garden	Fields
Description	Scattered houses	Diversity of early woodland regrowth species, dominated by *Uapaca kirkiana*	On slopes, with rocks and stones used to combat soil erosion	8 year old *E. camaldulensis* plantation with good form, canopy height of approx. 15 m. Sparse undergrowth of indigenous species	Diversity of tree species	No water in dry season	*E. camaldulensis* coppice, felled 1 yr previously, had been singled and weeded, very little undergrowth	Banked with stones	Siltation, no water in dry season	Abandoned. Vegetation mostly *Uapaca* trees	Well maintained diversity of Miombo species	Well drained black soils. Sugar cane, bananas, maize and vegetables grown	Good soils, minimal erosion, maize grown
Tenure	Individual	Communal under control of Village Headman	Individual (not a resident of Aliseni)	BCFP	Communal, under control of Village Headman	Commun al	BCFP	BCFP	Communal	BCFP	Communal	Communal	Individual
History	Yao tribe settled in 1920's	Originally dense woodland, protection began in 1989, after clear felling in 1986	Previously owned by member of village	Cleared of natural vegetation in 1986, which was burned to make charcoal, eucalypts planted in 1988	Originally dense woodland, protection began after clearfelling in 1986	This was perennial when area was under Miombo	Originally under Miombo woodland cover	Made in 1986	This was perennial when area was under Miombo	Previously used people who were displaced by BCFP	Used since 1920's	Once served as a reserve food source for the village. Less used in recent years due to water shortage	Cultivated since before 1980
Products	Labour	Poles, fruits, mushrooms, thatch grass	Maize and beans	Firewood, poles, termites, fruits, mushrooms, graze	Poles, medicine, fruits, mushrooms, thatch grass	Fruits, rope, fibre, bamboo	Poles, firewood, fruits, medicines, graze		Graze, fruits	Firewood, charcoal	Firewood, for funerals only	Vegetables, sugar cane, bananas, graze	Maize

the two are not necessarily always closely related. The coppice site, which had significantly higher floral diversity than the control and the plantation site, actually provided the community with the lowest number of woodland products (six, compared with seven for the plantation and thirteen for the control). This example illustrates the limitations of assessing sites based on biological diversity alone, particularly in areas where human resource use is an important consideration.

Interpretation of the results presented in this report must take into consideration the following. Firstly, due to the brief nature of the work, figures given for time spent collecting and for quantities of products collected are estimates, not measurements. These estimate rely on people's memories, and as such are increasingly susceptible to error with time passed since the occurrence to which they relate. Secondly, because the collection of products from the different vegetation types was not monitored over a period of time, the study concentrates on the diversity, rather than the quantity of products collected from each vegetation type. Thirdly, the village used in this study is one of many within the plantation area, and was not chosen at random. The reason for its selection was the existence of the protected natural woodland regeneration above the Village Headman's house (the site which served as the unplanted control in the species composition study). The existence of this site and its continued protection in the face of resource scarcity is testimony to leadership and co-operation within the community. Such co-operation may not exist to the same degree in the surrounding villages. Finally, concerning questions about the impact of the project, the comparison most likely to be made by those asked is that of the situation before the plantations were established with the present situation. This is misleading as it does not take into consideration what the situation is likely to have been had Wood Energy and BCFP not come to the area.

The above stated, the recurring message from the villagers of Aliseni was that the Wood Energy and Blantyre City Fuelwood Projects had been responsible for the removal of resources which had been important in their daily lives, and that their overall impact had been negative. The amount of land available to them for cultivation had been severely reduced, as a result of which residents of a nearby village had emigrated. A multitude of products had either been lost, such as honey and game, or severely reduced such as some species of fruit and mushrooms. This loss of nutritional products is a very serious concern in a country where malnutrition is a major contributory factor to the exceptionally high rates of child mortality (World Bank 1995).

The fuelwood plantations are not the first land management system to be imposed on people in this area. In colonial times much of the Chikowi area was given over to European owned estates with native peoples often reduced to the level of indentured labourer and forced on to marginal l and (Maluza 1980).

Through its own initiative the community had managed to prevent a small (0.8 ha) site from being planted, and had protected it in order that the original woodland cover should return. After just eight years this site was providing the community with a wide variety of products, many of which were not found in the plantation sites. This accomplishment and continued commitment shows not only good leadership and co-operation within the community, but also an understanding of the ecology of the indigenous woodland.

Management of an exotic plantation is very different to encouraging natural regeneration however, and it was apparent from the study that this community did not have adequate knowledge of the eucalypts to manage the plantation. This was evidenced by the attitude of the two women's groups, and by some of the suggestions made by two of the men involved in the transect walk. Educating members of the community about the requirements of the eucalypts and the reasons for the management practices which have been used by the BCFP will be an essential pre-requisite to a successful hand over. Given that a greater number of products are obtained from the natural woodland areas than from the plantations it is likely that the villagers will wish some of the plantation stands to be converted to native woodland cover. Silvicultural trials could be developed to determine the most effective way of achieving this; either clear felling followed by protection, or gradual thinning of the planted trees allowing the indigenous vegetation to take over.

One of the objectives of the BCFP was to provide an example of how a fuelwood project should be managed to other countries in southern Africa. Problems arose in the project because the needs of the people living in the plantation area were not given due consideration in the planning stages. This "top down" approach disrupted the local economies and land tenure systems, and caused wide spread opposition to government led projects (Kalipeni & Feder, in press). The Government now recognises that in order for natural resources to be managed in a sustainable manner community involvement is essential. Malawi's current forest policy duly places emphasis on participatory management of trees and forests. In line with this changing approach to forest management the BCFP plantations are to be handed over to the local comunities.

This study has shown however that changes at the policy level do not necessarily result in adequate progress on the ground. It is clear that at the time of this study the BCFP management had not engaged in sufficient communication with the villagers with regard to the planned handover, the ways in which it would affect the villagers, and the mechanisms by which they could become involved. The implications of this short comming are that some villages could become marginalised, potentialy leading to opposition to the new management arrangement and to conflicts between villages.

Conclusion

This study has shown that areas of natural regeneration provided the community with a greater diversity of products than did the plantations. The critical importance of woodland products in the lives of the Aliseni villagers was evidenced by their knowledge of the attributes and uses of different species, their estimates of time spent collecting woodland resources and by the distances travelled and money exchanged in order to buy and sell woodland products. Important points concerning the organisation and leadership of the village, and the communication, or lack thereof, between the present BCFP management and the villagers have been raised. It is apparent that needs of those living in the area where the eucalypts were planted were not given due consideration at the time of the Wood Energy Project and BCFP planning. This report has highlighted some of the resultant problems of resource scarcity in the area, however further work is needed to assess the needs of all the villages located within the plantations. Once this has been completed the community should be assisted in the production of a management plan designed to cater for those needs. The villagers do not currently have the knowledge required to manage then plantations. This needs to be resolved prior to the hand over. It is to be hoped that the transfer of ownership and management of the plantations can be done in such a way as facilitate their sustainable and profitable management by the local community.

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Appendix one – General and Specific Hypotheses; from Parrotta & Jones (1994)

1. Establishment of tree plantations on degraded lands can enhance biodiversity of indigenous and naturalised plant communities, relative to comparably degraded, unplanted but protected sites;

1.1 The rate of colonisation by native (or naturalised) forest flora will be greater within plantations than in adjacent (but protected) sites with a similar preplantation history, particularly on more severely degraded sites.

1.2 The increase in abundance and diversity of woody and herbaceous plant species within plantations accelerates with the onset of plantation canopy closure.

2. Recolonisation by indigenous plant species within the forest plantations is inversely related to management intensity and strongly influenced by plantation species selection;

2.1 The abundance and diversity of native forest species within plantations is inversely related to the frequency and intensity of understorey disturbances resulting from activities such as weed control and other silvicultural operations, grazing, fire, fuelwood collection and / or litter removal.

2.2 Diversity and abundance of woody and herbaceous species is inversely related to ground cover by grasses within plantations

2.3 The selection of plantation species affects the abundance and diversity of plant colonisers in their understories through their differential influence on factors such as: understorey light conditions and microclimate, soil fertility improvement (litter quality), litter accumulation (litter depth), and provision of habitat for seed dispersing wildlife.

3. Suitably designed and managed tree plantations can provide habitat for wildlife which are agents for seed dispersal;

3.1 Bird and mammal species that are the agents for seed dispersal are more abundant in the plantations than in surrounding deforested landscapes.

3.2 The abundance and diversity of plant species colonising plantation understories are closely related to the abundance and diversity of bird and mammal seed dispersal agents visiting or residing in the plantations.

3.3 Due to their increased structural complexity, mixed species plantations will harbour more diverse array of birds and mammals than single-species stands.

4. Historical and current land-use practices, proximity to natural forest stands, and degree of site degradation will strongly influence the rate of species colonisation and biodiversity within plantation systems.

4.1 The abundance and diversity of native (or naturalised) forest species and mycorrhizal fungal spores colonising plantation understories are directly related to their proximity to native forest stands or remnant patches of native vegetation (i.e., seed sources).

4.2 Native secondary forests are more significant than primary forests as sources of animal and wind dispersed seeds during the early stages of plantation understorey colonisation, while primary (or late secondary) forests are more important for increased species richness at later stages of development.

4.3 The diversity and abundance of native and naturalised species colonisation in the plantations and on unplanted, protected (control) sites will be positively correlated with soil fertility

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Springs as Unique Components of Natural and Social Environment

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Summary

Springs as a specific type of water bodies have great natural, scientific and social importance. Their faunistic complexes represent an important component of species diversity of Belarussian freshwater fauna. Belarussian springs are habitats for many rare and stenobiontic (mainly coldwater) species, refugia for relicts of previous geological epochs and links or "biocorridors" between modern North Scandinavian and South European mountain faunas. Springs are widely used as local sources of drinking water in many Belarussian villages and small towns and to a less extend as spas. From ancient times springs were regarded as sacred places in Belarus. At present the religious rites and folk feasts are celebrated at the springs. Some churches and chapels erected near the springs have significant historical and architectural value. Springs as unique natural objects increase the aesthetic value of the natural environment and represent popular places for recreation and tourism. Unfortunately, springs are the most vulnerable type of freshwater bodies. During the last decades many Belarussian springs were damaged as a result of wide-scale draining activities, tree felling and intensive development of industry and agriculture. Development of special legislation and practical measures for spring protection in Belarus is extremely important.

Introduction

Springs or points of groundwater outcrops represent unique types of freshwater bodies due to their relative constant low temperature regime. As a rule water temperature in winter in the majority of springs ranges from -1 °C to 6 °C and in summer from 6 °C to 12 °C. Therefore, springs unlike the other freshwater bodies in Belarus remain unfrozen throughout the winter. These feature results in special characteristics in the species composition and tropic structure of spring ecosystems which are different from those of other types of water bodies. Studies of the ecology and taxonomic structure of spring ecosystems have a long tradition in many European states, the USA and Canada (Thorup, Llindegaard, 1977; Biesiadka, 1979; Cowie, Winterbourn, 1979; Kownacki, 1985; Braun, 1986; Glazier, Gooch, 1987; Biesiadka et al., 1990; Roughley, Larson, 1991; Kordylas, 1994, etc.). In Belarus, similar special studies have been carried out only in recent years (Khmeleva et al., 1994; Moroz, Khmeleva, 1996; Moroz, 1996; Nesterowich, 1996). Despite this short observation period of the studies, extensive information is obtained on the actual state of springs, the species diversity of their faunistic complexes as a part of Belarussian freshwater fauna, their formation and trends in their changes under anthropogenic pressure. Special attention was paid to the importance of springs in the social and spiritual life of people and to the development of a concept for the conservation of springs in anthropogenically transformed landscapes.

Materials and methods

More than 100 springs located in all main geographical regions of Belarus were studied between 1995 and 1998. All three main types of springs (rheocrene, limnocrene, helocrene) and their transitional forms were investigated. Rheocrenes are located usually at hill bases or on their slopes. Typically, they represent one or several relative large ground water outcrops which form rheocrene springs. Their bottom is covered with sand and pebbles. In general, limnocrenes are similar to rheocrenes but differ by the fact that the outcrops of underground waters are located in small baths or hollows on a ground surface. The sandy bottom in the bath can be covered with fine-grained detritus and/or decaying leaves. Helocrenes are characterized by numerous very small groundwater outcrops on a relatively flat surface, forming swampy areas (Helocrene fields) with fine-grained detritus. One or several small brooks usually cross or border a helocrene field. The springs under study were located within various types of natural environment: beside others in coniferous, broadleaf and mixed forests, open places, natural reserves and agricultural lands, settlements. Both, springs in natural state in undisturbed areas and those transformed to different extents by human activities were studied.

Samples of spring fauna were collected by using standard catching tools, namely a circular hand net 20 cm in diameter and/or a 0.025 m^2 Ekman-Berge bottom sampler. The chemical composition of spring water (contents of nitrates, nitrites, sulfates and heavy metals) was determined for two groups of springs located in settlements and in undisturbed forests.

Results

The Republic of Belarus is located in the center of Europe in the western part of the East European Plain in the upstream basins of the Baltic (Niamey, Daugava, Western Bug, Lovat) and Black Seas (Dnieper, Pripjat). The mean altitude of Belarus is 159 m above sea level with a maximum at 345 m (Geography of Byelorussia, 1977).

The contemporary landscape of the country was largely shaped by periodical glaciations and meltuner streams. In the central and northern parts of Belarus the landscape is a hilly plain crossed by river valleys. The watershed Belarussian ridge formed by several separate uplands crosses the entire country from the west to the north-east. The southern part of the country is formed by the vast Polessie Lowland.

Springs are rather numerous in Belarus. Their overwhelming majority is found on the Belarussian ridge and Belarussian lakeland in the northern part of the country. In the area of Polessie Lowland with floodplain mire landscapes which are largely transformed into crop lands, springs are very rare. The importance of springs in the natural environment and social life is summarized briefly in Table 1.

Springs as habitats of freshwater organisms

Spring ecosystems have a specific biotic structure. Autotrophic organisms (planktonic or benthotic algae) are absent or very scanty in the overwhelming majority of springs. In the springs the main food source for water invertebrates is allochtonic organic matter, i.e. decaying fallen leaves, detritus, etc.

These peculiarities determine the species composition of the fauna of spring ecosystems which are often unique. Planktonic filtrators (Cladocera, Rotatoria) are almost absent there. The overwhelming majority of aquatic invertebrates in springs are detritophages (Trichoptera, Diptera and Plecoptera larvae, Isopoda, Amphipoda), carnivorous (Coleoptera, Hemiptera) and ectoparasitic (Hydrcarina) species.

Species diversity of the springs ecosystems is an essential part of species diversity of freshwater ecosystems in Belarus. More than 200 species of aquatic invertebrates are found in Belarussian springs (Table 2) and this number is far from being final.

In most springs, insects and their larvae are dominant representing about 75% of the species composition and more than 90% of the total biomass of the spring invertebrate community. The dominance of insects can be explained by the fact that they have a flying imago stage in their life cycle. Therefore they are able to populate the springs from other types of neighboring water bodies. In some springs, especially in contaminated ones and those located in open areas, freshwater clams *Euglesa personata* or isopod crustacean *Asellus aquaticus* may be dominant.

Tab. 1: The importance of springs in natural and social environment.

Natural significance	Social significance	Scientific significance
1. Outcrop points of groundwater; sources of supplement of surface water bodies; maintenance of their purity	1. Local sources of clear drinking water for the rural population	1. Unique natural objects, essential components of World and Nation Nature heritage
2. Increasing of biotopic diversity in natural landscapes, creating of ecotones	2. Spas, commercial production of clear drinking and mineral water	2. Indicator objects of monitoring of state and trends of transformation of natural environment
3. Moistening of adjacent vicinity, favoring growth of moisture-loving vegetation	3. Local centers of spiritual life: sacred places, sites of religious rites and folk feasts, sources of "sacred water"	3. Indicators of groundwater state in adjoining regions
4. Habitats for many species of aquatic invertebrates: a. Refugees for relicts of previous geological epochs b. Biocorridors between freshwater faunas of distinct zoogeographical regions c. Key habitats for rare and redlisted species, including "regional crenobionts"	4. Places of interest, tourism and excursion objects, recreation sites	4. Test grounds for ecological investigations: a. Structure and functioning of spring ecosystems b. Genesis, endemism and zoogeography of spring fauna c. Adaptations of hydrobionts living at constant low temperatures
5. Watering places for wild mammals, especially in winter	5. Watering places for domestic cattle	5. Objects for investigations of importance of springs in the spiritual life of people

The other taxonomic groups in spring fauna are Hydracarina, Crustacea, Mollusca, Turbellaria, Nematoda, Oligochaeta and Hirudinea.

Forests are very important in preserving a stable environment and resources of groundwater stock. Springs located in undisturbed natural forests areas are characterized by stable state, unpolluted water and extremely rich fauna. The majority of species living there are eurythermic and eurybiontic ones. Apart from springs they inhabit other types of water bodies, for example rivers, brooks, lakes and ponds. For example, ubiquitous ostracod *Heterocypris incongres* occurs in water bodies of different types, from warm West African temporary pools to cold Eurasian springs and brooks. Stonefly *Nemurella pictettii* is a common species in various types of European water bodies. Freshwater clam *Euglesa personata* can populate both springs and lakes (Khmeleva et al., 1994).

Crustaceans *Asellus aquaticus, Gammarus lacustris* and annelid *Tubifex tubifex* are able to exist in various types of water bodies. They can survive even in conditions of significant anthropogenic contamination.

Real crenobiont species or species which live exclusively in springs are not found in Belarus. However, some species occurring over its area can survive only in springs. They can be defined conventionally as "regional crenobionts" (Czachorowski, 1991; Czachorowski, Nesterowich, 1992). As a rule, they are species which prefer water bodies with cold and clean water. Their majority are water mites *Panisus michaeli, Zschokkea oblonga, Thyas rivalis, Sperchon thienemmani, S. resupinus, Lebertia schernowski, L. crenophila, L. holsatica, L. sefvei, L. stigmatifera* and *Hygrobates norvegicus.* Among these species, the most interesting are L. tschernowski which formerly was recorded in Karelian lakes only in depths of 8–10 m and coldwater *H. norvegicus.*

Two species of water beetles *Oreodytes sanmarkii* and *Agabus guttatus* were not found in Belarus anywhere outside springs (Moroz, 1996; Moroz, Khmeleva, 1996). Both of them are considered as boremontane with a wide geographical distribution. In Central Europe *O. sanmarkii* lives mainly in alpine regions in clean and cold mountain streams. In the Ukrainian Carpathians it inhabits the upstreams of temporary brooks and is unknown in the forest belt (Mateleshko, 1977). On the other hand, in northern of Europe it is found in plain Karelian and Scandinavian lakes (Gerd, 1965). The other species *A. guttatus* is distributed from Spain to West Siberia and India. In Poland and Ukraine it inhabits mountain brooks, rarely occurring in oligotrophic mountain lakes but is unknown in the lowland. In European Russia *A.guttatus* is recorded in cold plain Karelian lakes (Gerd, 1965).

Three species of water beetles *Limnebius aluta, Hydroporus nigrita* and *H. incognitus* are rare and local in Belarus. Proceeding from their distribution in Europe, they approach its southern border of occurrence just in Belarus (Moroz, 1993; 1995; Zakharenko, Moroz, 1988).

Larvae of the following Trichoptera species, such as *Crunoecia irrogata, Drusus annulatus, Potamophilax nigricornis* and *Parachionia picicornis* occurring in Belarus live exclusively in springs.

Among Turbellaria species it is necessary to mention *Crenobia alpina* which was recorded in Belarus for the first time. Its nearest location to Belarus is in cold alpine brooks in Central Europe.

"Regional crenobionts" are not typical for the fauna of Belarus as a country located in the temperate zone of the East European plain. The majority of these species are stenobionts. They prefer clear and cold water bodies in arctic or mountain regions. Low temperatures in springs allow them to survive in atypical climatic and landscape conditions. The ways of penetration of "regional crenobionts" to the modern Belarus fauna are not completely clear. Such species as *C. alpina* can evidently be considered as glacial relict which remained in the Belarus area since the end of the last phase of the glacial period.

Occurrence of water beetles *O. sanmarkii* and *A. guttatus* in Belarus can be explained both by preservation there since the last glaciation and by their gradual migration to the Belarus area from other regions through the chain of springs or cold water brooks. The same explanation is valid for the presence of the cold water mites *L. tschernowski* and *H. norvegicus.* Their larvae can parasite on many flying aquatic beetles and bugs.

Among the other spring inhabitants in Belarus, one of the most interesting is the amphipod crustaceans *Synurella ambulans,* a unique ancient freshwater species of North American origin (Dedyu, 1980). Their ancestors inhabited European water bodies at the boundary of the Permian and Trias periods (about 230,000,000 years ago) before the splitting of the Laurasian supercontinental massive. It mainly prefers the ground waters, but can occur in springs, deep wells and meliorative channels.

In Europe all species of the Synurella genus do not occur further north than 55°. Probably, Belarus lies at the northern limit of the distribution area of *S. ambulans.* Unlike other benthic crustaceans, this species endured the Pleistocene glaciations in Belarus due to migration into ground waters that were largely protected from the substantial climatic variations. Thus, Belarus springs appear to be a refugia for relicts of previous geological epochs and a link (or "biocorridor") between the current coldwater faunas of North Scandinavia and Central and South European mountain faunas. None of the spring inhabitants is included in the Red-Data Book of Belarus (1993). Nevertheless, some of them can be considered as potential red-listed species, in particular the group of "regional crenobionts".

Social and scientific importance of springs

Springs are of large social importance. At present, anthropogenic contamination of surface water in Belarus is a serious ecological and social problem. In rural areas surface and groundwaters are being intensively polluted due to the absence of a waste disposal systems in settlements, stock and poultry farms, by mineral fertilizers, herbicides, and so on. Wells are the most important sources of drinking water for a large proportion of the rural population in Belarus. The content of pollutants (nitrites, nitrates, heavy metals, etc.) in water of the majority of wells is 3 to 5 times higher than the Maximum Permissible Concentration stated by Belarussian Government for drinking and tap water.

Springs are characterized by extremely clear water. They are widely used as local sources of drinking water in many Belarussian villages and small towns. No essential differences in the chemical composition of springs located in undisturbed forest regions and in settlements are revealed (Fig. 1). Springs are original local centers of the spiritual life of people. In

Table 2: Taxonomic composition of fauna in Belarussian springs.

T a x a	Number of species	Dominant and indicator species
Plathelminthes		
Turbellaria	5	*Crenobia alpina, Polycelis tenius*
Annelida		
Oligochaeta	2	*Nais elingius, Tubifex tubifex**
Hirudinea	2	*Erobdella octoculata, Helobdella stagnalis*
Arachnida		
Hydracarina	16	*Hygrobates norvegicus*
Crustacea		
Cladocera	2	*Polyphemus pediculus, Scapholeberis murconata*
Copepoda	3	*Macrocyclops fuscus, Acanthocyclops viridis, A. vernalis*
Ostracoda	3	*Heterocypris incongruens, Ilyidromus olivaeus, Herpetocypris reptans*
Isopoda	1	*Asellus aquaticus**
Amphipoda	3	*Gammarus lacustris*, Synurella ambulans*
Insecta		
Ephemeroptera	4	*Baetis rhodani, Centroptilum luteolum, Cloeon dipterum, Heptagenia fuscogrisea*
Plecoptera	10	*Nemurella pictettii**, Leuctra fusca, L. hippopus*
Odonata	3	*Coenagrion hastulatum*
Trichoptera	18	*Crunoecia irrogata**, Drusus annulatus***
Coleoptera	58	*Hydroporus nigrita, H. striola, Acanacea lutescens, Ochtebius minimus, Helodes pseudominuta**, Oreodytes sanmarkii**, Agabus guttatus**, A. melanarius***
Heteroptera	15	*Hesperocorixa sahlbergi, Nepa cinerea, Notonecta glauca, Velia caprai, Gerris lacustris*
Diptera	50	*Macropelopia notata., Microspectra fusca, M. junci., Rheocricotopus atripes, Zavrelia melanura*
Mollusca		
Bivalvia	3	*Euglesa eichwaldi**, E. personata*
Gastropoda	11	*Lymnaea turricula, Anisus laveis***
Total	209	

** – polysaprobic species (indicators of water contamination).* *** – oligosaprobic species (indicators of water purity).*

Belarus they were regarded as sacred places from ancient times. Until now religious rites and folk feasts are celebrated at the springs. Among the feasts, in Belarus the most popular is the Ivan Kupala (John the Baptiser) Day. It is a folk feast of pagan origin which is celebrated at the period of summer solstice.

Many churches, chapels and other structures and monuments were erected near springs. Some of them have significant historical and cultural value. Local people consider spring water holy and wholesome for many diseases. In Belarus medical usage of spring water started in the 19th century. At the end of the 19th century, there were several water resorts and spas well known not only in Belarus but in other European countries. Unfortunately, the majority of them were destroyed during the revolution and wars. Springs increase the aesthetic value of their natural environment and are popular places for recreation. They can be used for the purposes of school educational excursions and ecological tourism. In Belarus many of the springs, especially those with a high discharge are unique natural objects corresponding to the juridical status of a nature monument of national or local importance. Some of them can be recommended for inclusion in the List of World Nature Heritage.

Springs are unique areas for research. They can provide unique information on freshwater ecology, zoogeography, fauna formation and adaptive mechanisms of hydrobionts for survival at constant low temperatures.

General principles of conservation of springs in Belarus

All data presented above convincingly indicates the importance of springs as components of the natural and social environment. Unfortunately, springs are the most vulnerable type of freshwater bodies. In Belarus many of them were destroyed as a result of large-scale drainage, felling, intensive development of industry and agriculture.

In settlements many springs were destroyed as a result of non-professional measures of better organization. In most cases such "measures" consisted in setting steel barrels or concrete rings at the sites of groundwater crops. It inevitably led to an increase of water amount in the spring, decrease in water exchange rates, increase of water temperature, silting of the bottom, contamination and deterioration of water quality.

In such springs species diversity of faunistic complexes decreases to a great extent. At first, "regional crenobionts" and other species preferring cold and clean water disappear. Only ubiquistic and eurybiontic species are able to survive there.

The development of a concept for spring conservation in view of increasing human pressure is urgent. Special regulation of spring protection is missing in Belarus. Spring classified as nature monuments are protected by the National Law on Specially Protected Natural Areas and Objects (adopted in 1994). Unfortunately, it is rather general and does not take into account some specific traits of springs as water bodies. For example, measures for protection of the natural environment of springs and groundwaters are developed insufficiently, prohibition of changes of the natural state of springs, especially sites of groundwater outcrops is absent, legislative aspects of spring management for scientific, recreational and commercial purposes are not sufficiently developed. Therefore, this law does not guarantee complete safety of the natural state and stable existence even of spring-

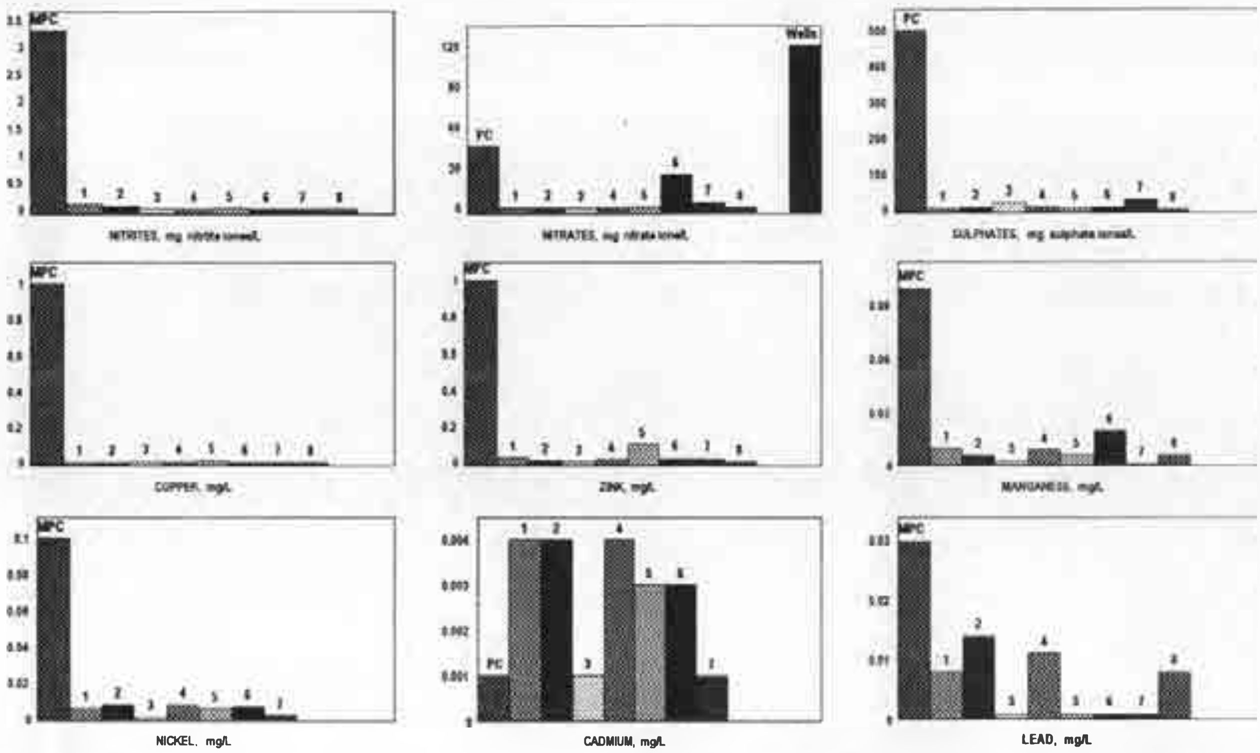

Fig 1. Concentration of several substances in the water of several springs in Belarus. 1–2 – springs in settlements, 3–7 – undisturbed springs in forests. MPC – Maximum Permissible Concentration stated in Belarus for drinking and tap water.

nature monuments. "Ordinary" springs which are not classified as nature monuments are not protected by this law at all. Current legislation on water protection in Belarus (Water Code of the former USSR) has become largely obsolete and the springs and stream brooks are not even mentioned in it.

In Scandinavian states (Sweden, Finland) the strategy of spring protection especially in managed forests is based on the concept of "Key Habitats" (Hänninen et al., 1996; Key Habitats in Woodlands, 1997). Key habitats are defined as "such areas where endangered species are found or can be expected to be found". In these countries all undisturbed springs are considered as key habitats. A special regime of key habitats as protective areas is guaranteed by the Swedish and Finnish Forestry Acts.

In Belarus the springs are specific habitats for many rare and potentially red-listed species of freshwater invertebrates. Some of them ("regional crenobionts") are only able to survive in Belarus in springs. Therefore, in Belarus all undamaged springs are typical key habitats and should be protected by legislation.

On the basis of our investigations, we elaborated a general concept for spring conversation in Belarus, taking into account their characteristic features. Springs are very small and discrete water bodies but aquifers under them occupy a much greater area. Therefore, the state and the stable existence of springs depend on the state of the groundwater and the adjacent surface areas, primarily the vegetation cover has great importance for water protection. In order to prevent deterioration or destruction of springs, special protective measures should be extended not only to springs as such but to their adjoining natural environment.

Protective and water-protective zones should be installed around sites of groundwater outcrops and along the streams being produced by them. The width of both zones and the special regime of their use for industrial, agricultural and recreational purposes should be ensured (Table 3).

We presented these suggestions to the National Assembly (Parliament) of the Republic of Belarus for preparation of a new edition of the National Water Code.

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Table 3: General principles of spring protection outside settlements.

Zone	Limits	Prohibitions
Groundwater outcrops	Outer borders of a spring bath or a helocrene field	Destruction and any change in the natural state of the springs, especially on sites of groundwater outcorps. Contamination by trash
Protective zone of springs and spring streams	Around the outer border of a spring bath or a helocten field and along of both banks of a spring stream: 30–50 m – for nature monuments of national importance; 10–30 m – for nature monuments of local importance and other undisturbed springs (key habitats)	Tree cutting, including any sanitary and care cutting near springs Construction of any capital building and settlements of summer houses Drainage and melioration work Road building Setting up tourist camps and tents Fire-making Watering and grazing of cattle
Water-protective zones of springs and spring streams	Around the outer border of a spring bath or a helocten field and along of both banks of a spring stream: 300–500 m – for nature monuments of national importance; 100–300 m – for nature monuments of local importance and other undisturbed springs (key habitas)	Clear-cut of forests Use of minimal fertilizers, herbicides and insecticides Location of industrial enterprises, cattlebreeding farms, petrol stations, dumps, etc. Use of heavy motor-car and tractor transport Ploughing the area Any damage and contamination of soil, surface and ground water

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Workshop: Tools and Measures for Conservation, Rehabilitation and Development of Biodiversity

The Diverse Tools and Measures Needed to Conserve, Rehabilitate, and Sustainably Use Forest Biodiversity

Charles Victor Barber

Abstract

The loss of forest across the planet is increasingly well documented, and the costs to humanity of the resulting loss of forest biodiversity are increasingly well understood. In many countries, indigenous and other traditional forest-dependent peoples have felt these losses most directly.

The causes for forest loss, too, are well known. Although they vary from place to place, it is clear that logging, road-building, oil exploration and mining are usually the first assaults on the forest, followed by clearing for small-scale and industrial agriculture and settlement. Over the past year, unusually dry conditions in Indonesia, Brazil, Mexico, and Central America have led to massive fires, the intensity and scope of which is a direct

result of the processes of forest degradation noted above.

Parks and protected areas are an important strategy for conserving what is left of the world's natural forest ecosystems, but they are insufficient in themselves. Protected areas will never be large enough to encompass the biodiversity that needs to be conserved and provide for wildlife corridors and the probability of global environmental changes. And protected areas cannot supply all of the goods and services that people require from forests.

Needed is a "bioregional approach" in which biodiversity conservation also becomes a guiding principle for other forest land uses principally timber production in natural forests and timber plantations and is applied to the restoration of degraded forest areas. This challenge calls for a broader concept of biodiversity conservation that encompasses protecting forests, using them sustainably, better understanding their make-up and functions, and sharing the benefits of their use more equitably within and among nations as mandated by the Convention on Biological Diversity.

This broader definition of biodiversity conservation requires in turn that we utilize a broader range of tools and measures. These must include not only technical solutions (like "low impact logging") but also new field-management approaches (like "integrated conservation and development projects" and community forestry) and a range of policy and incentive measures (such as timber certification, recognition of indigenous land tenure, and subsidies for conservation-friendly land- and forest-use practices. Finally, we must focus on the politics of putting good ideas into place. Countless solutions to the deforestation problem have been proposed, but few are implemented due to political obstacles. We must, in the final analysis, all become politicians as well as foresters, scientists, and conservationists, if we are to make a difference.

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Forest Management and Biological Diversity in Latvia

Jurgis Jansons

This paper will introduce the present situation of Latvia's forests and some phenomena found in them related to forest biodiversity.

Forests cover 45% of the territory of Latvia and must be considered as the main renewable natural resource. The species structure demonstrates the dominance of coniferous stands (Table 1). Latvia is located in a temperate transition zone between Northern boreal and Southern broad-leaved forests. The geographical location provides the typical diversity of growing conditions and species structure in Latvia.

One of the main interesting phenomena is the hydrological regime of Latvia's forests – about half of them are waterlogged forests with weak soil aeration and degraded tree stands. Management of these areas is not possible without improvement of soil aeration. It is done in about half of the wet forests while the second half remains undrained.

From the beginning of this century the forest typology of Latvia has been developed, and now we group our forests in 5 edaphic series – uplands (dry sites), wet mineral, wet peat, drained mineral and drained peat soil forests. Within the framework of the edaphic series forest types – the main units of forest classification in Latvia – are classified. The forest types are established following a list of requisites by estimating soil characteristics (humidity, moisture), tree stand's site index, ground cover vegetation and other indicators of biotopes.

The main unit of forest management in Latvia is a forest site with an average size of 2 ha. Forest sites less than 2 ha make up 70% of the total amount of forest sites in Latvia. Different regimes of forest management (including final felling) is planed for each forest site following the Forest Inventory. The mosaic-like distribution of forest sites creates the typical structural diversity of Latvia's forests.

On the other side, structural diversity is not the only component of forest biodiversity. In terms of modern comprehension mature forests are necessary to provide habitats until their natural destruction. The protection regimes for some forest areas were established in previous years and the ecological values are dominating the distribution of specially protected forests in Latvia at present. The total area of protected forests in Latvia is 11.5%, and the area of protected sites in commercial forests comprises 8.6% of the whole forest area (Table 2).

The set of natural reserves does not even represent the territory of Latvia. Therefore, the project "Silava" was started in the Forestry Research Institute aiming at the establishment of protected compartments which represent all forest types in each Head Forestry District (35 in total). The protected compartments projected will occupy 1.5% of all forest area and will represent the natural development of forests characteristic for each type.

The research results demonstrate the possibility to increase the ecological diversity in Latvia by management of waterlogged areas. We were looking for the dynamics of ground cover vegetation following drainage in drained areas compared with undrained areas. The ground cover vegetation is of extreme importance in evaluating forest growth conditions. Research on ground cover vegetation (vascular plants and bryophytes) dynamics must be considered as an important part of forest amelioration science.

The data sets used in this project were collected at the Forest Ecological Laboratory Vesetnieki in cooperation with the Forest Research Station Kalsnava. The forest lands of the Laboratory are comprised of drained peatland and drained mineral soil forests as well as undrained areas and originally dry sites. The aim of the Forest Ecological Laboratory Vesetnieki, established 35 years ago, has been to investigate forest hydrological processes and to work out the theoretical basis for forest amelioration in Latvia. In order to study the dynamics of ground cover vegetation, quite a number of sample plots were set up. The related studies were started and are still continued by Prof. Dr. A. Âboliòa. In 1975, the vegetation assessment using the points-squares method was carried out by Prof. Dr. P.Zâlîtis. In 1994, the enumeration was repeated by the author of this paper, using identical methods. The data obtained 19 years later allows us to analyse the dynamics of the vegetation over this period of time.

At Vesetnieki, 103 species of flowering plants and ferns representing 43 families and 89 genera were found with 31 species of 16 families and 24 genera classified as common. The nature of the flora is not uniform. There were some dominant species encountered in different regions of the Vesetnieki forests. Some species were rare in 1975, but were found to be common in 1994 *(Oxalis acetosella L., Urtica dioica L.)*.

There are differences in the distribution of dominant species in the forest types. In drained forests species typical of undrained areas were not recorded. The similarity between originally undrained areas and drained forests is very low (Tchecanovsky's similarity index K(s) in 1975 and 1994 was 0.05 and 0.028, respectively).

Ground cover vegetation may act as an indicator of forest growth conditions. The dynamics of the vegetation reflect an increase of soil fertility and the stabilisation of soil moisture conditions. For describing biological diversity, the Shanon's index was used. Biodiversity in drained forests is higher than in wet areas. Diversity increases after drainage of one part of a wet forest site while the other part remains undrained. This action helps to conserve some hygrophyte species. The increment of Norway spruce stands influences the light conditions of the ground cover vegetation. As a result the cover of shade tolerant plants increases, but the cover of light loving and half-shade tolerant plants diminishes.

It is useful to analyse the biological diversity on the basis of definite territories. In all the drained forests analysed, the Shanon's diversity index varies between H(s) = 3.337 and 5.029. These values are higher than in undrained areas - H(s) = 3.331. Over the last 19 years a small decrease in biodiversity in drained forests has been observed along with an increasing wood increment.

The drainage of wetland forests intermittently with areas left undrained enhances biodiversity. The Shanon's diversity index H(s) in these areas was 5.61 and 5.25 in 1975 and 1994 respectively.

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Table 1: Species composition in Latvia's forests.

Species	Area [%]	Volume [%]
Scot's pine	39.7	40.5
Norway spruce	20.6	19.8
Birch	28.4	24.5
Black alder	2.4	3.5
Aspen	2.5	6.1
Grey alder	5.34	4.6
Oak	0.34	0.4
Ash	0.84	0.6
Total	100.0	100.0

Table 2: Number and area of forests in different protection categories.

Forest category	Number of objects	Area 1000 ha	%
1. Protected forests			
1.1. Strict nature reserves	5	38.7	1.3
1.2. National parks	2	72.6	2.5
1.3. Nature parks	11	15.0	0.5
1.4. Nature reserves	180	87.6	3.0
1.5. Anti-erosion forests	26	44.4	1.5
1.6. Suburban parks	46	72.2	2.5
Total		330.5	11.5
2. Restricted management forests			
2.1. Protected landscape forests	6	55.1	1.9
2.2. Suburban forests	15	244.0	8.5
2.3. Forests for environment protection	31	224.4	7.8
Total		523.5	18.2
3. Commercial forests		2030.0	70.3
Specially protected areas		248.2	8.6

Forest Biodiversity Conservation in Australia

Rod Holesgrove

Introduction and background

Australia is the only developed mega-diverse biodiversity country and its forests are important reservoirs of biodiversity.

Partly as a result of a number of years of conflict between governments, industry and conservation groups over the use of our forests the Federal and State Governments have developed a National Forest Policy Statement. The governments are implementing important aspects of the Policy through the development of Regional Forest Agreements (RFAs) between the Federal and State Governments, for all of Australia's main timber producing areas.

The purposes of the RFAs include:
- the establishment of a comprehensive, adequate and representative reserve system;
- provide for ecologically sustainable forest management in off-reserve areas;
- to provide for long term stability of the forest based industries.

The RFAs are based on comprehensive assessments of all forest values. The basis of the forest biodiversity assessment is consistent with the Convention on Biological Diversity and Australia's National Biodiversity Strategy.

Forest biodiversity conservation and establishment of the forest reserve system

The objectives of forest biodiversity conservation are:
- to maintain ecological processes and the dynamics of forest ecosystems in their landscape context;
- to maintain viable examples of forest ecosystems throughout their natural range,
- to maintain viable populations of native forest species throughout their natural ranges;
- to maintain the genetic diversity of native forest species.

The Interim Biogeographic Regionalization of Australia (IBRA) is used as the basis of conservation planning.

Principles followed in the establishment of the forest reserve system are comprehensiveness, adequacy and representativeness.

A key issue in the development of the reserve system has been the development of biodiversity criteria, as well as criteria for other environmental values.

As a general forest biodiversity criterion, 15% of the pre- 1750 distribution of each forest ecosystem is to be protected in the reserve system.

Other biodiversity criteria include:
- where a forest ecosystem is recognised as vulnerable then at least 60% of their remaining area should be reserved;
- all remaining occurrences of rare and endangered forest ecosystems should be reserved or protected as far as is practicable;

In addition, criteria for old-growth forests and for wilderness values have been developed:
- where old-growth forest is rare or depleted within a forest ecosystem then all viable examples should be protected;
- for other old-growth forests, 60% of the forest is to be protected.

In the case of wilderness values, ninety per cent, or more if practicable, of the area of high quality wilderness that meets minimum area requirements should be protected in reserves.

As far as possible, forest areas identified for protection will be placed in Dedicated Reserves and should be equivalent to IUCN Categories I, II, III or IV.

The approach used in the assessment of biodiversity as well as other environmental values is as follows:
- information audit,
- data collection,
- data analysis
- development of conservation options and integration with the results of other assessments – social, economic and sustainable forest management.

Ecologically sustainable forest management (ESFM)

The other important component of forest biodiversity conservation is the establishment of management systems for the forest production areas, which will promote the sustainability of these areas.

The approach used in the assessment is to use independent experts to evaluate the State's forest management systems in terms of their effectiveness to deliver ecologically sustainable forest management.

In the case of biodiversity the aim of the ESFM assessment is to ensure that the forest management system maintains:
- biodiversity,
- forest productive capacity;
- ecosystem health etc.

The ESFM assessment is based on such matters as the National Forest Policy Statement, the outcomes of the UN Conference on Environment and Development, the Forest Stewardship Council and the International Standards Organisation.

As a result of the assessment, various management scenarios are generated which are integrated with the results of the other assessments.

Results and progress

Of the total of 12 forest regions in Australia, two Regional Forest Agreements have been finalised to date – Tasmania, and the East Gippsland Forest Region in the State of Victoria.

In Tasmania an additional 396,000 ha of public land has been added to the reserve system bringing the total area of reserves in Tasmania to 40% of the State.

In East Gippsland, under the Regional Forest Agreement, 521,345 ha or half of the region is now in reserves.

Some of our conclusions in terms of forest biodiversity conservation are:
- individual biodiversity surrogates such as forest ecosystems or environmental domains are not an adequate predictor of biodiversity;
- the area of land required to protect biodiversity (species and ecosystems) is frequently significantly greater than the area being incorporated into dedicated reserves;
- the sensitivity of different ecosystems and species to disturbance, both natural and human induced varies widely and many disturbances effect biota within and outside reserves;
- reserve design is not being addressed adequately in the integration tools; and, the economic cost surfaces need signifi-

cant improvement to generate and demonstrate that an efficient reserve system has been designed.

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Analogue Forestry as a Process of Biodiversity Management – Can Biodiversity be Conserved in a Large Scale Production Forest?

John B. Jack

Tools and Measures

*Analogue Forestry (AF)**
Human and biotechnical processes (detail these and decision model).
How might these processes be translated at ground level.
Ecosystem rebuilding guides
The smaller the logged area, the quicker the influx of mature ecospecies.
The closer the mature ecosystem, the quicker the influx.
The less intense and frequent the disturbance, the later the seral condition supported.
The smaller the overall loss of canopy, the quicker the progression to later seral conditions

Best Scenario

Assume we know what biodiversity there is and where it is in the production forest. We can not protect everything so we decide to prioritise in terms of rarity and value. We can not prioritise satisfactorily unless we know the regional and global significance of the ecosystem, species, gene, though value will to some extent reflect its global appreciation.

Thus even where we know a great deal about our production forest we can not protect its biodiversity without the input of regional and global interests.

Exclusion Options

If, as is frequently the case the richest areas of biodiversity are in the valley bottoms and as these zones in most developed countries are frequently denied to loggers for water quality reasons we might widen these exclusion zones and some cases extend them to the ridges. Biodiverse enrichment using AF techniques could be conducted in these outer estuarine zones.

These new biodiversity zones could be initiated following a staged logging of final crop trees, provided rare and valued species were removed from the zone prior to logging, then propagated and later replanted in that zone.

Alternately logging could be denied or minimised in the new biodiversity zone. Rare and valued species could be collected from adjacent areas (snig tracks and landings) designated for thinning or clear felling.

Modification Options

Where the rare and valued species are widely distributed across the production area (and/or where the mature ecosystem remnants are far from the logging area) the only option may be to modify the timing, frequency, intensity or extent of logging activities.

Timing; restrict activity when roots, rhizomes and tubers, fungal fruiting bodies, newly emerging organisms may be damaged, traumatised or killed.

Frequency; extent the logging interval to permit establishment of mid-sere species and continued health of any late sere species.

Intensity; restrict logging activity to thinning and confine operations to strip thinning and small patches (with prior recovery of rare and valued species). Reduce the size classes of salvage harvested and encourage lichens, epiphyte, mosses and saprophytic fungi and their mammal and arthropod consumers in the salvage areas.

Extent; reduce the overall canopy removed by thinning or clear felling in any one coupe to reduce trauma on reptiles, amphibians, small mammals and desiccating effects on sub-canopy and soil dwellers.

Other Co-operatives, Concessions, Franchises

- ISO 14000, Forest Stewardship Council or other; credits, penalties, compliance
- Compensation, tax arrangements, succession counseling
- Arboretum, nursery
- Advanced growth relocation to forest site/arboretum/nursery for sale and propagation
- Tree-climbing recreation/work lichen, epiphyte, flower collection
- Access technology- vehicular non-soil compression, animal underground bypasses, security monitors
- Humidity/cool chambers, perfume extractors
- Pharmaceutical screening, particularly for 'Orphan drugs'
- Nature Hikes
- Photography, art, artifacts
- Restaurant
- Public risk insurance
- Ecosystem Stability Institute to educate Regulators and Operators (See BIS, Bank of International Settlements Basle. Institute of Financial Settlements. ELF, Endangered Language Foundation, a charitable foundation.)

Tools and Measures

Analogue Forestry
Elaborate on AF for cleared site or modification of an existing tree plantation.

Ecosystem rebuilding guides
As for best scenario.

Worst Scenario

Assume we have to determine what biodiversity there is and locate it in and around the production forest.

Even more than in the "Best" case we need to involve local, regional and global inputs to help set priorities, collect data and clarify accountabilities.

Elaborate on interim and subsequent survey techniques and the iterative survey and goal setting arrangements.

In the worst case for timber interests; (that of finding rare and highly prized biodiversity on existing timber production areas), provide incentives for AF development on private property to provide alternative timber resources within 10 years.

Exclusion Options

As for best scenario, but not clear felling and biodiversity zones plus riverine zones to cover the total area of smaller catchments except where the surveys indicate adequacy of biodiversity and low rarity values.

Modification Options

Agree a 10-year moratorium on clear felling, except for conversion to better site-adapted species or rehabilitation of natural disasters (windfalls, insects, and fungi).

Other Co-operatives, Concessions, Franchises

Timber services, emphasising value adding e.g. pre-cut job lots, special finishes, style matching

Young growth timber products

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Analogue Forestry:

An Introduction by Ranil Senanayake and John Jack

Forests and other 'natural' areas have been subjected to increasing public scrutiny over the past 40 years. Much of this has been associated with a concern for loss of biological diversity including (more recently) the loss of cultural values of native peoples.

A challenge to emerge from the considerations of the operation of the Convention on Biological Diversity is the observation that over 99% of the biodiversity of a forest is contained within its non-tree component. While the ideal way of maintaining the original levels of forest biodiversity is in the scheduling and managing of forested land for conservation, there are relatively small resources available for the purchase or scheduling of protected areas. The establishment of protected areas and private reserves alone is not enough for conservation, due to their small area and the likelihood of conflict between conservation values and the human need for resources that are present within reserves.

The conservation of standing forest is a priority, but given present population and economic trends the degradation of biodiversity within the non-scheduled areas of forest will reach exponential rates unless directly addressed in the context of forest biodiversity conservation. For instance, one of the greatest unrecognised areas in tropical rainforest conservation and rehabilitation efforts is the loss of non-woody plant taxa and the subsequent loss of theorganisms dependent on these microhabitats. Analogue Forestry is a response that seeks to address both the genetic and cultural issues of biological loss.

This publication explores the major ecological processes that underlie Analogue Forestry. A 'forest' in the context of these discussions is distinguished from, for example, 'plantation'. The latter is basically a collection of trees of the same age and species and with little or no attention to the non-woody plants and of those not usually in a conservation context.

It is suggested that it is the diversity of species, functions and structures that distinguish the 'forest' from other collections of trees (plantations, shelter-belts, agro-forests and the like). Much consideration is given to the interconnectedness of functions within the forest over time and thus the importance of successional changes and adaptability of plants and other organisms of the forest ecological system. It is postulated that much of the undervaluing of forests in Western culture derives from an ignorance among the owner/managers (government and industry) of the wide range of 'products' of the forest, most of these from non-woody plants. In consequence the nature of forest products is dealt with in some depth.

Because of Analogue Forestry's derivation from the practices of forest management by traditional peoples its application requires that the cultural values of practitioners be fully taken into account in the design and operation of each new project. It further follows that the Analogue Forest will mimic the structures and functions of the most locally relevant native 'forest' (local ecosystem climax) and that it will fit (balance, function and structure) appropriately within the anthropogenic and natural landscape of the region.

Case studies detail how Analogue Forestry has been applied in two locations, one in Sri Lanka and one in Victoria, Australia. The experience distilled from these studies and those of the senior author in numerous Third World countries is listed as 'Prerequisites for successful Analogue Forestry'. The special issues that gene conservation raises and the role of Analogue Forestry in support of traditional conservation measures are also examined.

Integration of Biodiversity into Timber Production – The Swedish Approach

Lena Gustafsson

Abstract

Sweden is dominated by forests and forestry, which is highly mechanized, is conducted on almost all forest land. Forest products are a major export revenue in the Swedish economy. Centuries of forest use has caused large impacts on the dynamics and structures of the forests as well as on biodiversity. Due to the low proportion of forest reserves (less than 1%), the conservation efforts to a large extent are focused on the production forests. The species aspect of biodiversity is considered important and much emphasis is put on the conditions for rare and threatened species. During recent years there has been a shift in paradigm, from an intense, production-oriented forestry towards a larger focus on environmental issues, of which biodiversity is considered a main part. Biodiversity consideration is today integrated into day-to-day forestry, in all production forests. Conservation measures are viewed at different scales, ranging from individual trees, to groups of trees, stands and landscapes. Examples of biodiversity approaches are ecological landscape planning, woodland key habitats (stands with rich flora and fauna) and alternative management methods. National criteria for FSC forest certification were launched six months ago and already 20% of the Swedish forest land has been certified. The criteria are detailed and should they be followed this will imply improvements for the Swedish natural flora and fauna. Future challenges include to find ways to assess and monitor biodiversity and to develop and improve methods for the restoration of forest structures, processes and habitats.

Sweden is dominated by forests which constitute c. 50 % of the land area (Gustafsson & Ahlén 1996) and forest products are a major export revenue in the Swedish economy. About half of the Swedish forest land is owned by large forest companies and the other half of small private land owners, most of them in the southern part of the country.

Sweden belongs to three main vegetation zones: the nemoral (temperate) zone in the southernmost part, the hemiboreal in the middle and the boreal in the north. There are two dominating forest species Norway spruce *Picea abies* and Scots pine *Pinus sylvestris*. Due to the northerly location, the acid soils and to the recent glaciation, the forest flora of Sweden is species poor and there are hardly any endemic species. In total there are about 360 vascular plants, 2600 macrofungi, 300 bryophytes and 800 lichen species (Gustafsson & Ahlén 1996). The concept of biodiversity is complex but in Sweden the aspect of red-listed species is important. The number of red-listed species which belong to a forest environment is for vascular plants 66, macrofungi 465, bryophytes 74 and lichens 159, i.e. 18%, 18%, 25% and 20% of these species groups, respectively (Gustafsson & Ahlén 1996).

The flora and vegetation are highly affected by past and present forestry operations. Clearcutting has been a main harvesting system for decades. Large drainage operations of swamp forests have been performed. Chemical treatment of shrub vegetation following clearcutting was applied during the period 1960-1980. Fertilization is performed on c. 30 000 ha per year today (Pettersson 1996). The natural dynamics of the boreal forests has been prevented through effective control of forest fires. A very dense network of roads has made it possible to reach practically all stands of forests throughout the country. All these factors taken together, has resulted in a change in forest types with an increase of pine in the north and of spruce in the north relative to the 'natural state'. The area of old stands with a large proportion of deciduous trees, including minority tree species and very large trees, has decreased. The amount of deadwood is very low today. In total, modern forestry has implied a substantial homogenization of stands and landscapes.

Forestry has taken another direction during the 1990's. There has been a surprisingly sudden shift in paradigm in the whole forestry sector with a clear trend towards more conservation-oriented methods. The reasons are complex but include the effects of information campaigns initiated by the National Board of Forestry starting already in the late 1970's and continuing since then, the Convention on Biological Diversity, the new Swedish forestry law in 1993 in which environment has been given equal weight as production, NGO campaigns nationally as well as internationally and the consumer market with its demand on 'green products'.

Due to the very small areas of natural forest remaining and the low proportion of protected forests in Sweden (less than 1% of the productive forest land is protected beneath the mountain region (Misterewicz 1998)), there is a focus on the managed forests. The new forestry implies incorporation of conservation measures into day-to-day forestry in the production forests. Thus, there is strong emphasis towards management of the 'matrix', i.e. the productive areas outside protected forests. The present attitude is that conservation actions should be integrated in all forestry operations, on all forest land. Consequently, there has been a rapid development of standards for conservation in e.g. thinning and final harvest.

Conservation is viewed at in different scales. The smallest is consideration of details; structures like deadwood and individual trees (unusual tree species, large trees). One of the most evident signs of the new forestry is the retention of trees on clearcuts. Consideration of groups is saving of groups of trees of value to biodiversity, e.g. border zones of streams, small swamp forests inside felling areas and groups of deciduous trees. Consideration of areas is saving of larger tracts in which the flora and fauna is rich. Such areas can be of the size 0.5 ha to 5 ha or more and usually are of a woodland key habitat character. A woodland key habitat is a forest stand with a high biodiversity value in which red-listed species are present. Such habitats are mapped in large national inventory conducted by the National Board of Forestry. The large companies have the responsibility to perform their own inventories. The key habitats constitute c. 1% of the productive forest land and the supposed number for the whole country is 70 000-80 000.

There also is a development towards alternative management methods (Fries et al. 1997). Formerly, there were a few models; for Norway spruce regeneration clearcutting followed by planting and for Scots pine often leaving seed trees after harvest. Today, selective cuttings methods are being developed for management of sensitive habitats like mixed aspen-spruce forests and nemoral stands in which there is ingrowing spruce. Shelterwood cuttings are performed on damp spruce forest sites.

The importance of the landscape level in planning and management for biodiversity is expressed in the ecological landscape planning (ELP) which now is applied in the large forest companies, mainly in the boreal region. There are different ELP models, one of which focuses on the key habitats and connections between them and another in which the natural disturbance regimes form the basis for different management methods. 10-13% of the volume is estimated to be left for conservation when the ELP approach is applied (Angelstam & Pettersson 1997).

The new orientation within forestry has been rapidly incorporated within forest companies and the organizations of the small land-owners. Today the conservation efforts are far above the demands stipulated in the forestry law. The re-orientation seems massive but still values for biodiversity are lost. For instance, in a recent compilation on woodland key habitats, the Environmental Protection Agency found that c. 150 key habitats had been cut during the period 1994-1998 (Skogsstyrelsen 1998).

During the last three years forest certification has been discussed within Swedish forestry. The large forest companies and one organization representing small private land-owners have affiliated with the Forest Stewardship Council, FSC. Agreement has been reached on a number of certification criteria regarding socio-economic factors, production and environmental conditions. The main focus in Sweden is on environmental conditions and most marked on biodiversity. The list of biodiversity criteria is extensive and includes set-asides of 5% of the productive forest land on the properties, protection of key habitats, retention of at least 10 trees per hectare at final fellings, creation of buffer zones, conservation burning, 5-20% deciduous trees after cleaning and thinning, 5% of the area dominated by deciduous trees etc. The criteria were launched in January 1998 and already more than 5 million hectares of Swedish forest land (20% of all forest land) has been certified and the area is likely to increase.

In a Nordic perspective in order to preserve biodiversity, it is important to:

- Increase the area of protected forests
- Evaluate the effects on biodiversity of the new forestry methods (assessment, monitoring, indicators)
- Improve and develop methods for maintenance and restoration of biodiversity

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Conserving Forest Biodiversity in Protected Areas: Can Conservation and Development Co-exist?

Charles Victor Barber

Abstract

Most national parks and protected areas established in developing countries have followed the early 20th century U.S. model of of a pristine ecosystem walled off from human influence. This ideal has proved to be unrealistic in most places, due to the wide range of existing human uses and new development pressures on most protected areas.

One widely-promoted solution over the past decade has been "integrated conservation and development projects" (ICDPs), which attempt to ensure the conservation of biodiversity by reconciling the management of protected areas with the social and economic needs of local people. This reconciliation has proven very difficult when applied on the ground in particular places it turns out that economic development are conservation of wild forest biodiversity are often not easy to harmonize in the same place. In general, these projects have not worked very well to conserve biodiversity, although some have succeeded in improving the livelihood of the local people.

A more effective approach combines conservation planning and management on a bioregional scale, return to a stricter protection ethic for core protected areas, and a transition from state-dictated, business-dominated forestry to community-based forestry management in non-core forest areas.

This approach requires a broad set of tools and measures including: better baseline ecological and socio-economic assessments; participatory mapping and planning processes; better mechanisms for cross-sectoral coordination; decentralization and the building of sub-national institutional capacity; reform of land tenure; and a variety of community-based approaches in which NGOs often play an important role.

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Community Participation

S. John Joseph

Conservation of biological diversity has assumed great urgency because of the actual and threatened extinction of many species of plants and animals and disappearance of habitats. Currently there is a large and growing number of species recognized to be in danger of extinction. The increasing number of threatened and endangered species indicates loss of genetic variability and a decline and depletion of natural communities, at a time when population pressure makes additional food production from existing or less land imperative.

India's immense range of ecosystems, species and genetic forms have for some time been under serious threat. Habitat destruction, hunting and over exploitation, pollution and poisoning and introduction of exotics have caused a decline in many species and varieties of both wild and domesticated (agricultural) plants and animals. No one is sure how much we may have already lost, for we are aware of only a few mammals, birds and plants which have gone extinct. For each of those we know of, there may be several others (especially lower plant and animal forms) which may also been sent into oblivion by the destructive hand of humans. Of what is left, over 10% is believed to be under threat of extinction in the near future.

The loss of diversity is not only an ethical tragedy but also a great social, economic and cultural one. The majority of India's people are dependant on biological resources and natural habitats for their day to day existence for food, medicine, shelter, household goods, fodder, manure and not the least spiritual and cultural sustenance. It is therefore makes abundant sense that nature conservation must be pursued as a peoples movement.

For this we have to design institutional devices to promote community participation in a sustained manner. The several adhoc efforts currently underway, if linked in the form of a Network, would help to strengthen the NGO movement in this area and help to share experiences. NGOs can play a signal role in fostering public awareness of the importance of genetic diversity, already a prime component of many NGO programs. Some of them have also initiated conservation programs in a limited way over small gardens, heritage sites, and Sacred Groves but it needs to be supported and technically backed up. As a means to secure Community Participation it is necessary to identify all such NGOs having the desire, capacity and infrastructure to take up biodiversity conservation programs and foster linkages and partnership among them.

The indications are the need for harnessing resources optimally and orchestrating a co-operative mechanism among the institutions and agencies aligned for a common cause. Much has been secured and achieved in this direction by the initiatives of MSSRF by the formation of

National Biodiversity Alliance and the Community Biodiversity forum, and the action programs that emanated from these.

Community Participation is a process in which people control or people influence the decisions that affect them, so that better outcomes can be achieved.

This is viewed from two perspectives:

1. As a means for enhancing the efficiency of delivery, operation and sustainability of the program.

2. Participation is seen as not merely a means towards economic development but as an end in itself.

There are four levels of intensity of Community Participation:

1. Information Sharing
2. Consultation
3. Decision Making
4. Initiating Action

By this approach community members can move from being mere recipients of information to become active participants and begin to act as stakeholders.

Factors common to all levels are:

- Policy environment, i.e., policies of the Government regarding implementation of projects, cost recovery as well as operations and maintenance and the rigidity of the above policies.
- Institutionalization of Community Participation in project documents as an objective and specification of mechanisms at each stage.
- Project organization and delivery mechanisms.
- Agencies involved in the provision and production of goods and services; the co-ordination mechanisms; their monitoring and control.
- The orientation and capacity of these agencies to generate and sustain community participation.
- The flexibility available in the project design to adapt to changing community needs.
- The presence of other agencies (Government departments; other donor/supporting agencies) working in the same project area.

Community level factors operating at the village community level are:

- Infrastructure facilities in a village
- Environmental/geographical factors
- Functioning of local institutions
- Village leadership
- Level of income and disparity
- Literacy and awareness levels
- Past history of participation.

Based on these consideration the current program strategies are:

I. To run awareness and publicity programs (i. Trainers Training Program; ii. Training Program of different levels)

Spreading awareness among school children and rural families on the economic and ecological benefits of biological diversity is in progress.

The target groups being school children and rural families, activities have been planned separately for each group using diverse tools media and methods. It includes field visits, preparation of educational materials, organizing slide shows, video shows, organizing campaigns, raising of nurseries etc.

All the above strategies put together aims at ensuring total involvement and participation of local inhabitants, school students, local Government departments, Panchayats (Village Councils) etc. This in turn will facilitate in achieving the ultimate goal (i.e.) to reduce the existing pressure on forest resources. The above exercises can continue to enlarge community participation because of the potential which is evident from the responses of the school children, teaching staff and involvement and rural people.

To train a cadre of Conservation promoters among rural and tribal youth, who will help to spread the message and methods of biodiversity conservation among the people in their respective areas: Training of young tribal and rural women in *in situ and ex situ* conservation techniques, seed technology and the importance of biological diversity conservation will be undertaken by giving encouragement to them. Priority will be accorded to hotspot areas with reference to threats of biodiversity. The trained youth will constitute as conservation promoters. Only those who have a stake in living in their respective villages will be selected. They will be supported with the necessary techno infrastructure, so that they can help their own communities to halt genetic erosion and promote the conservation and sustainable utilization of their genetic wealth for future generations.

Activities: The following are the activities under the Community Biodiversity Conservation program

a. Policy Makers Workshop
b. Trainers Training Program
c. National Biodiversity Alliance
d. Training Program at different levels, and
e. Biodiversity Forum

Policy Maker's Workshop:
To formulate and implement the conservation strategies from the top level to the village panchayat (council) level this workshop is being organized in rich biodiversity areas once in a year. It consists of State Chief Secretaries of Forests and Environment, Principal Chief Conservator of Forests, heads of different state and national institutes, Presidents and Vice-Chancellors of Universities, representatives of active non governmental organizations and representatives of WWF.

National Biodiversity Alliance:
It is a coalition among conservation committed scientists, lawyers, forestry officials and the mass medias' to formulate the strategies to tide over the problems in the protected areas of our country which occupies three percent of our land mass with marvelous genetic wealth.

Biodiversity Forum:
The Biodiversity Forum is being organized to review the progress in the community involvement in promoting and conserving the biological resources and to plan for the future with the main theme of conservation and sustainable management of biodiversity. This forum could result in formation of networks which in turn would help in conservation of biological resources at the local level with the participation of local people. This forum may be conducted once in a year in different regions of our country.

II. To develop/modify policies and legislations

Guide governmental action and provide significant public forums by coalition with like minded NGOs e.g. Community Biodiversity Forum and networks to highlight problems and solutions as well as to motivate action. These forum aims at promotion of a network of various organizations, institutions and individuals from different areas, particularly women who have a concern and commitment for biodiversity conservation, and to capture the collective capacity.

III. Promote environmental education (by traditional and non-traditional means) and capacity building by organizing trainers training programs, to facilitate people to manage sustainably the natural resources

Build and strengthen government and non-government institutions, so that they have sufficient built-in capacity to address community issues. **The Trainers Training Programs** will include representatives from NGOs, organization personnel, community leaders etc. Here NGOs can function as vital catalysts at the community level and also act as a link between official agencies and communities. In these training programs training will be imparted to the representatives from NGOs, who would then train rural women and men in their respective villages on biodiversity conservation. This training is to equip them with knowledge and skill and give them confidence to conduct similar programs in their target area.

Trainers Training Programs are being conducted at the regional level within the state to selected non governmental representatives and in turn they will conduct grass root level training program as a sequel to the trainers training program at the village level to the different sections of people. It is proposed to conduct one trainers training program and 10 grass root level training program per year in the state of Tamil Nadu and Kerala.

Awareness program:
To create an awareness on the importance of biological diversity, its need and conservation to school students, rural and tribal youths and women. Two programs are being conducted per year.

IV. To train women in biodiversity conservation

The **Women Seed and Biodiversity Workshop** focused its attention in strengthening the role of women in genetic conservation and seed technology since women are traditionally involved in seed selection and in conserving them. By providing technology numerous unskilled workers can be given opportunities for skilled and value added work.

V. To reduce consumption and pollution by influencing public policy and the practices of consumers and business/industry

Organize campaigns to reduce consumption and pollution. Direct activities at local and national levels to combat global threats such as marine pollution and climate changes.

VI. To protect endangered species and habitats, and support and promote traditional *in situ* conservation strategies

By focusing attention on flag ship species such as elephants, tigers, rhinos and dugongs around which major ecosystem programs can be built and on key stone species that serve as indicators of ecosystem health whose survival is the responsibility of the local authorities.

Sacred grove being a cultural *in situ* conservation area; initiate steps and action to recognize and support such traditional *in situ* conservation initiatives. It is also imperative to take up documentation as a component of IPR to provide comprehensive base for defending conservationist right.

VII. To link conservation with human needs by promoting sustainable practices

Foster an integrated approach in the use of natural resources - at practical level in terms of local community involvement, management and benefit and at the policy level in the development of plans and activities by Governments.

Support programs involving women in the conservation practices of landraces. Traditionally women have been considered as seed selectors and conservers. Their role in selection and conservation will be strengthened through training and net working with women farmers.

Bring the women farmers to the benefits of modern technology in *ex situ* methods of plant conservation, primarily the gene bank facilities. On this context the community gene bank established at MSSRF can play a vital role, by giving traditional seed materials stored at our gene bank to these farmers.

VIII. To monitor maintain systems of effective and sustainable protected areas

This would ensure optimal representation of species, habitats and ecological process within designated areas for conservation objectives. To monitor threats for effective management, promote models of good management for education and training and ensure participation of local communities. The training programs will be organized in such a way that they include the components of monitoring and local threat alert mechanism for effective implementation of these programs. In all these programs for its greater success **the involvement of the local people** is a must.

Some Successful Examples of Community Participation

(a) Joint Forest Management

West Bengal has an unique distinction of having decentralized planning process and the forestry sector has gone up one step ahead in initiating "bottom up" approaches through micro-planning at village level.

People's participation has been recognized as critical for success of forestry development. To many foresters of India, the concept of people's participation was obscure; it meant merely to give some employment opportunities to rural people and/or to give some low priced forest products as fringe benefits. The type of intimate or intensive popular participation where local people act as equal partners with the Forest Department can hardly be achieved through these approaches. In most States now, **Forest Protection Committees (FPC)** have been formed mainly to protect the resources, against some benefits either in cash or kind. But developing a meaningful partnership with the community is still not in sight where the people are involved in decision-making processes for the management of the resources, and not only for forest protection. There is no denying the fact that issues in management of natural resources are often highly location specific and, therefore, deserve careful science (including Social Science) and technology-inputs. Developing an interface between specialized science and technology and grass-roots technology

Salient features of Joint Forest Management Resolution in West Bengal

Particulars	West Bengal
Formation of forest production committee	Initiative is taken Forest Department with help of Gram Panchayat (Village Council)
Composition of executive	Along with 6 members from the community Grampradhan/ members of local Gram Panchayat & Beat Officer
Role envisaged and powers of Forest Department	Technical guidance
Regulatory role of Forest Department	Termination of individual membership by Regional Forest Officer, Dissolution of the Executive Committee
Facilitating role	Preparation of an action plan with people and its approval by the District Forest Officer
Role of gram panchayat	Recommendatory role in selection of beneficiary/members. Constitution of the Forest Protection Committee/Executive committee. Provide support to Environment Protection Committee
Role of NGOs	Catalysts of civil society
Usufruct benefits	25 % of net sale proceeds; all non timber forest products
Quality and forest type	Degraded, protected forest

can be the beginning of a viable joint management practice.

Sharing of the forest products between the Forest Protection Committees (FPC) members and the Forest Department (FD):

1. The FPC members get 25% of the biomass produced through forestry operations such as RDF coppicing, multiple-shoot cutting (MSC) and thinning, whereas the FD receives 75%.

2. The FPC members are entitled to collection of grass, fallen twigs, fruits, flowers, seeds, etc. free of royalty. However, entire sale seeds and kendu leaves so collected cannot be sold in the open market; they must be deposited with the local Large-Scale Multipurpose Co-operatives Depots run by the Tribal Development Co-operative Corporation.

3. At the time of every final rotational harvesting the FPC gets 25% of the net cash sale proceeds of the pole/timber harvested.

(b) Interface Forestry Program (IFP) of Tamil Nadu

These are successful models of Community Participation in Tamil Nadu State: IFP in four sample villages viz. Jalluthupatti (JP), Allikuzhi (AK), Sigaramahanapalli (SP) and Thagarai (TG) were taken up for a study. All these villages are socio-economically backward with predominance of tribal and backward communities. Homogeneity of the population makes it easier to identify appropriate claimants as evidenced from Sukhomajri experience (Levine, 1986). This is also true of JP and AK which have homogenous population.

The landless agricultural labour and marginal farmers outnumber the other two classes of small farmers and big farmers in the villages studied barring SP where the number of small farmers is high.

Livestock:

The livestock population in the four sample villages comprises 1641 cows, 545 bullocks, 616 buffaloes, 3086 sheep and 1111 goats. If the forests have to be closed for grazing effectively, at least the milk animals (cows and buffaloes) have to be provided fodder (15 kg/day/animal). The total annual requirement of fodder in the sample villages is estimated to be around 12,540 tons.

Investment:

The project was initiated in 1988 in JP and AK while it was extended to SP and TG in 1991. The total investment in all the four villages is Rs. 226 million over seven years. The major investment was on reforestation coupled with soil and moisture conservation works such as construction of percolation ponds, check dams, random rubble check dams and contour stone walls. The average annual investment in each program village is around Rs. 10 million.

Village welfare amenities such as provision of drinking water, construction of community halls, thrashing floors, etc. were undertaken under the scheme. Health camps benefited over 1500 people and adult literacy made 405 literate. Forest based income generation activities like mat weaving, basket making, dairying and pisciculture were promoted to provide alternate avenues of employment so that pressure on natural forests could be minimized (Gautam Dey 1994). Linkages between fodder banks and dairying was developed.

Benefits

Water Level:

The most important benefit that could be perceived by the people immediately is substantial increase in water availability due to afforestation and soil conservation measures. The increase in water level varies between 25-200% in JP, 0-25% in SP, 25-100% in AK and 20-25% in TG.

Agriculture Improvement:

The augmented water supply has lead to improved agriculture. The total area under crops has increased, the number of crops, the cropping pattern and crop mix in these villages have changed towards economically valuable crops. For instance, JP grew 93.8 ha of tapioca, 31.92 ha of paddy during 1993-94 compared to 37 ha and 6.2 ha in 1987-88. As a consequence the land value has increased by about 50%. Migration level has come down from 61 persons in 1987 to 10 persons in 1993 as a consequence of improved employment.

Regeneration of forests has improved, the floral diversity markedly redeeming over 30 different native species. Illicit felling has stopped. A steady flow of income to the tune of about Rs 50,000 is being realized by the locals using each watershed from Non Timber Forest Products (NTFP) collection. Gap planting with NTFP plants like tamarind and gooseberry in future will further augment this income in future.

Literacy:
Adult literacy campaign made 405 literate comprising of 40 in JP, 60 in TK, 175 in AK and 130 in SP. **Health camps** conducted benefited over 1500 people in these villages. Besides, the level of awareness about forest conservation has increased to a significant extent among the villages.

Housing:
In JP, there were 133 huts and 10 tiled houses before the commencement of the program. Now there are 109 huts and 34 tiled houses. Two bio-gas plants have also come up now though the principal cooking medium is only fuel wood. All the houses in JP are electrified under free power supply scheme.

Employment:
Over 32,427 man days have been generated annually through forestry work. Yearwise data on the man-days generated in each program village indicates that the maximum number of man-days to has been generated during 1992-93 and 1993-94.

Economic Analysis:
The social net present value of IFP in Tamil Nadu as a whole for the first four years has been estimated to be between Rs.61 million to Rs.135 million at a social discount rate of 5.6% and 8.1% respectively.

Jalluthupatti – A Case Study:
The total cost vis-à-vis the total tangible benefits were quantified and analysed for JP. The net benefits from the sample village has positive NPV. The net present value at 6% and 8%, social discount rate works out to Rs.3.15 million and Rs.2.93 million respectively. The total benefit of Rs.2.93 million comprised Rs.1.11 million from forest wages Rs.0.99 million from agricultural income and Rs.0.14 million from agricultural wages. The cost benefit ratio works out to 1.77.

The relative significance of various benefits from the program vis-à-vis total investment in JP was analysed. The five benefits fall in the following order based on their respective co-efficient of correlation.

I. Total income (r = 0.913),
II. Average water level (r = 0.869),
III. Paddy area cultivated (r = 0.856),
IV. Area cultivated (r = 838),
V. Inverse of people's migration (r = 787).

The most important and immediate direct benefit of the forest restoration is increased income from agriculture. As most of the benefits from the forests will accrue only after long gestation period, this approach of improving agriculture in adjacent village will be a profitable intervention as dependence of villagers on forests can be minimized to that extent.

There are several intangible benefits such as
I. Reduction in soil erosion,
II. A more evenly distributed water supply,
III. Well distributed rainfall, improved species diversity in the forests,
IV. A positive external effect (aesthetic landscape) and
V. Improved living standard of the people.

If these intangible benefits are also taken into consideration the net benefits will increase.

(c) Eco-Development

"Poor can not be asked to remain poor and conserve the environment; this is an insult to poverty". Change over from exploitation to protective system exacerbates hardship of forest user group due to lost access and income from forest. Action plan to offer employment opportunity specially for target groups (ST, SC and forest dependent groups) need to be chalked out not only through silviculture based operations, but also through support services, ecologically compatible, to meet the needs of the community, thus schemes on fringe area development (Eco-development) in the shape of raising tassar/silk host-plant on wastelands, raising fruit trees, developing silvo-pisciculture, agro-forestry, silvo-pasture etc. will need attention. Simultaneously, activities like structural constructions for drinking water supply, ground water recharging, minor irrigation, mariculture, apiculture can be thought of. Installation of solar lighting system in remote areas, distribution of solar cookers, fuel efficient chullahs etc. will minimize dependence on forests.

Further, integrated inter-sectoral approach like literacy program, immunization package, maternity and child welfare, sanitation can be offered to fringe-dwellers by an integrated institutional framework. Such extra forest territory inputs will help enlisting people's support and ensure their involvement in rural and forestry development.

In the Mundanthurai-Kalakkad Tiger Project Area the Eco-Development Program was initiated with World Bank support. The planning of activities in this P.A. was done with the help of local communities having a stake over this area. Participation of local NGOs was also secured in planning and implementation of the program. Before the preliminary exercise, the NGOs and Community Leaders, Forest Department Officials went through a social orientation course organized by a renowned Gandhian Institution. This motivated them properly to the objectives and tasks of management. A participatory conflict resolution approach was followed in planning the various management activities. The project was implemented for 3 years with great involvement and participation of all stakeholders. Considering this successful approach in Community Participation in the management of protected area, it is now proposed to be implemented in another 7 Tiger project areas (P.As) of India. The perceivable benefits and outcome of Community Participation are:

- The communities have become increasingly active in planning the protection of natural resources.
- The village have organized themselves into the Forest Protection Committee/Conservation Management Group (FPC/CMG), worked with enthusiasm on macro planning and come up with a draft Conservation Management Plan.
- Community Participation is not only providing momentum to plan implementation but it has also contributed to greater coherence and environmental awareness in the community.
- FPC is currently collaborating with the local administration to address most difficult tasks for management of the area - goat browsing; and head-loading.
- Community Participation at all stages of the management process has led to self-imposed regulation of less damaging environmental practices. A particularly good example of this are: (a) Farm Forestry in Community Lands, (b) Agro-For-

estry practices in fields, (c) Selling of goats, and (d) Stall feeding of goats.

Important elements and tools to be considered for success are:

1. NGO role and involvement
2. Seminars, Workshops and Symposium
3. Public Forum
4. Activists taken on board of task force and committee
5. Building in Community Participation into project design / organization
6. Taking into account the needs and preferences of local people/communities - Provisions to meet this social welfare
7. Involvement of village level institutions
8. Involvement of women
9. Networking and stakeholder approach
10. Conflict resolution and management skills
11. Provision for Environment Impact Assessment

Conclusion

Between professional foresters and local communities often different perspectives exist with respect to forest resources and the objectives for forest management as well as the kind of management practices to be used. The presence of many different types of indigenously developed forest types, many of which are intricate local systems for forest management, hardly have been recognized by foresters. These examples indicate that in stimulating sustainable forestry for rural development it is important that local people should not be conceived as an unnatural external factor to forests, but rather as a highly specialized ecological agent acting within the forest. They may have either positive or negative influences on the forests; these influences are time and location dependent. The concept of sustainable forest management should therefore not only be used with respect to ecologically and socially sound, professionally guided wood production schemes in either natural forests or timber plantations, but also with respect to the maintenance and development of a wide variety of indigenously-developed forest types. This means that the concept of sustainable forest management should incorporate the notion that not only the ecological integrity and social functions of forests should be maintained, but also the indigenous ingenuity and creativity in conserving, enriching or even reconstructing forests.

To the Garwhali people of India, the worship of Bhumi Devta signifies the peoples veneration hand and natures. Another feature of the Garwhali Society is the strong preference for settling the disputes within the community, using a traditional opinion leader or a representative of the local Panchayat (Village Council) as mediator rather than taking cases to the courts or police (official down). These people are said to love justice as much as they love nature. In cases, when people feel they do not get justice through the mediator they turn to prayer of non-violence to achieve resolution of a conflict.

This value given to pious and patient behavior provides a release of anger, which they view as unhealthy, at the same time as it resolves community problems.

It has even helped severely to remove corrupt officials. It remains to be seen however, whether this traditional approach to conflict resolution can save the trees or forests which the Garwhali venerate, at a time when unprecedented demands are made upon the land – Chipko Movement (Tewari, 1994).

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Use it or Lose it: INBio's Integrative Concept for Biodiversity Conservation

Werner Nader

Abstract

Deforestation in the tropics is accelerating at the end of the second millennium and is threatening the persistence of global biodiversity. Whereas deforestation rates in the 1980s were already horrifying with nearly 1% of tropical forests destroyed annually, record destruction has been observed in the years 1997 and 1998. Only in Central America forest fires have recently effected 14,800 km² or 8% of the forests of the region. The problem is urgent, because losses in biodiversity are irreversible. Practical solutions are needed and one example is the Costa Rican Instituto Nacional de Biodiversidad, INBio. Following the simple trilogy SAVE-KNOW-USE INBio's mission is the conservation of Costa Rica's biological wealth through facilitating its knowledge and potential non-destructive intellectual and economic uses.

The institute became most famous through its innovative bioprospecting approach (USE), but is rather following an integrative strategy, which includes a National Biodiversity Inventory (KNOW), the dissemination of information to potential users of biodiversity and for awareness building (USE) and conservation and development (SAVE) in collaboration with the governmental national system of conservation areas (SINAC) and the communities around the protected areas. In biodiversity prospecting INBio has pioneered collaborations with international industries in the field of pharmaceuticals, agrochemicals, cosmetics and biotechnology, which include the sharing of benefits from future products for biodiversity conservation, technology transfer and building of a scientific and technological capacity in the source country. The Costa Rican population itself has to recognize the importance of biodiversity as a source of inspirations for the inventor and developer and thus for the future development of mankind. This is only possible, if the scientific and technological capacity is strengthened within the country.

Loss of Biodiversity – An International and Accelerating Problem

At the end of the second millennium tropical deforestation is further accelerating and is threatening the persistence of global biodiversity. Deforestation rates in the 1980s already looked grim with an annual destruction of 10,499,000 or 1,199 ha per hour or nearly 1% of the closed forest coverage (Table 1, Reid, 1991). The inventory of forest destruction is not yet completed for the 1990s, but it is already clear that 1997 was and 1998 will be record destruction years due to devastating forest fires.

Most ill-famed are the Indonesian fires. According to a study of David Glover of the IUCN World Wide Fund for Nature an area the size of Costa Rica was burned in Indonesia by fires that were primarily set by businesses and military trying clear forests in order to install palm oil plantations and other cash crop lands. About 70 million people were exposed to health problems due to the fire haze last year (Study of David Glover, of the Economy and Environment).

But also in Central America the smoke of burning forests darkened the sky over months and could be smelt up to Mexico. The horrifying inventory of the Central American Commission on the Environment and Development (CCAD, 1998) lists 42,286 fires on an area of 2,537,160 ha between December 1997 and May 1998. This is nearly 5 % of Central America with an area of 51,186,500 ha (Table 3). Already in 1996 deforestation looked grim with 2.13 % of the Central American Forest destroyed (Table 2). But only in the first six months of 1998 8.12 % went up in flames.

It is easy, this year, to blame El Niño. But many of the fires where started deliberately to clear land, only to run out of control in the drought and heat. The real trouble, now as for 30 -40 years past, Nicaragua and Honduras alike, is not weather but people: big ranchers clearing land for cattle, slash-and-burn peasant farmers, timber companies logging indiscriminately and often illegally (The Economist, May 30th, 1998). Nicaragua's La Prensa states: Desolation and destruction are everywhere; if nothing is done Nicaraguans will be without flora, fauna or food.

Over 20 % of Species Might be Lost in the Next Decade

Scientists already alarmed the public in the 1980s about the catastrophic extent of loss of biological diversity. Based on the data from that decade the prognosis on species loss was 8,000 to 28,000 per year and by the year 2045 a loss of 9 to 19 % of tropical closed forest species, if the deforestation continues at a rate of 10 million ha / year (Reid, 1991). In Central America deforestation in 1998 will be ten times higher than the average rate observed in Latin America in the 1980s (Table 3). We might have lost over 20 % of the tropical biodiversity already in the first decade of the new millennium.

Forest destruction gains speed despite of all international efforts to put it on hold, despite all conferences, conventions and workshops, attended by international experts and despite all international roll-calls. Biodiversity became a wide-

Table 1: Destruction of Tropical Forests in the 1980s (Reid, 1991).

Continent	Closed Forest in 1980s (000 ha)	Average annual deforestation in 1980s (000 ha)	% annual destruction
Africa	203,714	1,508	0.74
Latin America	673,715	5,278	0.78
Asia	288,953	3,713	1.28
TOTAL	1,166,382	10,499	0.94

Table 2: Deforestation in Central America in 1996 – Source: CCAD/CCAB-AP/UICN-ORMA. 1997. Diagnósticos Forestales de Belice, Guatemala, Honduras, El Salvador, Nicaragua, Costa Rica y Panamá.

Country	Surface (ha)	Forest coverage (ha)	Forest coverage (%)	Deforestation (ha/year)	% of total	% of forest
Belize	2,143,500	1,773,000	82.72	10,000	0.47	0.56
Guatemala	10,889,000	3,480,100	31.96	90,000	0.83	2.59
El Salvador	2,097,000	385,087	18.36	11,653	0.56	3.03
Honduras	11,249,200	4,536,700	40.33	108,000	0.96	2.38
Nicaragua	12,142,800	3,764,172	31.00	100,000	0.82	2.66
Costa Rica	5,113,300	1,845,687	36.10	18,000	0.35	0.98
Panamá	7,551,700	2,422,724	32.08	51,000	0.68	2.11
TOTAL	**51,186,500**	**18,207,470**	**35.57**	**389,000**	**0.76**	**2.13**

Table 3: Forest Fires and Damages in Agriculture and Forestry, December 97 to May 98 – Source: Information of the Workshop about Forest Fires in Central America, San Pedro Sula, Honduras, June1998. Proyecto de Monitoreo de los Recursos Naturales (Detección de Incendios Forestales), ODA – MARENA.

Country	Total area (ha)	No. of fires	Forest affected (ha)	Agricultural land affected (ha)	Total area affected (ha)	% of total area
Belize	2,143,500	656	22,960	16,400	39,360	1.83
Guatemala	10,889,000	10,906	381,710	272,500	654,360	6.00
El Salvador	2,097,000	227	79,450	5,675	13,620	0.64
Honduras	11,249,200	9,594	335,790	239,850	575,640	5.12
Nicaragua	12,142,800	15,196	531,860	379,900	911,760	7.51
Costa Rica	5,113,300	1,511	52,885	37,775	90,660	1.78
Panamá	7,551,700	4,196	146,860	104,900	251,760	3.33
TOTAL	**51,186,500**	**42,286**	**1,480,010**	**1,057,150**	**2,537,160**	**4.96**

spread catch-phrase and is used depending on the specific interests of the user. The ongoing discussion on its legal, ethnic, ethical, cultural, social, recreational, scientific, educational and aesthetic aspects gets sometimes diffuse and theoretical and it seems more and more difficult to attract the attention of the public in the North on the catastrophe occurring in the tropics. A focus is needed on the central point of the problem. Its causes are diverse like global climate change, cattle ranching, timber production, slash-and-burn peasant farmers, urbanization etc. and are driven by greed, poverty and negligence. But the effect is always the same: the loss of one of the most important resources for the future development of mankind, biodiversity. Only if the public is convinced and aware of this importance for the survival of their children and grand-children, drastic measures seem feasible. Good examples from the practice are needed and fantasy and innovation with the same diversity as observed in nature.

Case Study Costa Rica

The forest inventory of the CCAD for 1996 reveals that deforestation rates were considerably lower in Belize and Costa Rica compared to the other countries of the region (Table 2). Whereas Belize is a low populated country with only 200,000 people living on an area of about 21,000 km^2, Costa Rica is as densely populated as its neighbors. The résume of the forest fires in 1998 also indicates that Costa Rica is better off than its neighbors (Table 3).

This was not always like this and in the 1960s and 1970s Costa Rica was a leader in deforestation in Central America and became one of the most studied model cases for the economic and ecological consequences of forest destruction in the tropics (Repetto, 1992). Between 1943 and 1987 Costa Rican forest decreased from 38,250 km^2 to 14,759 km^2, a loss of 74 %. An impressive picture of the development of deforestation during this time is given in Fig. 1. The forest areas, left today, are mainly under conservation. Outside of conserved areas only about 200,000 hectares of primary forest persist. Erosion between 1970 and 1989 washed off 2.2 billion tons of soil and nutrients of 17 % of the value of the annual crops and 14 % of the value of livestock products. Alone in 1989 3.2 million cubic meters of timber with a commercial value of $ 400 million were destroyed, more than the interest payments due for foreign debts. Nearly half of the forests were slash-and-burned to generate pasture land for the country's once flourishing meat industry. The hamburger connection with Costa Rica saved the US-consumer a couple of cents on his favorite fast food. Due to low prices and declining consumption of beef in the USA the export of meat from Costa Rica is reduced to less than $ 30 million in 1997 (Costa Rican Export and Import Directory, 1998), which is less than 5 % of the income from tourism. Losses in biodiversity and other natural resources due to deforestation to generate pasture land are also in monetary terms several fold higher than the income from the meat industry ever was.

Sustainable Use of Biodiversity

Costa Rica already reacted in the 1970s and since then has put over 25 % of the country under protection. In the first half of the 1980s the country underwent a deep economic crisis due to high oil and low coffee prizes. The conservation areas came under pressure and the problem escalated, when gold-diggers entered the Corcovado National Park at the Southern Pacific coast on the Osa Peninsula. It was

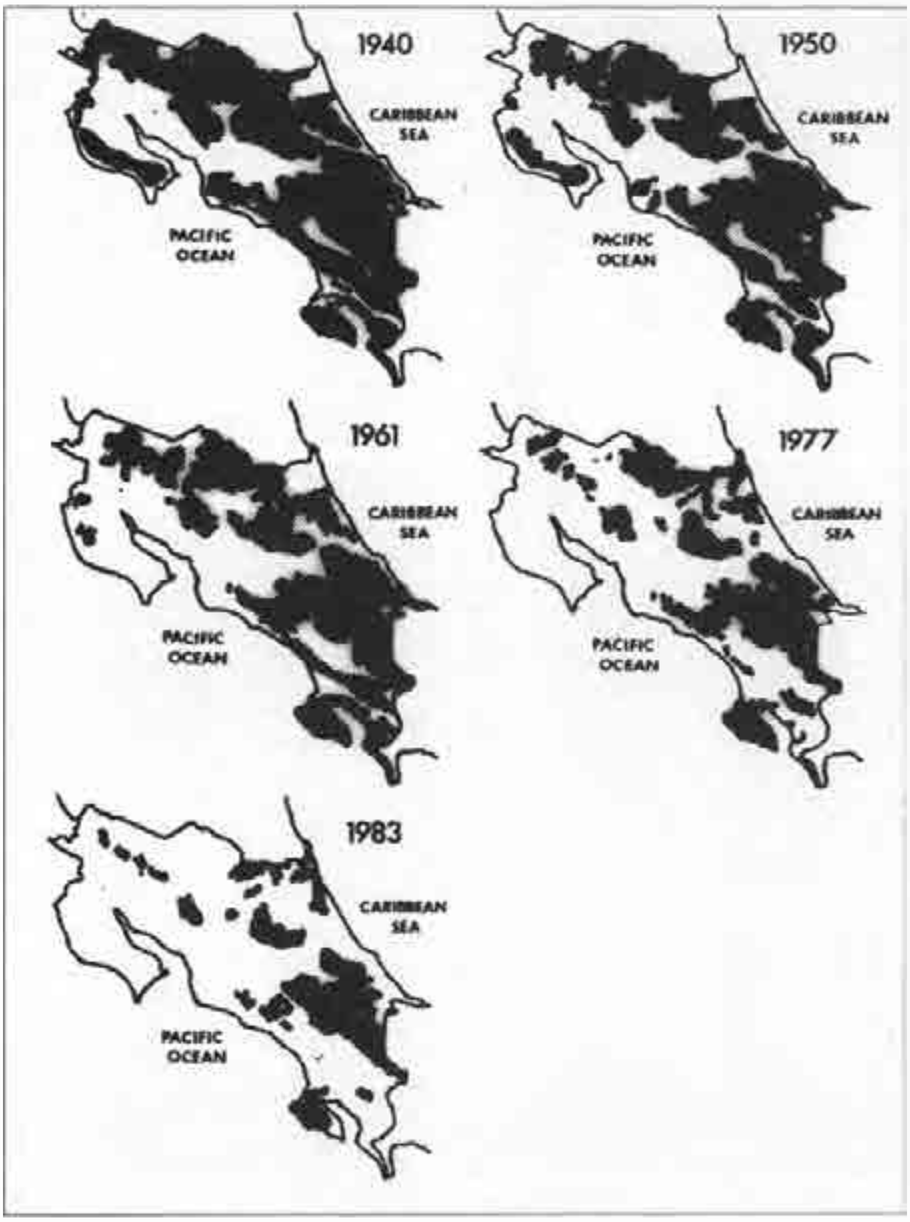

Fig. 1: Development of deforestation in Costa Rica, 1940–1983.

difficult to justify to the public to put apart a huge part of the country just for nature conservation without any obvious and direct benefits for the people. It was during this time when the idea was born to develop innovative, intelligent and sustainable uses of the natural resources of the country, in particular of its biodiversity.

The Instituto Nacional de Biodiversidad

Costa Rica is particularly rich in biodiversity. On an area of only the size of the state of Lower Saxony in Germany occur over 13.000 plant and 350,000 arthropod species. The continent of Europe in comparison offers about the same number of plant species. Consequently in 1989 the Instituto Nacional de Biodiversidad, INBio, was founded with the mission

- to conserve Costa Rica's biological wealth through facilitating its knowledge and potential non-destructive intellectual and economic uses.

INBio is applying a quite simple principle, which consists of three interrelated key elements: SAVE, KNOW and USE. Products are developed from biodiversity through fundamental and applied research and part of the benefits from their sales or uses are reinvested to biodiversity conservation. Disregarding the element KNOW leads to ignorance. SAVE and KNOW without USE is the situation of the ivory tower of fundamental science. KNOW and USE without SAVE leads to exploitation and extinction. Today's Costa Rican strategy for sustainable development is based on this principle with the intention to put all elements into balance (Nader and Rojas, 1996b).

A key element of the institute's strategy is the National Biodiversity Inventory, the KNOW. Elements of USE are the bioprospecting approach and the information dissemination program "Gestión Social". The program on development and conservation is the major component of SAVE and collaborates with the national system of conservation areas (Sistema Nacional de los Áreas de Conservación, SINAC) and the communities in the neighbourhood of these areas to improve the infrastructure in these regions for tourism and develop sustainable uses for biodiversity.

Although this approach is integrative and considers the governmental level as well as the local communities and fundamental research as well awareness building among school children, politicians, tourists and rural population, INBio became most famous for its bioprospecting activities. INBio pioneered research collaborations with high-tech industries as a contribution to biodiversity conservation and it was this pioneering achievement which attracted immediate international attention rather than the other contributions of at least equal importance.

The INBio-Merck Agreement

The value of biodiversity for evolution, human culture, functioning of ecosystems, as a tourist attraction and for recreation remains without any doubt. But it seems that values for the development of new pharmaceuticals are more spectacular and exotic. Thus it is only legitimate to use this attraction for conservation.

INBio's pioneering achievement was a research agreement with the pharmaceutical giant Merck, Sharp & Dohme. Merck & Co. has a long tradition in the development of pharmaceuticals from natural resources and most prominent examples are

- Renitec (enalapril) to reduce blood pressure with annual sales of $ 2,310 million. The structure of this chemically synthesized drug was derived from a peptide, which occurs naturally in the venom of the Brazilian fer-de-lance *Bothrops jararaca*.

■ Mevacor (lovastin) to lower blood cholesterol with annual sales of $ 1,250 million, which is a lacton produced naturally by the soil fungus *Aspergillus terrestris*.

■ Zocor (simvastin), a chemical derivative of lovastin with annual sales of $ 1,960 million (all data on sales volumes from Pharma Pipelines, 1996).

The most spectacular achievement of the INBio-Merck contract from 1991 was a benefit sharing agreement with royalties on sales from future products to be paid by Merck to INBio to support biodiversity conservation and investigation. Table 4 summarizes the most important terms and conditions of the contract, which has been extended two times so far.

But the collaboration with Merck also reveals that drug discovery is highly risky and time consuming (see the article "Biodiversity – Source of Inspiration and Innovation" of the same author in this issue). Although the collaboration lasts over 7 years by now, no product from Costa Rica has as yet entered the drug market. Two natural compounds with important activities had been reported from the collaboration, Apicidin and Lonchocarpol A. Apicidin is a secondary metabolite of a micro-fungus of the genus *Fusarium* (Darkin-Rattraym et al., 1996), Fig. 2. It is a cyclic tetrapeptide and inhibits the histone deacetylase of Apicomplexan parasites like *Plasmodium falciparum* (malaria), *Cryptosporidium parvum* (cryptosporidiosis) and *Toxoplasma gondii* (toxoplasmosis). All these diseases cause serious health problems, particularly in the tropics. Cryptosporidiosis, for example, is spread rapidly through drinking water and outbreaks had been reported in urban slums. Apicidin also kills the parasite *Eimeria tenella*, which is responsible for coccidiosis in poultry and many other domesticated animals. Whether Apicidin or one of its chemical derivatives will ever make it to the market, will depend on the results of the toxicology, then preclinical and finally clinical studies.

Another product from the collaboration is Lonchocarpol A, a flavone originally isolated from the last larval stage of the moth *Melipotis perpendicularis*, collected by INBio (Salvatore et al., 1998). Further studies revealed that only animals feeding on the leaves of the legume *Lonchocarpus minimiflorus* contained the compound. The plant provides the natural compound, which is enriched within the animal and possibly protects against infections and parasites. Lonchocarpol A was at the time of its discovery at Merck already known in literature and had been isolated from other plants species like *Erythrina, Citrus, Lupinus* and *Sophora*. Notwithstanding a new biological activity was described at Merck for the compound as an antibiotic against methicillin-restitant *Staphylococcus aureus* and vancomycin-resistant *Enterococcus faecium*. It is highly improbable though that Lonchocarpol A will ever make it to the market because its antibiotic activity is antagonized by blood plasma.

Biodiversity for the Bioindustries

Since 1991 INBio has developed 9 other agreements with industry (Nader and Mateo, 1998, Table 5). The majority of them are in the field of drug discovery. But biodiversity offers many other opportunities including the development of new fragrances, pesticides and biocatalysts. In a collaboration with the biotech-company Diversa Corp. INBio pioneered gene prospecting (Nader and Rojas, 1996a). In this approach DNA from microorganisms is isolated directly from environmental samples and genes are cloned, which code for industrial enzymes and pathways for secondary metabolites. Gene technology opens a broad field of new opportunities in bioprospecting and in consequence the biological and genetic resources of the tropics will gain increasing importance.

Each new collaboration with industry increases the chances for Costa Rica to get a product developed from biodiversity and royalties for conservation. Thus it makes sense to develop bioprospecting as broad as possible (Tamayo et al., 1997). But more important than the future income in dollars is capacity and awareness building within the country. In this sense INBio is already offering new opportunities to Costa Rican scientists to practice their skills. From each industrial partner training and technology transfer is requested. Increasing experience and scientific and technological capacity makes the institute more attractive for new and more demanding collaborations. But not only the scientists at INBio, also the population

Table 4: General terms and conditions of the INBio-Merck agreement.

- Two years, non-exclusive, renewable: 1. November 1991, 2. July 1994, 3. August 1996
- Limited number of selected samples
- Research Budget for:
    - Ð contribution to maintenance of conservation areas
    - Ð INBio's collecting & extraction processes
    - Ð Equipment & lab supply
    - Ð Training of Costa Rican scientists
- Percentage of future revenues (royalties) to be shared in a 1:1 ratio with the Ministry for the Environment

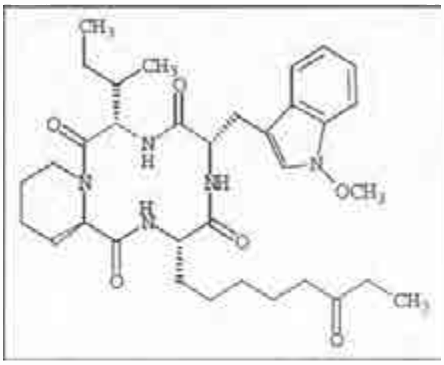

Fig. 2: The cyclic tetrapeptide Apicidin from a microfungus of the genus Fusarium from Costa Rica (Darkin-Rattray et al., 1996).

becomes aware of the treasures in their forests and consequently mental barriers will be build up against forest destruction.

Biodiversity can support the socio-economic development of a country at various levels. Its aesthetics attract tourism. Fruits, medicinal plants, essential oils and timber are products from the tropical forest with a direct market value. And there is the indirect value as a source of inspirations for the inventors and developers in industry (see the article "Biodiversity - Source of Inspiration and Innovation" of the same author in this issue). Both direct and indirect values from biodiversity should be developed for non-destructive uses. The necessary know-how has to be established within the source country and benefits have to return to its population.

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Table 5: INBio collaborations with international industry.

1. Merck & Co.: Drug discovery
2. Bristol-Myers Squibb: Drug discovery (ICBG project)
3. Strathclyde University: Drug discovery
4. AnalytiCon AG: Drug discovery
5. Phytera, Inc: Drug discovery
6. INDENA S.p.A.: Phytopharmaceuticals
7. Givaudan-Roure: Fragrances
8. British Technology Group, ECOS: Bio-nematicide DMDP
9. Intergraph Corp.: Software
10. Diversa Corp.: Recombinant Enzymes

Sustainable Aquaculture-Systems in the Rainforest – Fish Culture in the Surroundings of Manaus

Ulrich Werder

1. Introduction

Deforestation has become a more and more convenient and apt means to create new farming areas worldwide. In Brazil for example, large-scale human migration into the Amazon forest was already initiated in 1974 by INCRA (Instituto Nacional de Colonização e Reforma Agrária), leading to a constantly rising demand for food and farmland (Smith 1976). Small-scale farmers on subsidiary level, but especially large and medium-scale landholders who generally practice extensive beef cattle ranching mostly for export, often do not see any solution other than burning down the forest completely.

During the past 3 decades (until 1991), an estimated 40 million hectares (= 400 000 km²) of forest land have been clear-cut in the Amazon alone for a number of purposes, more than 50% of these areas being used for pasture-based cattle production (Serrão and Nepstad 1995). From 1961 through to 1986, 30% of the beef needed to make hamburgers in the USA came from Central America. Between 1960 and 1980, 6.000 square kilometers were transformed into pastures in Costa Rica, and 14.000 square kilometers in Honduras (Santos and Salati, 1995). These few examples show how global markets affect the environment of tropical forests.

Keeping in mind the extremely low productivity of cattle farming on pasture-transferred forests (Mattos and Uhl 1994), along with the destructive effects, the irretrievable losses of ecological structures and biodiversity including all socioecological implications, the question arises, whether the traditional western approach for food production is valid and applicable worldwide, or if different and modified systems of animal and protein production might be more useful in the tropics.

2. A new approach

Many of the negative impacts of deforestation are due to a narrow sighted western view of possible forest utilization. Traditionally, forests have been considered impenetrable, perilous and dangerous. Therefore cutting down forests for the sake of cattle production and timber has always been considered a honorable task. However, recent experiences with tropical agricultural development projects, especially those including western technology transfer into other socio-ecological systems, clearly show the need for new approaches to resolve problems *in situ*.

New approaches demand new ways of thinking and/or surveys and evaluation of yet little known interrelations in relatively unexploited resource-systems. Rather than modifying the physical and natural environment of unknown ecosystems to satisfy the requirements of our western food producing technology, we must definitely look for new ways to modify and adapt our technology to meet the demands of the actual conditions in the tropics.

Instead of striving for immediate peak production rates, a conceptual framework for a rational utilization of resources aiming at a maximum long term benefit should be developed. This can only be achieved by fully utilizing the tremendous range of resources that are unique to areas like the Amazon, for example, or any other region. In order to achieve this goal the specific and outstanding resources of the respective region must first be recognized and appreciated as such. Among some others, the major physical resources of the Amazon are: forest and fresh water, the major biological resources being: genetic diversity and the adaptations of native species to local conditions.

3. Some aspects on forest- and fish-ecology

Tropical rainforest eco-systems differ substantially from all other forest ecosystems on our planet. Some of them are seasonally inundated, forming temporary habitats for aquatic organisms amidst trees and bushes every year. In Central Amazonia, water level may fluctuate up to 12 m and more annually, and trees may be 6-8m under water. Huge areas, normally inhabited by terrestrial animals during low water season turn into lakes of amazing productivity and uncommon, not yet recognized or fully understood types of food chains during high water.

At the beginning of high water season all kinds of fish invade the inundated forests to forage on detritus, insects, other fish and vertebrate as well as on plants and astonishingly to many scientists (while this is common knowledge among local fishermen) also on plant seeds, such as of the rubber tree or the brazil nut. Some species undertake long distance migrations of up to many hundred kilometers (Godoy 1967). Locally highly appreciated market fish, such as Curimatã (Prochilodus), Matrinchã (Brycon) and Jaraquí (Semaprochilodus) aggregate into smaller or larger shoals of thousands or hundreds of thousands of individuals before migrating into the flooded areas where they utilize the vast offers and possibilities of space, shelter and food.

Traditional fisheries exploit such fish populations, but due to human migration into the rainforest and the increasing need for land and nutrition, the local demand for fish has constantly increased during the past 2-3 decades, and so has the fishing effort. Intentions to implement sustainable management systems for natural fish populations have been few and of little success, since basic knowledge about age and growth of fish was quite limited until recently (Werder 1997, 1998). Instead, intensified and uncontrolled fishing has lead to a non-measurable over-exploitation of stocks. This is illustrated by large amounts of undersized juvenile fish on the markets.

However, fish has always been the primary and most valuable animal protein source for human consumption in the amazon area, and are therefore better suited for local markets than any other imported products. So, wherever cash crop for export purposes is not needed, fish should be considered as an alternative option to cattle production.

4. Fish ponds in the forest

At the same time as people began to occupy the "Inferno verde" (green hell), the question arose if local fish from the Amazon might be suited to substitute imported cattle and play a similar role in fish culture as for example trout, carp and tilapia in other parts of the world.

Beginning in the late 1970s, a number of case studies were conducted at the National Institute for Amazon Research – INPA (Instituto Nacional de Pesquisas da Amazônia), Manaus, Brazil. The first approach was to gather knowledge on ecological specialization of these fish, on their acceptance among local people and their role on local markets. One vital assumption was their capability of being kept in ponds and their feeding ability on artificial or locally produced diets. Another important assumption was that it would be possible to construct ponds in the forest or on already degraded and almost useless farmland, without needing to cut down large areas of forest for their construction.

4.1 Ponds

A variety of pond-types were tested and implemented successfully in the area around Manaus. This includes groundwater-ponds, standard fish-ponds and small river-dams. Such pond systems are easily combined with small scale farming systems, normally without having to deforest areas much larger than the ponds themselves.

4.2 Fishfood

A major project objective was to take advantage of the fishes specialization for utilizing plant products in inundated forests and thus make use of natural forest products from the area.

The experiments show that selected regional fish species can easily be fed on locally produced pellets (Werder and Saint-Paul 1979) instead of using expensive imported diets, which to a large degree consist of fish proteins derived from other endangered marine species. Low quality agricultural waste products as well as by-products and residues from other fields of production are easily integrated and/or combined with locally available fruits and seeds (Werder and Anibal 1982). Even macrophytes as the water hyacinth, elsewhere considered a plague, can substitute fish meal in diets after having functioned as biological filter, in-

Figure 1: Small groundwater pond in the forest (about 120 m^2).

Figure 2: Series of small river dams (each of about 100 to 200 m^2).

Figure 3: Reservoir of 1ha surface area in the forest.

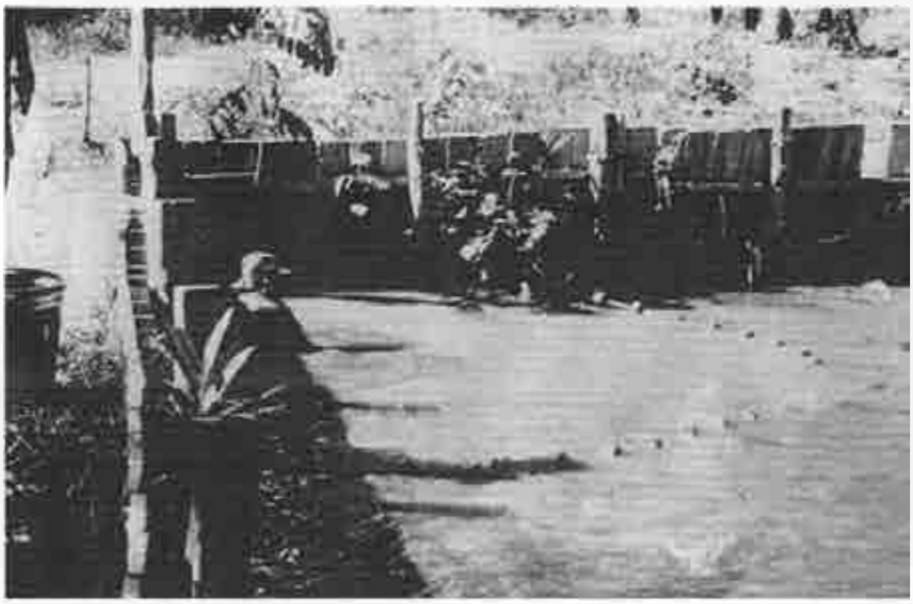

Figure 4: Seining fish from a groundwater pond.

Figure 5: First harvest from a small pond after a 10 months growth period (stocking density 1 ind/m²).

sect trap and shelter for juvenile fish in the ponds (Saint-Paul, Werder and Teixeira 1981a, 1998b).

It is therefore possible to not only avoid the misuse and waste of high quality human nutrition for fish food, but also to utilize otherwise degraded products, residues and surplus production combined with locally available products of the forest and turn them into first grade quality fish proteins for direct human consumption. Pond fish from the Amazon thus take over the roll of pigs as historically developed waste converters in other human societies.

5. Production

As compared to cattle production, fish farming does not only produce high quality proteins for human consumption, but it also is by far more efficient than cattle production. While the latter produce seldom more than an average of 50 to 250 kg/ha/year on deforested grasslands (Mattos and Uhl 1994), fish production can easily achieve annual rates of 2000 to 5. 000 kg/ha in ponds (Werder 1981).

In order to produce 1 ton of live weight per year, between 15 and 22 ha of deforested land are needed in extensive cattle production, but only about 2 to 0.2 ha of pond area for the same amount of fish. So the area demanded for fish production varies between 10% and 1% of the area needed for the same live weight of cattle.

At an average fish consumption rate of 155g/day/caput a pond area of 1 ha can support up to 6-8 families with fish throughout a year.

6. Summary and Outlook

Imported cattle undergo a very complex process of selection and adaptation to climate, diseases, parasites and low food-conversion. Generally spoken, ecological conditions in Amazonia are quite unfavorable for the plain survival of cattle. But the fact that evolution has not provided any larger grass-feeding mammals with facilities to successfully cope with living conditions in the rainforest is often being neglected. Production is not only low from the beginning, it even decreases with increasing time of land usage. Despite these well known ecological and associated socio-economic implications, cattle production still continues under specific socio-economic and political pressures (Salati 1995).

Regional fish species do not show any such deficits as described for cattle. They have undergone a natural selection process and are well adapted to local conditions. Moreover, they have developed survival strategies, which are unknown to their relatives in other regions of the world. As previously mentioned, some of them feed on seeds and fruits of forest trees.

One of the greatest advantages of local fish production is the acceptance of the product and the accessibility of both markets and/or products. Fresh fish is easily transported to nearby villages and thanks to the peoples mobility, production sites can be visited without excessive travel effort. Little space is demanded for pond construction, and wherever water is needed for either direct human consumption or for irrigation purposes, reservoirs can be utilized not only for water storage, but also to produce high quality fish-proteins in proper tanks.

Because of the short distances between small decentralized production units and consumption centers, little losses due to transport can be expected. Provided local processing facilities for salting and smoking were constructed, product quality can be further improved for the purpose of storing and long-distance transport.

Only a small percentage of land is needed for the same production as of cattle. Since large areas of forest have already been destroyed, fish culture and pond construction could make use of degraded land in order to play an additional role in recuperating such areas.

While in cattle ranching, biological diversity becomes reduced to a few species in flora and fauna, fish culture preserves and perhaps even adds to local biodiversity and it additionally utilizes its natural potential for food production in a sustainable way.

Besides all this, the water from fishponds has become enriched with nutrients and trace elements, which normally do not occur in such concentrations in natural waters. Applying these enriched waters directly as irrigation water certainly saves a lot of direct and indirect costs for artificial fertilizers needed for agriculture.

Fish culture in the forest appears to be an appropriate and integrated approach to sustainable utilization of forest resources in Amazonia. It should therefore be promoted and implemented wherever suitable, perhaps also in other parts of the world.

Table 1: Composition of some experimental diets. Imported ingredients of commercial diets are partially replaced by locally available substitutes (from Werder and Anibal 1982). Vitamins and vegetal oil may be added.

Diet No.	I (g)	II (g)	III (g)
Ingredient			
Fish or Meat	290	125	100
Wheat	50	50	100
Soybean	365	450	100
Corn	295	155	-
Rice	-	220	-
Rice bran	-	-	200
Buriti (Palm)	-	-	100
Draff	-	-	150
Brazil Nut	-	-	100
Water Hyacinth	-	-	150
Total	**1 000**	**1 000**	**1 000**

Table 2: Production Parameters for cattle (from Serrao and Nepstad 1995) and fish in Amazonia.

	Cattle first cycle	fish in ponds	cattle second cycle
average live weight gain (kg/ha/year)	45-64	500-5000	150-250
area needed for the production of 1t live weight (per ha and year)	22.2-15.4	2.0-0.2	6.7-4.0
area needed for 1t live weight production (%)	20=100%	10-1 40-4	5=100%

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Non Timber Forest Products of India

S. John Joseph

The last three decades have been a witness to a gradual increase in the importance of Minor Forest Products (MFP) or Non-Timber Forest Products (NTFP) resources. Sustainable production of these NTFP resources then becomes the need of the hour and is, therefore, a matter of great concern to all forest managers and all those involved in management of NTFPs. Quantitative resource accounting of minor forest products is required to be done in order to fulfill the market requirements and trade within the country and abroad. Accurate accounting of MFPs has been a difficult job owing to the system of disposal of non-timber forest products from the forest areas as they have been offered on lease either in the name of general MFPs or in the name of medicinal plants and revenue earnings thereby collected have also been recorded in a similar fashion.

These products play a crucial role in supporting community welfare as significant sources of edible product, fodder, fuel, fertilizer (mulch), fibers, medicines, gums and resins, oils and construction materials. Millions of people around the world living in the vicinity of forests subsist on these products. They help to provide opportunities for additional employment and income. Activities related to the collection and primary processing of NTFPs lend themselves suitable for equitable participation of women and indigenous people. While some of the NTFPs have entered national and international trade, they tend to have the comparative advantage in supporting development of rural and backward areas.

Efforts are now underway to make an assessment of production of commercially important MFP items in India which earn handsome revenue and foreign exchange like the beedi leaves, sal seeds, mahua flowers, myrobalans, gum karaya, sandalwood etc. Trade of these items has also been nationalized in a few states after Orissa state took the lead in nationalization of the trade in MFPs in 1962. The production figures of about 30 individual items is now available with the Orissa Forest Department Corporation. Other states have followed suit but adequate item wise production data of MFPs is not available for most of the states in India.

The trend in forestry so far has been to classify all forest products into two main groups - major and minor. The former group comprises of wood for timber, small wood and fuel wood resources. This group, believed to spell big money, has also been the chief recipient of concern and attention of all forest economists and managers in India. However, it is the latter group hitherto refered to as 'minor' that has been neglected for long both by virtue of its misleading name and a deliberate de-esteemed value. Today this MFP linked with livelihood/food security of millions of people below poverty line offers a potent alternative to derive economic benefits from forests in a sustainable manner.

The type of forests from which NTFP are gathered in Peninsular India and the NTFP scenario are given hereunder:

These MFPs or NTFPs are obtained from fruits, flowers, leaves, twigs, bark, roots of plants and other products from animal and mineral origin. They could be grouped into the following nine categories:

I. Edible plants
II. Medicinal plants and spices
III. Essential oils
IV. Oil seeds and fatty oils
V. Gums & Resins
VI. Tans/Dyes
VII. Fibers and flosses
VIII. Bamboos and Canes
IX. Miscellaneous items of plant origin such as beedi wrappers, cork, toys etc.; honey, lac, silk of animal origin and stones and mica of mineral origin.

Citing NTFP operations from 3 large states in India, we have Madhya Pradesh known for Beedi and large scale NTFP operations, Andhra Pradesh where 2 millions tribals are engaged in a cooperative network for procurement of NTFP and Maharashtra model of district Tree-Growers Cooperatives for Marketing of Tree Products.

Madhya Pradesh is situated in the centre of the country and is the largest state with a geographical area of 443,346 sq. km. This includes a forest area of 155,414 sq.km which constitutes 35 % of the total land area and about 22 % of the total forest area in the country. Due to a great multiplicity of topographical features, soil and climatic factors, diverse types of natural vegetation are available. The state is a union of extremes as quality and types of forests is concerned. Forest types ranging from dry thorny forests to tropical moist and even sub-tropical, semi-evergreen forests occur in the state. By composition, the three major forest types are Sal (16.5%), Teak (17.8%) and miscellaneous forests (65.5%).

A large number of minor forest products and medicinal plants are also found in the natural forests. These forest products have tremendous potential and make significant contributions in terms of income and employment in rural areas near forests. Some MFPs, like tendu *(Diospyros melanoxylon)* leaves, Sal *(Shorea robusta)* and Harra *(Terminalia chebula)* have been nationalized considering their significance in employment generation and economy of rural people as well as their economic role in industry. Other important non-wood forest products are Mahua *(Madhuca latifolia)*, Mahul *(Bauhinia vahlii)*, Achar *(Buchanania lanzan)*, medicinal plants, etc.

Tendu Leaves *(Diospyros melanoxylon)* – Known also as Beedi Leaves

Tendu leaves are obtained from small trees and wildly growing bushes of *Diospyros melanoxylon*. The leaves are used as wrapper of beedi (cheap cigarette). The state produces the largest quantity of tendu leaves and it is estimated that about 41 per cent of the total production in the country is from this state. Trees are deciduous, new leaves come out from middle of March to May. The plucking of leaves is done in May. The leaves are plucked and tied into bundles known as gaddies of 50 leaves in each. For 100 bundles the rate paid is Rs.35/-. The leaves are dried in the sun on both sides.

The production of tendu leaves increased from 2.5 million standard bags in 1973 to 4.1 million in 1993. The eighties witnessed a sharp fluctuation in tendu leaf production.

The Government of Madhya Pradesh in 1989 established a three-tier cooperative structure for collection, processing and disposal of tendu leaves. The agent system was done away with. Under the present system there are 1947 primary cooperatives, 44 district unions and at the apex there is M.P. State Minor Forest Produce Trades and Development Cooperation Federation. It is reported that the new system of collection and marketing has increased the income of collection (MFPD 1993). Survey has revealed that average number of bundles made per labour/family/per day is 100. Despite the fact that cooperation of tendu leaves has benefited the rural masses as well as generated revenues, it is yet to acquire the cooperative-structure and involvement of people in a meaningful way. There is a need to link MFP cooperative societies with the Joint Forest Management System which will ensure benefits to all and lead to institutional development.

Sal *(Shorea robusta)* – Seed

The sal tree is widely distributed in central, eastern and southern parts of the state. Sal seeds yield the sal butter. The seeds are husked and boiled and the oil is skimmed off. The oil soon solidifies to a white butter.

In 1992, about 300 tons of sal oil were exported to Japan for cocoa butter extender at a FOB price of US$1,150/ton. The deoiled sal seed is used for cattle feed and its market price is US$60/ton and about 48,000 tons which is about 70% of the total production was exported. The present rate paid to collectors is Rs.1.35/per kg. There are more than 1,300 collection centres in the state.

Sal seeds are collected from the time ripe fruits start falling in May and continues till the onset of rains. The sal seed trade is nationalized, the Government has appointed MFP Federation as the sole agent for purchase and sale of seeds. In addition to the committed supply of sal seeds to industries at concessional rates, the federation also sells it through tenders.

The sal seed production shows regular fluctuations at periodic intervals. These fluctuations signify every alternate year as a bad seed year. Sal seed production has shown increasing trend only up to 1982-83. On the whole it increased at the compound growth rate of 4.90 % per annum. If the series is broken into seventies and eighties, then the sal seed production increased at the rate of 10.13 % during the eighties. Sal seed production varies from year to year, the highest collection was in 1977-78. The co-efficient of variance for the last two decades was 85.5 % for the seventies thereafter stabilized at 39.33 % depicting that the eighties as compared to seventies were relatively stable. Least square trend has been used to show the direction of change. The co-efficient of the trend is positive which shows significant growth in sal seed production during the period.

Employment generated has been estimated with sal seed production in 1992, which was 546 thousand quintals. On the basis of primary survey it was found that a labour can approximately collect 15 kg per day; employment generated is 36.4 lakh person days. The employment through collection activity alleviates the

Tab. 1: General contributions of forest foods to human nutrition.

Type of Forest Food	Nutrient
Fruits and berries	Carbohydrates (fructose and soluble sugars), vitamins (especially C), minerals (calcium, magnesium, potassium); some provide protein, fat or starch
Nuts	Oils and carbohydrates
Young leaves, herbaceous plants	Vitamins (beta-carotene, C), calcium, iron
Gums and saps	Proteins and minerals
Invertebrates (insects, snails)	Protein, fat, vitamins
Vertebrates (fish, birds, mammals)	Protein

problem of seasonal unemployment and increases the income level of rural households.

Harra *(Terminalia chebula)* – Gall Nut

Fruits of the tree of *Terminalia chebula* commercially known as chebulic myrobalan is one important tanning material. The two other commercially know myrobalans are *Terminalia bellerica* and Emblica officinalis. However, neither of the two species compares favorably with the first one.

Madhya Pradesh accounts for 75 per cent of the total production in the country. Myrobalans are one of the most important tanning materials of the pyrogellol class. These tans produce a brownish colored deposit on leather called bloom, as opposed to the catechol class of tans which do not produce this bloom. Myrobalan tan is not very astringent and penetrates the hide very slowly.

Production of myrobalans in the state has shown a lot of fluctuations during the past two decades. The production has generally ranged from 21 to 200 thousand quintals. During the past 7-8 years, it has stabilized to 120 thousand quintals. According to a survey (Khare, 1992) average income earned for Harra collector per collection house hold is Rs.255/- in the season.

Medicinal Plants

Innumerable varieties of medicinal plants and herbs are found in different forest types, they are found growing in the under-storey and as ground flora (Tab. 2). In the past due to biotic pressures and over-utilization many plant species of medicinal importance have diminished.

Forest degradation and deforestation is closely linked to poverty and unemployment in rural areas. The rural population living near forests depend upon them for daily requirements of fuel, fodder, flowers, fruits, seeds, roots, rhizomes, leaves etc. One or the other species are being utilized as food, spice, medicine, fibre, building material. Due to these pressures, areas formerly rich in forests and medicinal plants have become barren. The list of threatened species is increasing. There is a need to preserve and multiply these plants and to create special areas as gene pools. Many medicinal plants can be cultivated to meet commercial requirements.

Although medicinal plants have tremendous economic and medicinal value, very little information is available regarding their marketing system. The entire trade is in the informal sector. Market surveys are being conducted to find the marketing channels, price spread, prospective markets, consumption within the country and export.

The linkage between collectors and actual consumers is long, changes need to be made to share profit margins more equitably in the market channel. A detailed study of medicinal plants collected by rural population for which ready markets exist in major trading centres is necessary for stabilizing the trade and ensuring proper margins to the collectors.

Mahul *(Bauhinia vahlii)* – Leaves

Bauhinia vahlii is a gigantic climber and one of the most abundant of Indian climbing *Bauhinia sp.* Its leaves are extensively used as leaf cups, plates and it is also used in pan shops as a wrapper. It occurs in almost all forest types in the state, but most of the collection is reported in sal forests. The total collection of mahul is about 1,00,000 quintals annually. Almost all the produce is sent to South India. The collection generates substantial employment in rural areas near forests ranging from 2 to 3 months in most areas and 6 to 7 months in areas with rich sal forests.

A study on price spread in marketing of *Bauhinia vahlii* leaves (Bhatnagar, 1989) reveals that collector's share in consumers rupee is 33.33 % whereas the marketing margin is 46.67 % which is high. In 1986, the state government stopped the system of royalty on all non-nationalized non wood forest products.

Andhra Pradesh Example of Girijan Cooperative Corporation Ltd. for Tribals:

The Girijan Cooperative Corporation Limited, Visakhapatnam (GCC) is one such organization that has been successfully promoting multipurpose tree species for non-wood forest produce in tribal areas of Andhra Pradesh. GCC was established in 1956 as an undertaking of the State Government of Andhra Pradesh with the objective of socio-economic upliftment of tribals. The Corporation is serving 2.0 million tribals through its network of 800 Daily Requirement Depots (DRD), 33 branches, eight divisional and two regional offices with about 2300 employees. It is actively engaged in procurement of Non-Wood Forest Produce (NWFP) and Agricultural Produce (AP) from tribals; marketing the produce; supply of essential commodities; and provision of credit for Seasonal Agricultural Operations (SAO) and consumption purposes.

To strengthen GCC for stopping the exploitation of tribals, the Government has awarded monopoly rights to the Corporation over the purchase of 35 items of NWFP in the operational areas of the Corporation. The Government has also decided to meet the staff costs of the Corporation which enables payment of higher procurement price to the tribals. In the year 1990-91, the Corporation achieved a NWFP and AP procurement turnover of Rs. 165 million.

Technical Assistance:
Tribals are provided training in identification, determination of nature and availability of non-wood forest products, quality and grading of the product, storage and marketing. This enables them to bring out a quality product while conserving the tree species providing NTFP. The produce is brought by the tribals to the nearest DRD where it is procured by the GCC staff.

Processing and Value Addition:
In order to obtain better prices for the produce, GCC is planning to add value to the raw products through processing and discovering new end-uses. A non-edible oil unit at Vizianagaram is producing 'Kutir' soaps with neem base. A modern unit for tree seed oil extraction, soap-base and soap manufacture is coming up in Nirmal, Adilabad District. A shikakai and soapnut processing and packaging unit in Rajahmundry District produces herbal shikakai and soapnut powder. A modern honey processing and packing facility is being set up in Rajahmundry.

Future Strategy:
GCC has initiated various programs to expand the scope and area of operation to provide more effective service to the tribals. It is planning to raise the income level of the landless tribal NWFP gatherer by encouraging procurement of a number of products. For this purpose, it has

Tab. 2: Occurrence of Medicinal Plants in Different Forest Types. Source: Prasad and Bhatnagar, 1991

		Forest Type	
Species	**Sal**	**Teak**	**Mixed and Miscellaneous**
1. *Abrus precatorius*	*	*	*
2. *Andrographis paniculata*	*	*	*
3. *Anacylus pyrethrium*	*		
4. *Allium laptaphyllum*	*		
5. *Acorus calamus*	*		
6. *Adhatoda vasika*		*	*
7. *Asparaus racemosus*		*	*
8. *Achyranthus aspera*		*	*
9. *Aeole marmelos*			*
10. *Allium cepa*			*
11. *Allium sativa*			*
12. *Aloe barbandensis*			*
13. *Cassia fistula*	*	*	*
14. *Circuma amada*	*		*
15. *Curcuma londa*	*	*	*
16. *Cannabis sativa*			
17. *Curcuma angustifolia*	*	*	*
18. *Costus speciosus*		*	*
19. *Celastris paniculata*	*	*	*
20. *Curcuma caesia*	*	*	*
21. *Calotropis gigantia*			
22. *Chlorophytum tuberosum*	*	*	*
23. *Curculigo orchiodes*		*	*
24. *Curcuma aromatica*			*
25. *Cyperus seariosus*			*
26. *Dioscorea bulbifera*	*		
27. *Dioscorea hispida*	*	*	*
28. *Emblica officinalis*	*	*	*
29. *Elepharispermum subsessile*		*	
30. *Gardenia gumifera*	*		
31. *Gloriosa superba*	*		
32. *Gardenia lucida*		*	
33. *Helicteris isora*	*	*	*
34. *Holarrhena antidysentrica*	*	*	
35. *Hemidesmus indicus*	*		*
36. *Mallotus phillippinesis*	*	*	
37. *Mentha arvensis*			*
38. *Nyctanthus arbortristis*	*	*	*
39. *Peraria tuberosa*	*		
40. *Piper longum*			*
41. *Plubago zeylanica*			*
42. *Psoralia carylifolia*			*
43. *Rauvolfia serpentina*	*		*
44. *Sida cordifolia*	*		*
45. *Swertia angustifolia*	*		*
46. *Strychnos nuxvomica*			*
47. *Terminalia belerica*		*	*
48. *Terminalia chebula*		*	*
49. *Terminalia cordifolia*		*	
50. *Urginea indica*	*		
51. *Vetiveria zizinoides*	*		*
52. *Withania somnifera*			*
53. *Ocimum bacillicum*			*

identified various medicinal herbs and non-traditional oilseeds which have potential for increasing the income of tribals, especially during the lean period.

On the marketing front, plans are afloat to set up or revitalize various processing industries including value addition. Some of the units which will be set up in the immediate future are Gum Karaya Processing Unit, Niger Seed Cleaning and Sterilization Facility, Cleaning Nut Processing Unit, and Turmeric Processing Facility. GCC proposes to widen its consumer base by undertaking processing of forest products to directly usable end products. The Corporation has also initiated steps to tap the export markets, either directly or through joint ventures with reputed cooperatives of importing countries.

Maharashtra Tree Growers' Co-operatives

By promoting producers cooperatives or associations, small-scale producers can be helped to gain access to information, greater negotiating strength and economies of scale to be competitive with larger enterprises. This calls for strong policy support and regulatory instruments to correct market imbalances and distortions.

The Agroforestry Federation of Maharashtra, headquartered in Nasik, consists of 25 district-level tree-growers' cooperatives. It provides marketing and technical support to its member cooperatives and individual farmers, mainly in the marketing of eucalyptus wood and seeds of *Jatropha curcas.*

The Nasik Tree Growers' Cooperative Society already gives its members a rate of return 30-40 per cent higher than what they could bet individually in the market. Other benefits that members gain through collective organization include:

- advice on demand and supply conditions at the district, region, and national levels
- lower transportation costs through combined loads
- technical advice on harvest timing and methods
- greater responsiveness to changes in regulations
- economies of scale for storage of produce at optimum locations
- collective bargaining and even cash advance during periods of storage.

All these products have numerous direct and secondary uses and generate several tangible and intangible benefits for people – the rural poor, forest dwellers and indigenous tribals. They become a major source of subsistence and income when consumed and marketed locally by these folk. However, when utilized/marketed locally by the rural poor/tribals, these NTFPs command a very low market value, hence provide very low earnings and are generally quantified and also evaluated as per the local trader's terms/discretion. This happens because of lack of information available with rural poor/tribals regarding actual value price commanded by end products in subsequent market levels or the international markets and the price differentiation for raw, semi-processed or processed NTFPs, guiding suitable marketing openings and measures for quantification.

Over a period of time, however, a number of NTFPs have been channeled into markets in a big way - domestic as also international mostly in unprocessed or semi-processed forms. This has led to a regular export-import trade of NTFPs between India and several other countries. The quantity exported and the revenue earnings from exports of NTFPs from India has been found to significantly increase for a number of commodities. On the other hand, imports of some NTFPs have shown a decline either due to significantly increased production within the country or availability of suitable substitutes for imported NTFPs. Whatever the case be, export-import trade of NTFPs does play a very significant role in developing the economy of the country through foreign exchange earnings.

Some of the countries to which India regularly exports its NTFP resources are Afghanistan, Australia, Austria, Bahrain, Belgium, Canada, Finland, France, German Federal Republic, Ghana, Hong-Kong, Japan, Israel, Italy, Kuwait, Kenya, Korea, Malaysia, Maldives, Mauritius, Nepal, Netherlands, New Zealand, Nigeria, Oman, Philippines, Portugal, Qatar, Seychelles, Singapore, Somalia, Sri Lanka, Sweden, Switzerland, Tanzania Rep., United Arab Emirates, U.K., USA, USSR, Zambia. On the other hand, a number of NTFPs are imported from Hong-Kong, Indonesia, Italy, Singapore, Zambia, France, German Federal Republic and many other countries.

Analysis and Discussion

Every country has an inherent wild land biodiversity wealth which enables it to reap many benefits, the major one being socio-economic and national development of the country by the utilization of the natural resources. However, land biodiversity is not eternal – and a country has to pay both direct management and other related costs. Non-availability of the natural resources or very low production warrants the need for imports to ensure sustainable supply. Faulty management concepts of resource utilization and policies can very easily upset export-import balance of resources within a country and thereby affect its national economy.

Of the innumerable natural resources in India, people are mostly ignorant about the potential of Minor Forest Products (MFPs)/Non-Timber Forest Products (NTFPs) which have also been the chief recipient of poor attention. Information on export-import of MFPs/NTFPs is only available along with innumerable items published in "Monthly Statistics of the Foreign Trade of India" Vol. I, (Exports) and Vol. II (Imports) by the Directorate of Commercial Intelligence & Statistics, Calcutta.

MFPs have never been at par with timber products of forests and even an economic analyses of their availability and their commercial importance has never been appropriately carried out so far. An attempt is made to put on record all export-import information on MFPs available in India from the above Monthly Journal. Values of export and import are inclusive of duties/taxes and levies charged on all the items. Criteria for the charged duties/taxes of levies is, however, not known.

Table 3 depicts the quantities (in tones) of the twelve groups of NTFPs exported and the value of revenue or foreign exchange earned (in lakhs or hundred thousands of rupees) during 1970-71, 1980-81 and 1990-91.

Table 4 represents the percentage contributions of various twelve MFP/NTFP groups to the total exports for the year 1990-91 so as to project an idea of the current value of revenue/foreign exchange earning from each group of MFP/NTFP.

The data furnished for various MFPs/NTFPs into broad groups gives rise to a specific problem for monitoring an individual NTFP item closely in its changing trends of availability, demand, supply and the price commanded. Taken as groups, specific items of NTFP which set trends, command high values or are traded in large quantities, fail to catch attention in the average stock-taking. Therefore, analysis of specific items should be made to arrive at definite conclusions for trade. Three possibilities emerge in the absence of any distinct trends:

I. There are a number of MFP commodities which show a export potential over a ten year period but nose-dive in the next year period.

a. Causes of increase/decrease in MFP production have never been the subject of study due to the prevalence of timber and the timber-oriented approach of the policy in general especially in the developing countries. If a country changes its decision of exporting raw materials to processed/semi-processed goods only, the foreign exchange earnings are bound to increase.

b. There may be simple dwindling of resources due to over-exploitation.

c. A number of items may not be exported due to replacements by synthetic substitutes.

d. There may be better – use options available at home.

e. Exports may come down if raw material quality does not conform to the prescribed standards.

II. There are a number of MFP items which record an increase in percentage quantities exported over both the periods (1990-91 over 1980-81 and 1980-81 over 1970-71) but the percentage value of revenue/foreign exchange earning/ remains static or has even decreased.

III. On the contrary, there are some MFP items whose percentage increase in quantities have remained the same over the two period phases but the value of revenue foreign exchange earnings commanded has increased tremendously. There may be an insatiable demand for the MFP resource but various factors such as increased awareness of the uses/potential use of the item now limit the export potential. But this, in turn, leads to an increase in the commanded value. An example of this is the unique anti-cancer extract taxol, from *Taxus baccata* (medicinal plant) and Sandalwood. Limited supplies are now being provided of this medicinal plant at increased prices due to the information now gained about its anticancer properties. This example, of course, is not reflected in the tables as the MFPs have been analysed as groups namely edible, medicinal etc. Similar examples and other situations may also be prevalent in other groups.

A simple increased rate of inflation may also be cited as a cause for the same.

Challenges ahead

Quantification of potential production and actual production of NTFPs locally used and marketed/traded within the states and outside the states along with the quantum of exports/imports by India is very essential for sustainability. Trade data furnished here is likely to be helpful in partly accounting at least the actual production of different items of MFPs which enjoy export trade. NTFP resource items used locally by the forest and village dwellers for their local use generally go unaccounted, hence, the Forest Departments should make an assessment of the potential availability and actual collection for each item appropriately. Owing to the lack of such information, the production cannot be appropriately regulated commensurate with their requirements.

The basic challenges and the future plans of work that lie ahead of developing and developed countries differ in their basic approach/objectives. For a well defined, mutually and symbiotically beneficial and balanced relationship, developing countries need to build and develop their natural resources vastly while developed countries with their know-how on-hand technologies need to share them adequately and honestly and not aim always to tilt the balance of benefits in their own favour. Information on end-use and end-destination of all MFPs should be explored / shared honestly and is a 'must' for a thorough understanding for MFP export-import. Further, for a balance between working policies of developing and developed countries, international trade agreements like GATT (General Agreement on Tariffs & Trade) and TRIPS (Trade Related Intellectual Property Rights) vis-à-vis provisions of national economic policies need to be investigated thoroughly. These studies would be most needful in the construction and modification of trade regulations between countries, and maintaining the export – import trade balance by a critical analyses into the exports – imports of a country. Import analyses are equally important for identification of processes

Tab. 3: Quantity and value of NTFP groups exported.

	1970–71		1980-81		1990-91	
	Quantity in Tons	Value in Lakh. Rs.	Quantity in Tons	Value in Lakh. Rs.	Quantity in Tons	Value in Lakh. Rs.
Edible Products	80084.62	7848.95	586728.86	57457.00	202174.67	79351.51
Medicinal Products	15057.21	552.32	68673.10	5452.74	71485.21	18755.95
Spices	24566.35	3147.74	73294.30	13807.74	76980.02	25278.72
Essential Oils	816.77	361.33	1362.70	947.31	4362.41	5353.45
Oil Seeds & Fatty Oils	22565.48	667.78	7200.42	774.14	50738.88	8994.75
Gums/Resins	47056.29	1572.50	63519.13	6969.25	65615.97	12034.13
Tans/Dyes	6627.81	87.20	5442.94	237.06	8608.61	1288.53
Fibers/Flosses	9187.10	224.46	3618.11	236.45	4605.67	724.56
Bamboo/Canes	1249.81	7.37	28206.57	124.24	41.26	10.25
Misc.: Plant Origin	4647.24	201.57	13184.53	1167.01	6207.27	2680.03
Animal Origin	2981.93	58.00	59.39	67.17	156.74	39.82
Mineral Origin	19560.92	1245.91	725471.36	2799.51	498480.37	13344.22
Grand Total	**234401.53**	**15975.07**	**1576761.41**	**90039.62**	**989457.08**	**167855.92**

Tab. 4: Percentage contribution of different NTFP groups to the total exports (Value in Lakhs of Rs.) in the Year 1990-91.

NTFP Group	Percentage
Edible Products	47.2
Animal Origin	0.023
Essential Oils	3.1
Medicinal	11.1
Oil Seeds/Fatty Oils	5.35
Tans/Dyes	0.76
Spices	15.05
Fibers/Flosses	0.43
Gums/Resins	7.16
Bamboos/Canes	0.006
Mineral Origin	7.94
Miscellaneous	1.59

which help to increase the natural resources and also to identify import substitutes. It may also be possible then to identify and promote market support/intervention organizations like the SPICE BOARD and NDDB (National Dairy Development Board) which help to stabilize the general market.

The bottom line for a healthy MFP trade is a total transparency at all levels which would enable assimilation and analysis of all data for possible interventions, viz. market, institutional, financial and policies for improvement. This has to be further supported by an effective market/trade information system. Perhaps, India should take a cue from some of the South East Asian Countries like The Philippines which has developed community level market information systems. Further works and research, therefore, has to steer in this direction for improvement.

The Recommendations for NTFP Management

1. Well laid objectives and approaches for future management
2. Organized management for cultivation, harvesting and utilization
3. Quantitative resource accounting and assessment of production
4. Nationalization of trades – considering the exploitation of poor/tribals
5. Procuring and value addition strategies to benefit poor local/tribal people
6. Effective marketing/trade information system
7. Export and import balance consistent with national economy
8. Well defined symbiotically beneficial balanced relationship between developing and developed countries (To develop natural resources and share knowledge and technologies)
9. Viable working policies under GATT and TRIPs.

"Minor forest products now form the potential pillars of sustainable forestry which need more organized management in their cultivation, harvesting and utilization aspects in catering to the changing needs of the people in a dwindling environment".

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Management of Mangroves at Matang Peninsular Malaysia: A Case Study on Conservation, Rehabilitation and Development of Biodiversity

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Abstract

The Matang Mangroves, located on the west coast of Peninsular Malaysia, is a forested area of 40,151 hectares of 19 reserves stretching a distance of 52 kilometres. Reserved in 1902, the Matang Mangrove has been sustainably managed for wood production through 10-year working plans developed since 1950. Presently about 82% of the are is managed as production forests of primarily *Rhizophora,* and the remaining 18% of the area of mainly accreting *Avicennia* and dryland forests is protected and managed as functional forests for conservation of biodiversity, and for ecotourism, research and education.

Even before the Convention on Biological Diversity was developed, management efforts at Matang Mangrove subscribed to the concept of conservation and sustainable utilisation. Though the production forests are now plantations of predominantly *Rhizophora* species, the emphasis in the management plans on the maintenance of the mangrove system ensures that a fishing industry continues to flourish and a variety of wildlife species are conserved. This emphasis is translated through intensive reforestation that follows the clean-felling form of harvesting, and the protection of the non-production forests. Recently, facilities have been improved to integrated ecotourism into the management of the mangrove ecosystem at Matang.

Remote Sensing for Quantifying Structural Diversity in Forests for Forest Biodiversity Assessment

Klaus Halbritter

Abstract

It is assumed in this study that there is a certain relation between the three-dimensional structure of a forest stand and its biological diversity. If this is true, reliable and feasible methodologies should be found to describe, inventory, map and assess forest structure in its three dimensions in order to further contribute to quantifying forest biodiversity. Whether or not biodiversity of a forest is related to its ecological value is not discussed here. This question has been discussed vividly, and will most likely continue to be discussed intensively among scientists. Nevertheless, many people think that even if the ecological value of a forest is not a strict function of its diversity, and vice-versa, there may be some kind of relation for certain types of forests, depending on the degree and type of human impact. In Europe 'Impact' mainly means the type of its silvicultural treatment but could also be thought of to be any indirect effect of human activities on natural forests relicts. Mapping the ecological value of forests in Germany ("Waldbiotopkartierung") has been done by several federal states ("Bundesländer"), mainly by field investigation. Aerial photographs have a high potential to considerably facilitate field work in forestry at large and medium scales, and have been supporting the terrestrial data collections in many cases. Aerial photographs at suitable scales have been made available for the forest biotop mapping activities of at least some of the Länder. As for the terrestrial approach for data collection, the information content of the photographs cannot be extracted before and in course of the terrestrial mapping work at the entire potential of a modern high resolution CIR film exposed by a high precision 23 cm x 23 cm aerial survey

camera. Therefore, a methodology is under development to extract their information at higher intensity than is possible at present, in order to correlate the quantitative data with generally acknowledged indicators of diversity in the future. Statistical and advanced mathematical methods are being tested in the course of a research project, which will be completed soon at the 'Institut für Forstpolitik und Naturschutz' of the University of Göttingen, Germany. The European progress in finding suitable indicators of biodiversity and the ecological quality of forest stands is closely observed in order to find new parameters to be correlated with the findings of quantitative and qualitative evaluation of aerial photographs. The author is one of 26 members from 18 European countries of a concerted action of the EU Commission, DG VI (Agriculture) with the aim to identify and classify indicators for monitoring and evaluation of biodiversity of forests in Europe ('BEAR').

KEYWORDS
Forest Biodiversity, Indicators, Forest Structure Analysis, Forest Resources Inventory, Remote Sensing, Photogrammetry, Ecological Information Systems.

Introduction

This study represents an effort to further quantify forest biodiversity. It is assumed here that there is a certain relation between the structure of a forest, its spatial arrangement and "diversity" and the permanent – or at least frequent – presence of certain organisms within any of the strata of the forest "body". The "body of a forest" here is defined as the total volume of its immediate neighborhood, the space directly influenced by the total of trees which represent a forest stand. This "space influenced by a forest stand" is certainly not strictly defined by the terrain surface as its lower, and the canopy surface as its outer, margins – neither of these two surfaces are as strictly defined as some sort of membrane, e.g. a skin. Both border areas are characterized by intensive interaction between their neighbouring volumina, i.e. the pedon and the atmosphere, respectively.

The organisms considered under this aspect should be "typical" for a certain type of forest stand. Ideally, they should have a definite or assumed indicator value for the biotop quality of the whole forest stand being investigated on.

It seems to be an interesting question to study whether such interdependencies between the three-dimensional structures of a forest stand and certain species residing in it with rather diverse distribution, either permanently or frequently, exist – and if so: which are these, how do they function and how do these react to disturbances? Which species, plants or animals, behave in which way under certain canopy conditions, and when do the organisms occur where within, underneath, beside or above a certain type of forest stand which is characterized by a certain canopy structure and patterns of structures. In which way do they influence each other, and finally: which species indicates what when and where, and how obvious is its response to processes and disturbances that occur at certain places and at certain times in the forest? How can their response possibly be quantified, i.e. "measured"? Which are the patterns of their presence or absence at certain moments in time? Do they change periodically or irregularly or apparently not in any systematic way or even not at all?

An extremely interesting aspect is to study how do the "parties" involved, i.e.: the forest body, its environment and the organisms by which a forest stand and/or its environment is populated, react to certain influences, either anthropogenic or natural ones?

In order to study such phenomena, two types of knowledge at least are necessary to have: first, knowledge about the indicator quality of forest-typical species and the structures they evolve and second, feasible and approved methods for analyzing the structure of forest stands in their three dimensions, i.e. under a horizontal and a vertical aspect. To acquire the first is the task of zoologists and botanists, foresters and others who have competence in forest-typical species.

Regionalization of data

Data should to-date not be collected any longer without geographic reference at small and large scale. It is no longer sufficient to know that a certain species existed in a forest at a certain date. Studying the complexity of a forest ecosystem requires also to record where an individual of a species was found and what the place was like in terms of its biotic and abiotic composition and structure when it was found there. Information of such kind, mainly about the characteristics of individual's behavior in relation to their environment, should therefore be viewed and recorded under three-dimensional spatial aspects, even though they may be rather complex.

"Behavior" here does not refer to the option of a certain mobility of animals, to move from one location to another in accordance with environmental conditions and momentary needs of the individual itself, but "mobility" here refers also to the growing and germination behavior of plants which depend significantly on various conditions – which again are dynamic entities. Even micro-microclimatic conditions in the closest proximity of a single plant effects its growth pattern and speed and thus its architecture, size, volume, mass and shape: at places favorable to a certain species at a certain time it may multiply its number of individuals, and it may reduce its number or even completely retreat at those which are not.

Interdisciplinarity

Highly specialized groups of biologists have studied the known species. As species are numerous and often enough not easy to classify, fauna and flora are complex to study at depth with high intensity. Therefore, in order to handle the variety of species, a rather high degree of specialization is necessary to have in both main branches of biological sciences. Some zoologists specialize in large mammals, e.g. deer or roedeer, and others in invertebrates, e.g. snails and insects. Some botanists may be more familiar with lychenes and bryophytes, others with woody plants. In order to see the entirety rather than only some aspects of it, expert knowledge should be pooled.

While any expert knowledge is a prerequisite for any scientific study, generalistic, synoptic knowledge gets the more important the higher the degree of complexity of the system is in which a certain species or community of species is identified. Especially if their role is studied in the context of "forest biodiversity", highly specialized knowledge cannot reach very far without a synoptic viewing of the facts. Under ecosystematic aspects this applies both in terms of a broad knowledge on species and their development and behavior in relation to their environment as well as in terms of the scale at which biotopes are studied: either with a magnifying glass or at great distance, like from an airplane or even from spaceborne platforms. The EU concerted action 'Indicators for monitoring and evaluation of forest biodiversity in Europe' (BEAR) is facing this kind of problematic, bringing together scientists from various disciplines to work on the same issue.

Quantifying forest structure for biodiversity assessment by Remote Sensing

The structure of a forest stand can be quantified in various ways. Data can be collected either by terrestrial methods or by remote sensing. The method described here is based on remote sensing, more precisely, on aerial stereophotogrammetry.

The goal is to identify effectively by which methodology forest structures can be quantitatively described, inventoried, mapped, evaluated and monitored with reference to the total forest "body" in its three dimensions in order to further contribute to quantifying forest biodiversity. In a second step, analysis methods have to be identified which are suitable to extract maximum information from the collected data for a minimal set of indicators.

At present, mapping the ecological value of forests in Germany ("Waldbiotopkartierung") is done by several federal states ("Bundesländer"), mainly by field investigation. Aerial photographs have a high potential to considerably facilitate field work in forestry at large and medium scales. Although aerial photographs at suitable scales are available for the forest biotop mapping in progress, their information content is extracted in practice before and in course of the terrestrial mapping work not according to the full potential of a high resolution CIR film exposed in a high precision 23 cm x 23 cm aerial camera.

A methodology has been under development since 1995 to extract their information contained in more depth than is possible at present, and correlate the quantitative data with indicators of biodiversity. Unfortunately, no standards for generally acknowledged parameters exist at present yet. Statistical and advanced mathematical methods have been tested in the course of a research project, which will be completed soon at the Faculty of Forestry and Forest Ecology of the University of Göttingen, Germany. The European progress in finding suitable indicators of biodiversity and the ecological quality of forest stands is closely observed in order to find new parameters to be correlated with the findings of photogrammetric and interpretative evaluation of aerial photographs.

Inventoring forest structure for biodiversity assessment by Remote Sensing

The global attention to the ecological value of forests has increased in the past decade so that some states have reacted to the stakeholders' desire to have information about the ecological quality and value of "their" wooded land and therefore have started inventorying their forest land with increased respect to its biotop qualities (e.g. ARBEITSKREIS FORSTLICHE LANDESPFLEGE 1996). Especially in a period of limited public and private budgets, it seems to be highly desirable to have at hand objective methods for classifying forests according to this "new" value. The forest owner, a homo oeconomicus, wishes to know what the actual value of his forest is, in addition to the market value of the timber being produced there and the real estate value of the forest ground. Validating the actual value of woodland to a country's economy, apart from the income received by its owners, seems to have become one of the major challenges of forest research and management. One major factor for drawing nearer to this aim is to develop methodologies for the inventory and assessment of the ecological value of a given forest stand, making use of most sophisticated technologies (e.g. JEFFERS, 1996; KÖHL et al., 1996). Forests have increasingly been considered to be a complex system of biotopes, phytotopes and zootopes, with various ecological amplitudes and frequencies of species. Being consumers of organic matter, a myriad of individuals from numerous species depend on the organization and quality of woody and herbaceous plants within their habitats. To some stakeholders, the quality of a woodland is measured in terms of the existence of certain animal species, to some others, plants are the major factor. Considering all facts, plants represent the most evident, dominant and characteristic organisms of European woodlands. The spatial volume (including the atmosphere within, below its 'surface' which can be rough or smooth, depending on the structure of the stand) on one hectare of forest ground dominated by trees may be in the order of e.g., between some 50,000 m^3 in a young spruce stand and in the range of 150,000 to 300,000 m^3 in an old beech stand. These figures depend on how space is defined, in which silvicultural way the stand has been treated and whether diseases or natural disasters have affected its three-dimensional structure and density in the past.

Although mainly man-made, and often rather monotonous, the European forests represent a multitude of very different characteristics and hence, represent very different types of biotopes in terms of floristic and faunistic diversity. Plants, animals and abiotic features of a forest stand can be inventoried and classified by experts in various ways. Since structural diversity can be perceived even without profound botanical or taxonomic knowledge by any person walking through a forest, it seems desirable to find a methodology for classifying this diversity in a way which is generally agreed upon by scientists as well as by stakeholders. For this purpose, forest stands should be considered in terms of spatial geometry in a way which respects what forests really are: a heterogeneous mass of organic and inorganic matter, which cannot be satisfactorily described just by the distribution of tree heights, tree diameters at breast height (DBH), timber volume, total biomass and tree positions in relation to one another at a certain moment and observe the changes of these variables after certain periods of time.

Monitoring forest structure for biodiversity assessment by Remote Sensing

Remote sensing has substantial advantages over pure field work when synoptic viewing, observation of the forest canopy surface and structure - and especially the cost-benefit ratio of such an inventory are of interest. Moreover, in setting up long-term monitoring systems, it is important to document the situation at a certain moment. For about a century, remote sensing has provided various technologies for forest inventory and assessment. Remote sensing will never be able to entirely replace forest field work because there are a number of features which cannot be perceived or measured from above, either because they are shielded by branches or because of the limited geometric resolution of the sensor in relation to the dimensions of the objects of interest. Yet, it can provide quantitative information in the radiometric as well as in the spatial domains and the data can be stored for a long time for future reference. The documentary effect of remotely sensed data should not be underestimated in the design of a biodiversity monitoring scheme and of a forest ecological information system. Archived primary data will be welcome by future generations for refering to past conditions of the woodlands at their time, the management of which might be subject to more severe restrictions than nowadays. Although far from being overambitious by trying to provide a universal monitoring and validation scheme this project may contribute to a neutral classification of the biotope characteristics of woodlands in Europe by a strictly quantitative approach, paying special attention to the aspect of spatial geometry of tree stands in their three dimensions.

Material, Methods, Techniques, Area Description

Forest structures have been extensively analyzed based on data which have been collected more by fieldwork than by remote sensing (e.g. FUELDNER and VON GADOW, 1994; PRETZSCH, 1992; HOULLIER et al. 1991). The most popular approach for forest ecological studies based on remote sensing data is the analysis of spectral properties of forests imaged by various airborne or spaceborne sensors, either quantitatively or by visual interpretation (e.g. KOCH et al., 1994; ACKERMANN et al., 1994; GREAVES et al., 1993; KENNEWEG et al., 1986). For analyzing forest structures by remote sensing, spectral analysis alone usually does not lead to very good results due to great complexity of structures and textures of objects, and also their shadows. Therefore, some authors have already applied photogrammetric measurements of spatial properties within aerial photographs (MÜNCH, 1994; HENNINGER, 1983) rather than classification based more on their spectral properties.

The technical approach here is the creation of digital canopy surface models by photogrammetry. A study of such canopy modeling was already published in the seventies (HILDEBRANDT et al., 1976 and 1974), followed by a doctorate research (DJAWADI, 1977). In spite of the considerable technical progress, no similar approach had, to the author's knowledge, been reported until the mid-nineties (BELEIT, 1994). For performing more intensive experiments with further sophistication and with a larger data basis than the previous ones, it was felt necessary to model and analyze very different structural types of forest stands (HALBRITTER, 1995, 1996, 1997). The Institute of Forest Management of the University of Göttingen received a set of color-infrared (CIR) 23 cm x 23 cm aerial photographs at an average scale of 1:4,500, taken on 19.07.1992 with sufficient overlap for stereophotogrammetric measurements covering a forest reserve ("Naturwaldzelle Hellerberg") located in the German federal state of Nordrhein-Westfalen, forest district Obereimer-Neuhaus, Staatswald Naturschutzgebiet Breitenbruch, which is part of a mountainous area in Sauerland. The average terrain elevation is 320 m above sea level. Within one stereomodel, 6 significantly different structural types of forest and combinations of them were identified which have served as training sites for these investigations on the analysis of complex 3D forest surfaces. The test sites sizes are between 0.5 ha and 1.0 ha.

An orthogonal grid of 1 m x 1 m was generated and placed above each training site within the photo stereomodel created in the analytical photogrammetric plotter, KERN DSR 11-18. At each gridpoint, the vertically "floating" measuring mark was set, coming from above, to touch the crown surface. For broadleaved trees, e.g. mature beech *(Fagus sylvatica)*, there was little problem to define the crown surface at a given raster point, because in July the foliage is well developed, forming a closed crown surface. For coniferous trees, i.e. spruce and larch *(Picea abies* and *Larix decidua)*, the crown surface is not well defined as the branches protrude from the bole, star-shaped with only rather short secondary branches filling the space in between. To avoid subjective influence on deciding where the crown 'surface' of a coniferous tree actually is (a tree crown has no smooth 'skin' like an animal), the behaviour of the return-signal (echo) of an airborne laser scanner was imitated during the measurement. This means that the coincidence of the measuring mark with the crown surface was defined to be at the height at which the measuring mark exactly touched the first branch 'encountered' coming down vertically from above in the stereomodel. The planimetric Gauss-Krüger coordinate and the height above sealevel of each point was registered in a file which was later edited in the geographical information system (GIS), ARC/INFO. To compensate for the influence of the terrain morphology underneath the forest stand, a digital terrain model was measured from the 20 m contour lines of a map of 1:2500 scale, using ARC/INFO and a digitizing table. For estimating the terrain height at the planimetric coordinate of every canopy surface point, a regression plain was calculated using the statistical program WINSTAT. Then the interpolated terrain height at each gridpoint was subtracted from the corresponding canopy height. Terrain influence on the 3D stand model was eliminated or at least minimized by this procedure. The data with such 'normalized' canopy heights were stored in ASCII format, to be further processed with the matrix-oriented programming language IDL (by Research Systems Inc.) for visualisation and further mathematical analysis.

Results

The result was a "normalized" 3-D model of the forest canopy surface of each of the test stands. In the appendix, examples for graphical products from the collected data are displayed. The measuring mark of the photogrammetric instrument was utilized according to the behaviour of a laser beam emitted from approximately vertically above the site. Whereas the ground is usually obscured to the operator's eyes by rather dense black shadow in the stereo model of a CIR aerial photograph the laser beam penetrates the shadow and can therefore record the ground height in canopy gaps with the same accuracy as on top of a branch illuminated by sunlight. An operator who wants to measure the ground height within canopy gaps has considerable trouble to do so because he usually cannot identify it and has to estimate the height, introducing considerable height errors. Before going deeper into analysing 3D forest surface models it had to be verified if, for economic reasons, photogrammetric operator measurements could possibly be replaced by automatic procedures, i.e. by image autocorrelation. It seemed rather unlikely that algorithms perform well enough on the complex surfaces of forest canopies.

A pilot study with the commercial stereo-image autocorrelation algorithm MATCH-T (by INPHO, Stuttgart; pilot study reported in: INSTITUUT VOOR BOSBOUW EN NATUURBEHEER IBN-DLO and GRONTMIJ GEOGROEP GEODATA SERVICE, 1996), and considerations for the non-commercial program MEPAS (Institute for Photogrammetry and Engineering Surveys, University of Hannover. Dr. K. Jacobsen, personal communication, 1996) were better than expected but showed that the shadow effect within and between tree crowns has an even more serious effect than on an operator's eyes when such a matching algorithm has to eliminate the parallax within the stereoscopic image model. The reason is that within the shadow parts there is virtually no texture at all and therefore the program has not enough pictorial information in the vicinity of the coordinate where it shall match and, therefore, cannot eliminate the parallax between the two corresponding images. The resulting effects depend on the matching algorithm employed. At present, there are several competing stereo-image matching algorithms, both commercial and scientific. At least two major principles can be distinguished: one will register a height value at every predefined location, no matter if it is plausible or not, whereas the other will register a point height only if the parallax could be eliminated successfully. Consequently, the first type will leave no gaps within the area to be measured thus producing a complete orthogonal matrix of heights z(x,y). This may produce rather absurd height values in shadowy areas. Points with heights of 20 m or more above the maximum canopy height, as well as 20 m or more below the ground level were encountered (Halbritter, 1996). The second type will produce only reliable height values but will leave gaps within the area to be measured at those coordinates where there was not enough texture in at least one of the two images. The data file for producing a 3D stand canopy model will have missing values which impairs the quality and authenticity of the model. In both cases, editing has to be done by a photogrammtry operator.

The amount of time and costs saved by employing image matching algorithms depends on the complexity of a forest stand, mainly on the percentage of areas with low or no texture in at least one of the images. This means that stands with many shadowed areas will produce more faulty heights than stands with few and/or small shadow areas. Therefore, homogeneous, even-aged, monospecific, dense, old stands of broadleaved species (e.g. 160 years old beech with closed canopy) will require much less editing by an operator of the automatically collected heights than heterogeneous, uneven-aged, multispecies, recently thinned stands of coniferous species.

Time studies have shown that the pure measurement of a single canopy surface height takes between 0.7 and 3.0 seconds, depending mainly on the roughness of the canopy. The time required for model orientation, aerotriangulation etc. has not been taken into account in these figures as the time needed for such tasks, in relation to the actual digitizing time, depends very much on how many percent of a stereoscopic model area will actually be digitized. When continuously digitizing extensive and coherent areas within one model, the model orientation time is negligible compared to the actual measurement time. If only small areas in each model are to be measured, the proportion of model orientation time in the 3D modeling process rises.

Discussion and Conclusions

It must be emphasized that due to slowness of measurements and monotony of the work, purely analytical photogrammetric ocular measurement by an operator can be justified only for research projects on small areas, and not really for commercial purposes or for larger areas. For these, automatic data collecting methods are compulsory. At present, airborne laser scanner data are tested for their suitability to generate accurate digital canopy models. Laser scanning of forest canopies does not entirely make obsolete further investigation in more sophisticated image autocorrelation algorithms which will perform better on complex forest surfaces with much shadow within. Whereas for new data collecting missions airborne laser scanning will probably be preferable if the accuracy of the results compares to those of photogrammetric methods: whenever retrospective analysis of forest structure dynamics is desired one is obliged to work with archived aerial photographs. In archives throughout the world a wealth of aerial photographs of woodland is stored, comprising a wealth of forest structure information of the past. First experiments with airborne laser scanner data give rise to the assumption that such data may well serve for effective 3-D modeling of forest stands. From a forest ecologist's point of view, it is a problem that this technology was developed for efficiently digitizing the terrain surface for producing digital terrain models (DTM). Vegetation cover of the terrain is an obstacle to this. Therefore, during a commercial laser scanner mission, mainly the last echo ("last pulse") of each emitted laser beam is recorded. The reason for this is that, when there is a more or less dense vegetation layer above the ground, the last echo of an emitted laser beam will be reflected by an obstacle closer to the actual terrain than an earlier echo of the same beam. For 3D forest modeling, it is exactly the first pulse which is desirable to record, this desire being adverse to the interest of the main civilian user group of such a type of data, i.e. the geodetic agencies and terrain mapping companies. It should therefore be assessed which economic potential could be expected from people with interest in detailed quantitative information about the three-dimensional geometry of forest stands.

The main issue of this research is to develop mathematical procedures for characterizing different types of woodland so that the technology of 3-D modeling of forest stands might be incorporated into future woodland information systems for more effective inventory, classifying and monitoring of the diversity and possibly the 'ecological quality' of forests. The results of the mathematical procedures will be published after the completion of the project. The mathematical procedures developed for the analysis of data collected by aerial photogrammetry may be also applied to those collected by an airborne laser scanner. The analysis of such 3D forest stand models will be reported in another article.

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Appendix 1: Illustrations

Short Introduction

Various ways of representing the structure of a forest visually in three dimensional space are displayed here. The data utilized to generate the models consist in a volume model of the space between the terrain surface and the forest canopy surface. The surface of a forest stand is represented by an orthogonal grid with 1 m x 1 m mesh collected by remote sensing. A digital terrain model was subtracted from the canopy model in order to eliminate the influence of terrain morphology on canopy surface morphology. The heights of gridpoints of the surface model coinciding with gaps in the forest canopy are zero meters.

The forest stand used here consists of two tree species.

Coniferous (taller) trees: spruce *(Picea abies)*, Age 84

Deciduous (smaller) trees: Alder *(Alnus glutinosa)*, Age 61

A forest road cuts through the stand in a curve.

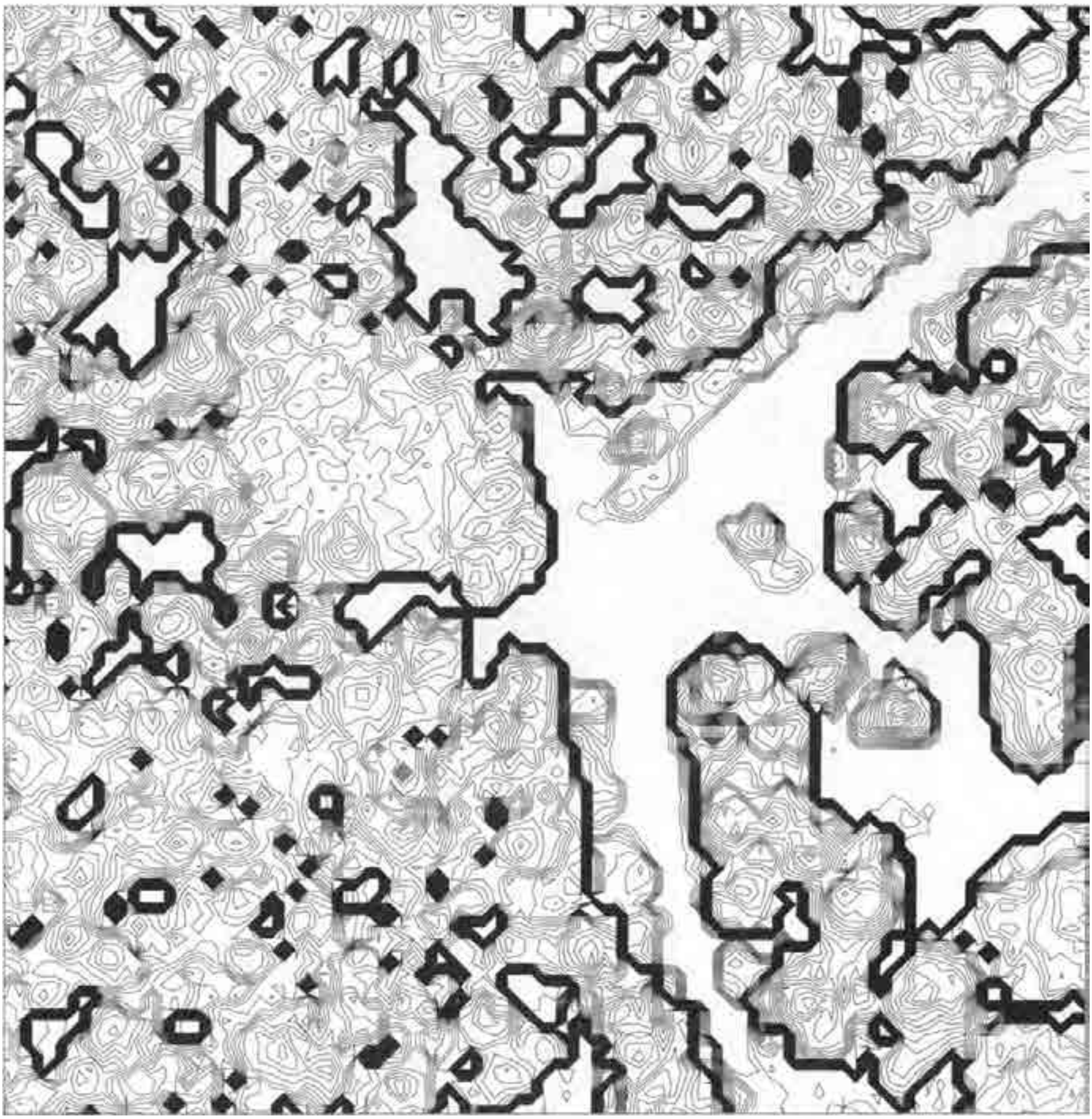

Figure 1: Contour line model – The stand surface is represented by contour lines with 1.0 m height intervals. This type of visual representation of a surface is well known from topographic maps where terrain relief is represented by contour lines.

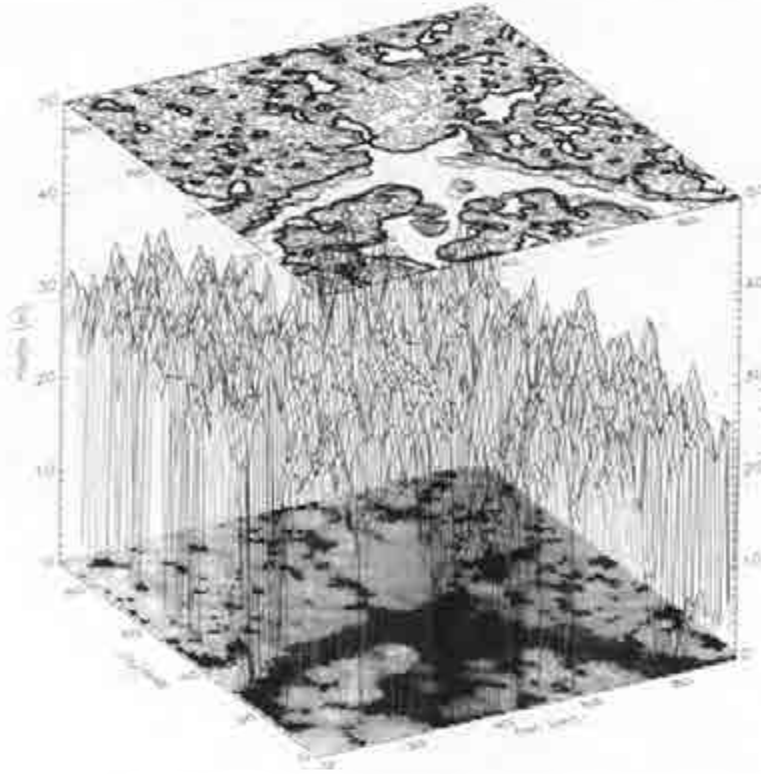

***Figure 2:** Triple Image – Top: Contour line model – Middle: Fishnet model – The nodepoints of the surface model are connected by triangulation – Bottom: Image – Canopy heights are displayed as greyvalues of pixels in an image (darker pixels: lower elevations; brighter pixels: higher elevations – black: height = 0 m).*

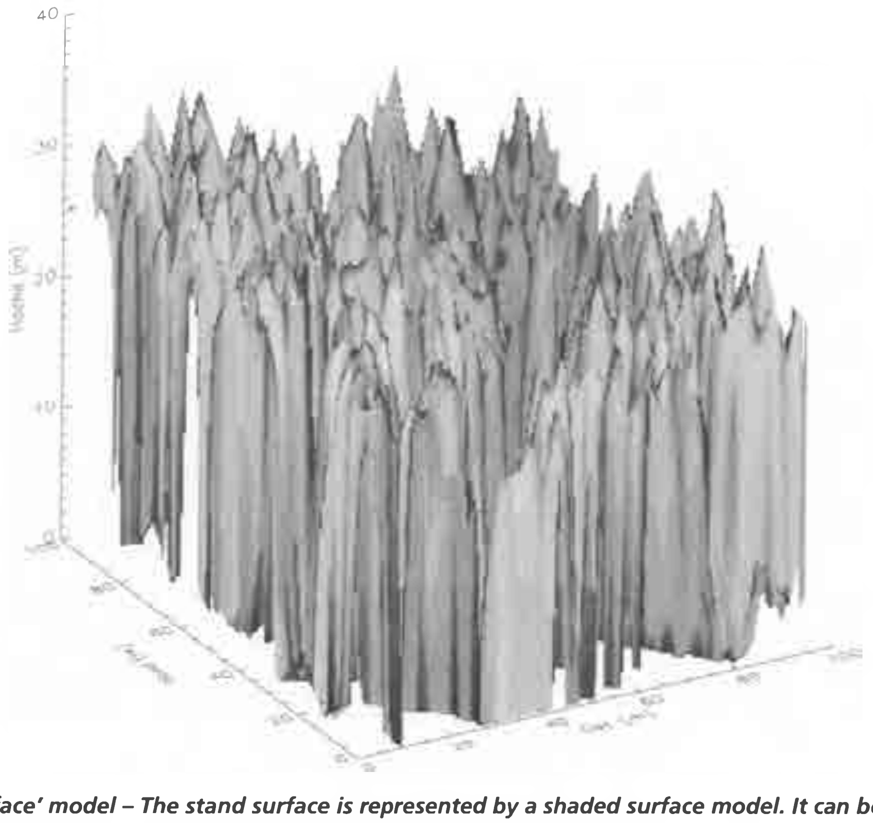

***Figure 3:** 3-D 'shaded surface' model – The stand surface is represented by a shaded surface model. It can be imagined to be an elastic skin draped over the trees from above and pulled down to the ground.*

Challenges of the Forest Genetic Resources in Romania

Valeriu Enescu and Lucia Ioniță

1. Natural framework

The territory of Romania is geographically situated on both sides of 45° parallel and is crossed by 25° meridian. Romania lies in the zone of Central Europe, at the limits of the transition zone to East Europe and South Europe. Romania's relief is characterised by a great complexity as well as by proportionality and harmony. The relief's proportionality is expressed by the following distribution of the natural unities:

- 30 percent mountains
- 37 percent hills and plateaus
- 33 percent plains.

The harmony results from the way the great reliefs are spatially located and which as a whole form an interesting natural amphitheatre, the center of which is Transilvan's Plateau.

The following relief units are to be found:

The Carpathian Mountains – all of them are located in Romania – with average elevations of 1100-1300 m in the Eastern Carpathians, 1500-1700 m in the Southern Carpathians and 800-1000 m in the Western Carpathians. Heights over 2500 m are found only in a few massifs (Făgăras, Parâng, Retezat, Bucegi). In the center of Carpathians there is a plateau called Transilvania.

The Carpathians are surrounded by the Subcarpathians and hills which form the transition between the mountains and outskirts regions: plateaus and plains.

Outside the Carpathians arch there are two large plateaus – Moldavia in the East and Getic in the South. Dobrogea is also regarded as plateau. Among the largest plains in Romania is the Tisa Plain in the West and the Romanian Plain in the South; both are characterised by low altitudes below 200m and even below 100m. The lowest and at the same time youngest reliefs are riversides and the Danube Delta.

Romania has a temperate-continental climate, the climatic elements vary within very large ranges mainly due to the relief. Thus, the annual mean temperature varies between 11.5 and 2.6 °C ; temperatures of the hottest month between 23.6 and 5.7 °C and of the coldest month between 0.2 and 10.5 °C. The annual rainfall varies between 350 and 1500 mm.

2. Vegetation

Due to the variety of relief forms, the vegetation generally has a specific distribution in relation to altitude and is certainly influenced by different climates.

The total forest area in Romania is 6.3 million ha which is 27% of the total land area. Historically, the forest area has been decreasing from 9 millions ha at the beginning of this century to the present area. The highest proportion of this decline was due to the expansion of agriculture, especially after the First World War. Nowadays the pressure of anthropogenic factors on the forest is very strong. 69% of the forest area are hardwood forest and the remainder are softwoods.

Romania's forest includes quite a large number of native species, which are spread over natural ranges accurately limited and stable enough.

There is a latitudinal and mostly altitudinal distribution of species within the geographic territory of the country. There is natural vegetation towards the upper part of the mountains in the alpine zone with some bushes and grassy plants. In low altitude forest areas there are no limiting factors, many species grow satisfactorily or even well both on so called steppe and along riversides.

In Romania, three zones of vegetation distribution are recognised: alpine, forest and steppe:

The **Alpine zone** is located in the highest parts of the mountains, lacking proper forests. It is only in its lower parts (subalpine subzone) that bushes of *Juniperus sibirca, Pinus montana, Alnus viridis, Rododendon kotschyi* and others are found. The transition from the alpine to the forest zone includes usually *Picea abies* and sometimes even *Fagus sylvatica, Larix decidua, Pinus cembra* and some hardwoods.

In the **forest zone** a number of subzones can be recognized:

– ***Picea abies*** **subzone**, where spruce is predominating, covering the Carpathian territories in a continuous strip. There are mostly pure stands or stands mixed with rare hardwoods.

– ***Fagus sylvatica*** **subzone**, covered by pure beech stands or beech mixed with *Picea abies* and *Abies alba*. It is the largest subzone both in altitude and in latitude where together with beech *Abies alba* stands are to be found. It should be pointed out that beech is the most important forest tree species with 34% of total forest area, and, what is of great importance, all stands are in natural state.

– ***Quercus sessiliflora*** **(lato sensu) subzone**, characterised by pure stands of sessile oak and mixed stands with *Acer pseudoplatanus, Fagus sylvatica, Fraxinus excelsior, Carpinus betulus, Betula sp., Populus sp., Sorbus sp.* In this area three species of oaks are to be found: *Q. petrea, Q. polycarpa* and *Q. dalechampi*. There are several shrub species.

– **Quercus robur subzone**, mainly covering the plains, partially the low hills and riversides. We can find pure stands and mixed stands (the so called "mixed broad-leaved forest"). Here are several species of hardwoods namely: *Acer campestre, A. tataricum, A. platanoides, Fraxinus excelsior, F. ornus, F. oxicarpa, Alnus glutinosa, Juglans regia, Malus sylvestris, Morus sp., Pirus sp., Populus sp., Salix sp., Prunus sp., Tilia sp., Ulmus sp.*, and several others. There are also a lot of shrubs and subshrubs. Among oaks we also can find *Q. pedunculiflora, Q. pubescens, Q. virgiliana* and a lot of natural hybrids and introgressions.

On the low hilly and plain regions in the Southern parts of Muntenia and Oltenia as well as in the Western part of Romania on heavy and compacted soils there is a subzone of *Quercus cerris* and *Q. frainetto*.

The silvosteppe covers the outskirts of the forest zone being wider in the Southern and Eastern part of Romania. This subzone consists mostly of xerophytic species namely *Q. cerris, Q. pedunculiflora, Q. frainetto, Q. pubescens, Fraxinus ornus, Carpinus orientalis, Prunus mahaleb, Ulmus sp.*, etc..

On the flooded riparian land along the rivers and in interzonal woody vegetation stands of *Salix alba, Populus alba, P. nigra* and *Alnus glutinosa* occur.

In some restricted areas or isolated stands there are *Pinus nigra* var. *banatica, Pinus sylvestris, Larix decidua, Pinus cembra,* etc.

As introduced species were planted many years ago *Pseudotsuga menziesii, Pinus strobus, Pinus nigra var. nigra, Robinia pseudoacacia* (on more than 250,000 hectares) and others.

To conclude, in Romania there is a large variety of species. Within forest species there is, at different levels, inter- and intrapopulationally, a very large genetic diversity. From the point of view of gene resource conservation the most important fact is that many populations are still in a natural state, growing on a very large variety of sites and many of them are of high productivity and quality.

In several international trails established many years ago in Europe and North America Romanian provenances of *Picea abies, Abies alba, Fagus sylvatica* and others proved to be among the best ones with regard to productivity and stability, quality of wood and resistance to adversities. The results of older or newer trails attest the truth that in Romania Carpathian Mountains, there are the most valuable gene centres (pools) of *Picea abies, Abies alba, Fagus sylvatica* and others.

3. Forest genetic resources

The forest sector, between 1976 and 1978 realised a new re-examination of the seed stands all over the country and re-valued the old areas according to the new "seed zone map of Romania". All the criteria for the selection of seed stands thus fell in line with the appropriate requirements in the "OECD Scheme for Control of Forest Reproductive Material Moving in International Trade". To all seed stands two main functions are attributed:

- to conserve the forest genetic resources
- to produce seeds of the best quality.

For this reason all seed stands are excepted from feeling and preserved as gene resources. In this way we preserve 2313 stands listed in "seed stand catalogue of Romania", with a total area of 70,179 ha of which 32,886 ha are conifer and 37,293 ha deciduous forest.

Soon after 1989, Romania entered the PanEuropean Process on Forest mainly in the framework of the First Ministerial Conference on the Protection of Forest in Europe – Strasbourg 1990: Resolution S2 "Conservation of Forest Genetic Resources". It followed the second Ministerial Conference – Helsinki 1993.

According to the above documents, Romania put in work a national policy of gene conservation, mainly *in situ.* Goal is to promote the maintenance of the broad genetic variation of all forest species in order to ensure the necessary evolution adaptability to a changing environment over many generations.

Objectives are to conserve:

– representative populations of phytogeographical regions,

– marginal and endangered populations,

– characterised genetic diversity for breeding,

– large (sufficient) genetic variation in reproductive materials,

– reference population for future research,

– still unknown genetic variation.

Using an adequate methodology of work 347 gene-resources were established with a total area of 11,304.3 ha for all main species. For all resources the aims and approaches are active genetic management and requirements are:

– autochthonous origin or well adapted "landraces";

– target area of gene reserve forest at least 100 ha, mosaic of stands with differentiated composition and structure.

For each source management is providing:

– maintenance of genetic variation and preservation of all natural evolution conditions,

– preparation of conditions for successful regeneration including thinnings,

– natural regeneration only with material of local origin.

By *ex situ* measures, in Romania population samples are conserved of different geographic origin of several species (69 trails), half-sib progeny tests (16 traits), comparative culture for testing seed sources (10 trails), interspecific hybrids, clones of poplar, willow and spruce and, not at last, 1004,5 ha of seed orchards.

Problems of forest genetic resources

The main present problems of forest genetic resources in Romania are:

– Absence of a unitary legislation for regulation of all aspects of practical activity in protected areas in general and of forest genetic resources in particular.

– Absence of a genetic management of forest genetic resources and a specific structure of silvic administration in a framework of general forest administration.

– The main forest genetic resources are not sufficiently studied, mainly with regard to genetic diversity using modern methods of genetic and molecular markers.

– There is not enough attention paid to the "minor" species (*Prunus avium, Sorbus sp.* and so on) mainly for conservation in a dynamic way within the framework of their natural ecosystems.

– "Key-stone species" are not established neither the implications for forest genetic resource conservation; in the same situation are vulnerable ecosystems.

All aspects of forest genetic resource conservation in the near future must be treated, even at political level, as a priority national task.

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Biodiversity and Some Aspects of its Management in Albania

Vasil Marku and Fran Gjoka

Abstract

Albania: country of natural resources and of high biodiversity.

The high biodiversity in Albania is connected with the variability of the physical-geographical conditions such as climatic differences, which are the results of marine and continental airean currents and of the very broken country`s topography; geopedological diversity and the dense hydrographic network.

The very rich biota compared with the country's area (3,250 vascular species, that represent 30% of European species, 30 of which are endemic in Albania; 5,287 animal species) and a large variety of habitats and vegetation types, including Mediterranean shrubs, forests (broad-leaved, conifer, and mixed conifer-broad-leaved), alpine and subalpine meadow and pastures, sand dunes and psamofil vegetation, river delta and riverine vegetation, coastal lagoons and marshes, streams as well as rivers and rocky coastal and marine ecosystems characterize Albania as a country rich in biodiversity.

The forests, which cover an area of 1,031,000 ha (or 35% of the total country's area) contain a very precious and important part of the country's biodiversity. In this context, the virgin forests (about 84,000 ha) constitute the most important habitats for threatened species.

Deterioration of the natural ecosystems and their conversion into agri-ecosystems and into new pasture ecosystems, intensive harvesting of the forests and other natural resources, fires, intensive exploitation of the aromatic and medical plants in their natural area, atmosphere and water pollution as well as agricultural intensification are the factors that are threatening the biodiversity in Albania.

For the protection of biodiversity it is necessary to adopt a method based on the principles of maintaining or restoring biodiversity in all levels in the reserved and non reserved areas.

An important aspect of GOs and NGOs programs for nature and biodiversity conservation is the establishment of a dense network of Protected Areas as an intensive way of biodiversity maintenance. Based on the study carried out for this aim, the protected area increased to 107,455 ha or 10.7 % of the total forest area in the year 1996, against 20,000 ha in 1995.

A draft proposal on the Country's Representative Network of Protected Area, which includes 301,748 ha and 191 km river course, has been developed and proposed to the Government for approval.

The achievement of the objectives of Protected Areas requests that in the buffer zone the application of agricultural practices should be based on ecological principles. This can be arranged by legislation.

The selection of gene reserve forests is another way to protect biodiversity. These forests cover an area of 495 ha and consist of Austrian pine, *Abies borisii regis, Pinus halepensis, Pinus pinea, Pinus maritima*.

The network of Protected Areas is capable to protect only a part of the national biodiversity. Therefore, sustainable management of the commercial forests, pastures, agri-ecosystems is important to maintain biodiversity as a whole.

Since the forests represent the main resource of biodiversity, the forestry activity is essential. In this context the application of the silvotechnique methods based on natural regeneration has been the main way for maintaining biodiversity in the productive forests. Thus the shelterwood, selective, and striped clear cutting systems have been used in Albania.

The improvement of degraded oak forests by recoppicing (about 200,000 ha) and afforestation of 196,300 ha bare lands has also resulted in an increase of biodiversity.

Biodiversity of the agri-ecosystems, estimated as an important part of the country's biological resources, can be increased by application of sustainable agricultural systems.

The preparation of a National Strategy and Action Plan is indispensable for biodiversity management in Albania.

Albania: country of natural resources and of high biodiversity

Albania, as a Mediterranean Country, is rich in natural resources (terrestrial, forest and water resources) with high ecological, economic and recreational values. In this context the very expressed complexity and biological diversity show a particular interest and value, thus giving Albania the status of "a country with high biodiversity".

The physical-geographical conditions such as the location along the coast of Adriatic and Jonian Sea, mostly mountainous relief of wide varying altitudes, climatic variability, geo-pedological diversity and dense hydrographic networks favour the development of a great biodiversity in Albania.

Combination's variegation of these factors has led to the creation of natural habitats for a great number of plants and animal species. The geographical position (almost equidistanced from Equator and North Pole), the influence of mainly marine airean currents and less of continental ones, relief's features determine climatic variability in our country. On this base, Albania's territory is divided into four climatic zones (Plane Mediterranean Zone, Hilly Mediterranean Zone, Pre-mountainous Mediterranean Zone, Mountainous Mediterranean Zone) and thirteen subzones.

The influence of the geological, climatic, tectonic and biological factors has made the country, although within a relatively small area, very distinguished in terms of soil diversity. The vertical zonality is characteristic for Albania although it can be distinguished in azonal and intrazonal soils. The group of zonal soils includes: meadows mountainous soils, brun forest soils, brown soils, and grey-brown soils, whereas the intrazonal soils include bog and salty soils. The alluvial soils form the azonal soil group.

The soils of Albania are mostly developed on sedimentary rocks (limestones and dolomite limestones of different geological ages) and less on magmatique-ultrabasique rocks. Soil-formation rocks are distinguished according to the high intensity of changes in their geological composition and structure. Changes in land use from human activity such as afforestation and deforestation, draining of swamps and creation of artificial lakes, building of industrial complexes and urban zones have modified the climatic conditions, influencing biodiversity.

Data on Albania's biodiversity

Albania is in relation to its area very rich in biota. There are about 3,250 vascular species growing in Albania, which represent 30% of all European species, 450 of which (15%) are growing only in the Balkan Peninsula, while 30 species are endemic in Albania (7). Forest dendroflora consists of 330 species (about 10% of total flora). The Albanian red book (9) contains the names of 320 species under varying degrees of threat from extinction.

The studies on fauna shows that it consists of 69 mammals, 320 birds, 3,965 insects, 313 fish, 15 amphibians, 37 reptiles, 408 molluscs and 114 crustaces (7). More than 100 animal species are classified as threatened.

The high biodiversity of Albania is related, above all, to the forest resources, which cover an area of 1,031,000 hectares or approximately 35 % of the country's total area. About 84,000 ha forests are considered as virgin forests, which constitute a natural richness of paramount importance for the biological diversity. More detailed data are given in Table 1.

The vegetation is distributed in vertical stripes or zones due to the climatic variations which according to the main species are denominated as follows:

1. Mediterranean shrubs zone(Lauretum)
2. Oaks or Sweet Chestnut zone (Castanetum)
3. Beech zone (Fagetum)
4. Norway spruce or mountainous Pines zone (Picetum)
5. Alpine pastures zone (Alpinetum)

The mediterranean shrubs zone covers an area of 1,040,000 ha. It is spread up to 300 m above sea level in the north and up to 800 m in the south. The main forest types or ecosystems are: Maquis, forests of Kermes oak *(Quercetum cocciferae)*, forests of Holm oak *(Quercetum ilicis)*, forests of Macedonian oak *(Quercetum trojanae)*, forests of *Quercus macrolepis* Kotschy *(Quercetum macrolepidis)*, forests of Aleppo-pine *(Pinetum halepensis)*, mixed forests of Aleppo-pine and stone pine *(Pinetum pineae – halepensis)*.

The oak zone covers an area of 1,060,000 ha spreading up to 900 – 1000 m in the north and up to 1.400 m above sea level in the south. It consists especially of different kinds of oak forests *(Quercetum pubescentis, Quercetum cerris, Quercetum frainettoi, Quercetum petraeae)*. In this zone, there also grow Sweet Chestnut forests *(Castanetum sativae)* and Hornbeam forests *(Carpinetum orientalis)*.

The Fagetum Zone covers an area of 530,000 ha. It spreads up to 1,500 m in the north and up to 1,800-1,900 m above sea level in the south. The main forests are beech forests *(Fagetum sylvaticae)* and Austrian pine forests *(Pinetum nigrae)*. Less common are silver fir forests *(Abietum albae)*, located in the north of Albania. Silver fir forms mainly mixed forests with European beech, but can also form pure stands as well. In this zone, in southern Albania, there are some forest stands of *Abies borisii regis (Abietum borisii regis)*, while in northern Albania there are birch forest stands *(Betuletum verrucosae)*.

The Norway spruce or mountainous pines zone covers an area of 180,000 ha. It spreads up to 1,900 m asl in the north and up to 2,000 m asl in the south. This zone includes the Bosnian pine forests *(Pinetum heldreichii)* and the Macedonian pine forests *(Pinetum peucis)*. Common spruce forests are less spread in our country and mainly grow in the northern part of Albania.

The Alpine pastures zone begins at 1,900 – 2,000 m above sea level. The vegetation of this zone is mainly composed of herbaceous plant communities while mountain pine *(Pinus mugo)* forms small forest stands *(Pinetum mugo)*.

Tab. 1: Forests of Albania (According to the data of the year 1995).

	Forest Type	Area (ha)x1000	Growing stock (m³)x1000 Timber	Fuelwood	Total
A	**Forest Resources (total)**	**1031**	**51876**	**30944**	**82820**
I	**Coniferous Forests**	**176**	**12845**	**5845**	**18690**
1	Austrian pine	110	7492	3691	11183
2	Maritime pine	35	542	481	1023
3	Silver fir	16	3032	904	3936
4	Other conifers	15	1779	769	2548
II	**Broadleaved Forests (total)**	**600**	**39031**	**17863**	**56894**
1	Beech	195	30909	7266	38175
2	Oak	330	6783	7672	14455
3	Poplars	1,5	57	30	87
4	Other shrubs	73,5	1282	2895	4177
III	**Shrubland Broadleaves**	**255**	-	**7236**	**7236**
1	Arbutus	59	-	2180	2180
2	Hornbeam	92	-	3026	3026
3	Other Broadleaves	103	-	2030	2030
B	**Protective Forests (total)**	**903**	**46839**	**26286**	**73125**
1	Annual growth 1.4 m^3 ha^{-1} $year^1$	-	-	-	1272
C	**Protective Forests (total)**	**128**	-	-	**9695**
1	For soil, water etc.	108	-	-	7358
2	National Parks	8	-	-	1535
3	Hunting Preserves	11,4	-	-	738
4	Nature Monuments	0,6	-	-	64

The beech forests, Austrian pine forests, high oak forests and mixed forests consist of beech, Austrian pine, silver fir and Bosnian pine. They are of paramount importance in economic aspects because of the limited extent. Scots pine forests *(Pinetum sylvestris)*, birch forests *(Betuletum albae)*, English oak forests *(Quercetum roboris)*, and Norway spruce forest *(Picetum albae)* have a special value for our country, while the Macedonian pine forests *(Pinetum peucis)* and Bosnian pine forests have Balcanic and European values.

The plant communities such as *Euphorbieto - Genistetum hassertianae, Forsythetum europaea, Peterietum ramentacea* are endemic or subendemic of Balkan ones with rare values of biodiversity (8).

There are regions with high value of biodiversity almost in all of the country's territory, nevertheless the emphasis can be put on the typical Mediterranean forests and lagoons as well as on some mountainous areas such as Bjeshket e Namuna (2,500 m asl), and Lura (1,500 m asl) with its karstic lakes (1). In these areas there are a considerable number of endemic species of plants and animals, which constitute a richness of unique values.

Threats to biodiversity in Albania

The biological diversity in Albania has faced a wide spectrum of man-made threats, which can be classified as follows:

1. Deterioration of natural ecosystems and their conversion into agri-ecosystems and into new pasture ecosystems

This phenomenon has affected a lot of plant and animal species and communities, almost all ecosystems from mountainous forests and pastures to aquatic ecosystems (lakes, lagoons). The change of land use (Table 2) gives a clear view of this phenomenon.

The table shows that the forest and pasture area have been reduced to a considerable amount. In this context is to be mentioned the total deforestation in the lowland zone of elm forest *(Ulmus foliaceae)*, ash forests *(Fraxinus angustifolia)*, English oak forests *(Quercus robur)* and large-scale deforestation for food crop cultivation of the oak forests in the hilly land of the Hasi region (Kukes district) as well as of the Dumre region (Elbasan district). Likewise, about 15,000 ha shrublands have been converted into cultivated polyphite pastures which are suffering intensive erosion.

The losses in biodiversity and in natural habitats are connected to the drainage of swamps and wetlands as well. The arable land gained in this way has been estimated to cover about 200,000 ha.

2. Intensive harvesting of the forests and other natural resources

During the last decades, under the conditions of centralized economy, forest harvesting was characterized by a misbalance between the annual increment of the forests (annual allowable cut) and the actual cutting. The ratio has been 1: 2.5-3, thus reducing the country's forest resources.

This problem has become more acute these last 7-8 years particularly for the forest near roads and inhabitable centres. Also, during these years all the windbreaks, vineyards and fruit trees plantations, the trees along roadsides and canals, which in their complexity have functioned as "ecological corridors" have been damaged.

Because of uncontrolled cuts, overgrazing and pruning for fodder, a considerable area (about 200,000 ha) of forests has been degraded.

Also, non-use of fertilizers and overgrazing have led to degradation of about 25,000-30,000 ha natural pastures, a vegetation form which is dominated by *Nardus stricta*.

The infringement of the hunting rules and the usage of illegal tools constitute a permanent threat for some of the game species and aquatic fauna.

3. The fires

Fires in forest constitute a serious threat for biologival diversity. They destroy natural biotopes and intensify erosion. This phenomenon is becoming very frequent over the last few years.

4. Intensive exploitation of aromatic and medical plants in their natural areal

This practice has led to their rarefaction and threat for extinction of some species such as: Mountain tea *(Sideritis roeseri)*, *Salvia officinalis, Colchicum autumnale*, and certain kinds of *Orchidaceae*.

5. Atmosphere and water pollution

The biological diversity is endangered from different forms of industrial and agricultural pollution. Emissions into atmosphere from chemical, metallurgical, cement and thermocentrales of considerable quantities of SO_2, nitrogen oxides, etc., the relatively high usage of agricultural inputs (fertilisers and pesticides) have caused serious damage to biodiversity. In this context we can mention the complete abolishment of about 1,200 ha broadleaved forests in Gjallica Mountain (Kukes district) due to the impacts of the copper factory. The industrial residues poured into streams and rivers have caused a considerable damage of their fauna.

6. Agricultural intensification

The extreme concentration and specialisation of agricultural production as well as the creation of generally homogenous agricultural landscapes in the lowland areas has had a negative impact on agriecosystems' biodiversity. As a result, the wildlife habitats have been destroyed.

Tab. 2: Land resources of Albania (1000 ha).

	Year 1950		Year 1991		Year 1997	
	ha	%	ha	%	ha	%
Total Area	2875	100	2875	100	2875	100
Agricultural land	391	14	702	24	699	24
Pastures	816	28	417	15	403	14
Forests	1282	45	1051	36	1026	36
Others	386	13	705	25	747	26

Some aspects of the biodiversity management

For the protection of biodiversity it is necessary to adapt such a method that is based on the principles of maintaining or restoring of biodiversity in all levels in reserved and non-reserved areas.

In particular, the protection of forest biodiversity is nowadays an important duty, if we take into consideration the fact that in forests live thousands of plant and animal species, which may contain important chemical components or genetic codes with a high potential value for humankind, providing natural medicine or resistant varieties towards diseases.

Both, the intensive and the extensive way, have been used to maintain the biological diversity in Albania.

The intensive way of biodiversity maintenance implies the establishment of a dense network of protected areas.

Protected areas, according to the definition of the Rio Conference, are determined areas that have been defined, arranged and classified to reach particular objectives of preservation.

In fact, establishing protected areas is indispensable because though the management methods of productive forests imitate natural phenomena, it can not be expected that forestry is reconstructing ecosystems equivalent to natural forests (6). The only means to preserve the typical flora and fauna of natural forests is to establish a sufficiently dense and representative network of preserved areas. Therefore, in Albania, a network of protected areas has been established. From 1966 on, the Decision of Council of Ministers stated the first six Forest National Parks. Until 1995, three categories of protected areas have been determined: Forest National Parks, Game Reserves, and Natural Monuments, which include about 20,000 ha forests, In these categories have been mainly included forest ecosystems, thus not all natural heritage of our country is represented.

In the year 1994 in the framework of the project "Forest Integrated Management"(FAO, World Bank) an "Ecological Survey of High Forests" was carried out covering 85,000 ha, spread in the northern, central, and southern part of Albania (2). The main aim of this study was the determination of environmental, recreational, landscape, touristic specific values and biodiversity of these forests. These characteristics were taken into consideration to determine the areas which must gain a special protection status.

Based on the results of this study, with the Decision of Council of Ministers of the year 1996, the protected areas reached 107,455 ha, representing 10.7% of total forest area of Albania, or approximately 3.74 % of the country area.

According to the management categories of IUCN the existing system of protected areas is divided as shown in Table 3.

In the last years, nature protection has been the subject of NGOs' activity. Thus, we can mention the study "A NGO Nature Conservation Strategy" carried out by PPNEA (Protection & Preservation of Natural Environment Association), AAB (Albanian Association of Biologists), ASPBM (Albanian Society for the Protection of Birds and Mammals).

In the workshop organized in the framework of this project, "The Representative Network of Protected Areas of Albania" has been approved. In this network are included marine, coastal, forest and pasture ecosystems, which constitute about 10% of the country area. Table 4 shows this network, which has been proposed to the Government institutions for approval.

The avoidance of negative impacts by agriculture in the protected areas affords that in the buffer zone agricultural practices, in the cases of their applications, have to be based on ecological principles. Their development in these zones can be based on the integration of ecological agriculture combined with agri-tourism. In these cases the development of ecological agriculture must be included in the national action plan for biodiversity protection.

Depending on the geoclimatic, socio-economic conditions and tradition, production systems can be projected (sustainable agri-ecosystems) based on biotechnology, that consume less energy and external inputs, that prevent erosion and contamination of the environment and secure a harmonious integration of the agri-ecosystems and natural ecosystems. The application of such agricultural systems requests funds to support financially the farmers for a period of 3-5 years (conversion period), education programs, technical assistance and an appropriate legislation.

Taking into consideration the definition of biodiversity which includes as well the genetic diversity, gene conservation is an important activity connected with nature protection in general and the utilization of biological resources. Therefore, in Albania, gene reserve forests have been determined of the main species which are used in afforestation (Table 5).

The network of Protected Zones protects only a part of the national biological diversity, therefore sustainable management of the commercial forests, pastures, agri-ecosystems and aquatic ecosystems is important for maintaining biodiversity as a whole.

In the extensive way of biodiversity protection the action of forestry is essential. It must be such that as less modifications as possible of the environmental conditions are caused and habitats are maintained.

Such an objective can be realized by application of silvicultural methods which are based on the natural regeneration of

Tab. 3: The existing system of Protected Areas (PAs) of Albania.

PAs Category	No of PAs	Hectares
Strict Nature Reserves/Scientific Reserves	4	14500
National Parks	11	25860
Nature Monuments	300	4360
Managed Nature Reserve/Species and Habitat Management Area	26	42940
Landscape/Seascape Protected Area	3	2550
Protected Area of Multiple Use/Managed Resource Protected Area	4	18245
Total	**348**	**107455**

Tab. 4: The proposed Protected Areas (PAs) of Albania.

PAs Category	No of PAs	Hectares/km
Strict Nature Reserves/Scientific Reserves	12	16040 ha and 2 km river course
National Parks	7	100000 ha
Nature Monuments		358 ha
Managed Nature Reserve/Species and Habitat Management Area	9	16650 ha and 44 km river course
Landscape/Seascape Protected Area	17	120400 ha and 145 km river course
Managed Resource Protected Area	3	12400 ha
Areas of not yet defined protection status/Undetermined protected Areas	4	35900 ha
Total	**52**	**301748 ha and 191 km river course**

forests. Natural regeneration enables the realization of forest stands' functions without evident interruptions of them. It favours the maintenance of existing natural ecosystems. At the same time, natural regeneration preserves the genetic diversity maintained in native forests by natural selection.

Thus, in Albania, the shelterwood cutting system with two or three phases has been especially used in the beech and Austrian pine forests. Taking into consideration the fact that conifer timber in our country is showing a deficit and the natural extension tendency of silver fir in beech forests, the cutting method has favoured the increase of its percentage in order to create mixed forests (beech with silver fir). Whereas in mixed forests silvicultural practices have aimed at maintaining the existing composition of species.

Tab. 5: The gene reserve forests.

Species	Area (ha)
Pinus nigra	320
Abies borisii regis	140
Pinus halepensis	3
Pinus pinea	26
Pinus pinaster	6

The forest management plans recommend that a strip of about 50 m alongside watersheds and streams are left uncut. Uncutting of the rare species has been recommended, too.

In cases of wrong applications of the cutting intensity, in pure beech forests gaps dominated by *Rubus idaeus* and *Fragaria vesca* have been created. In mixed forests composed of beech and silver fir, gaps are dominated by *Vaccinium myrtillus* and *Erica herbaceae,* while in the Austrian pine forests the gaps are mainly dominated by *Erica herbaceae*. These phenomena modify temporarily the vertical structure of forests because of the abstractions of establishment in time of tree seedlings.

In some pure beech forests depending on site conditions it has been intervened to create mixed forests by sowing silver fir seeds and planting seedlings of different maple species such as *Acer pseudoplatanus* and *Acer platanoides.* As a result, not only the productive potential of the site can be exploited better, but the pure stands are gradually converted into mixed stands leading to increased biodiversity.

In our country, besides the shelterwood cutting systems, have also been used the striped clear and selective cuttings. The striped clear cuttings have been applied in Austrian pine forests only for experimental objectives, while selective cuttings have been applied very rarely, although this system imitates better the action of nature and preserves more heterogeneous structure of stands.

The management of productive forests must aim, beside others, at maintaining and increasing biodiversity, too. For this purpose, in the management plan, besides the information on site conditions, forests stands structure and other characteristics (age, height, diameter, density, cutting systems, sustained yield of timber products, stand improvement techniques and forest protection), must be determined the characteristic biotopes which may be for example wetlands, depression, rock outcrops and swamps.

Also, the improvement of degraded oak forests by recoppicing, which cover about 200,000 ha, has resulted in increasing biodiversity.

A good part of improved forests which grow on favourable ecological conditions will be converted into high forests where biological diversity will be higher.

The afforestation of bare lands and shrublands in the mountains, hills, and coastal sands has provided an adequate increase in biological diversity.

The first three hectares have been afforested in the year 1938, while the total afforested area until 1993 reached 196,230 ha. The main aim of these afforestations, besides the production of wood material, has been soil protection against erosion and the protection of the hydropower stations and pool basins. The priority had been given to indigenous species, prefering monospecific plantations. Among the conifers have especially been used the species: *Pinus nigra* Arn., *Pinus halepensis* Mill., *Pinus pinaster* Ait. and *Pinus sylvestris* L., while among the broadleaved species *Populus x euramericana* (Dode) Guinier, *Robinia pseudacacia* L., *Betula pendula* Roth. and different kinds of the genus Salix have been used. The species *Fraxinus ornus* L., *Fraxinus angustifolia* Vahl., *Castanea sativa* Mill., *Tilia sp.* and *Acer sp.* have rarely been used.

Biodiversity of the agri-ecosystems should be treated as an important part of the country's biological resources. Biological complexity and diversity, stability and resilience are essential characteristics of sustainable agro-ecosystems. Thus, the sustainable agriculture is considered as a tool for establishment and maintenance of biodiversity in the agricultural landscapes.

Policultures, hedgerows, fragmentation of agricultural landscapes and of production systems and the establishment of "ecological corridors" provide considerably increasing biodiversity.

An action plan for sustainable agriculture development in our country was prepared in the framework of the Project: "A NGO sustainable agriculture development strategy in Albania", implemented by two NGOs (Union of Agrarian Cooperators of Albania and Albanian Consumer).

In conclusion, the preparation of a National Biodiversity Strategy and Action Plan is indispensable.

This can include:

– Improvement of the existing legislation for the protection of biodiversity.

– Extension of the Protected Areas

Network in conformity with the international agreements.

– Deepening studies for identification of the biological richness in our country.

– Preparation of biodiversity management plans for the Protected Areas.

– Inclusion into the management plans of production forests of the instructions for the protection of biotopes with particular values of biodiversity.

– Education and participation of local population in the protection of nature and biodiversity.

– Equilibrium of cutting with forest natural increment (annual allowable cutting) and decrease of wood consumption by usage of alternative resources of energy must be the main objective of forestry and other state institutions.

– Passing towards the obligated applications of ecological agriculture practices in buffer zones should be considered as an important tool to maintain biodiversity.

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Poster Presentations and Additional Contributions

A Biodiversity Forecasting Model Using Bird Assemblages

Jean-Luc DesGranges, Richard Poulin

Abstract

Forest managers now face the challenge of sustainable development. This entails considering all forest components and their interdependences to ensure that measures targeting one component do not harm another. New approaches to decision-making are based largely on the use of mathematical model to establish silvicultural treatment plans that combine optimum forest yield with more efficient resource enhancement.

Since birds inhabit most forest compartments (canopy, trunks, shrubs, ground, gaps, etc.) they are considered to be a good indicator of biodiversity and, thereby, a relevant source of information on the impact of silvicultural practices. Since it is impossible to census all species inhabiting a particular forest (i.e. real biodiversity), studying an easily inventoried group comprising a hundred or so bird species should support the rapid development of expert systems for use in forest management.

We thus developed a computer model using ornithological and botanical data from some 1700 nesting bird censuses conducted over the past 25 years in northeastern North American forests. Using neural networks, we developed a forecasting model that can be used to predict bird populations based solely on the dominant vegetation in the three primary forest cover strata. Data collected in some 175 sampling sites in the Lower St. Lawrence Model Forest were used to test the accuracy of the model's forecasts. We are confident that the remaining few deviations can be corrected as the model is updated with more data from exploited forests. Any remaining flaws will be clearly identified and suggestions made to guide future work, particularly as regards the development of an expert system that can be easily consulted by forest managers.

So far, the preliminary results are encouraging. There is every indication that, once refined, the model can be used to characterize the bird life (species and relative abundance) in most of Québec's forests based solely on data obtained through LANDSAT-TM satellite imagery. This data will be used to produce bird distributional maps using remote sensing. Maps showing the geographical distribution of birds should greatly facilitate integrated forest management, since forest managers will be able to pinpoint, at least for one major group of vertebrates, species-rich sites and sites with a concentration of rare species. This knowledge will allow them to plan environmentally responsible silvicultural treatment plans that protect forest biodiversity.

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Hot Spots for Biodiversity in Swedish Forests

Lena Gustafsson

keywords:
Biodiversity, conservation, key woodland habitats, hot spots, red-listed species

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Abstract

The Swedish forests have been affected by forestry for a long time and today almost all forest land is intensively managed for timber and pulp production. The natural forests have been converted into production forests and this has caused considerable impacts on the flora, fauna and habitats. Still, areas with a high concentration of rare plants and animals occur. Such "woodland key habitats" are at present being mapped in a nation-wide survey, coordinated by the National Board of Forestry. Aerial photographs are used for identification. The estimated number of the key woodland habitats for the whole country is 60 000 - 80 000 and they, on average, cover 1% of the forest land. In two research projects the presence and abundance of red-listed lichens, bryophytes, macrofungi and vascular plants has been investigated in key woodland habitats and has been compared with the surrounding production forests. In this paper, the woodland key habitat inventory is described and results from the two studies on red-listed species are given. The application on forestry and biodiversity conservation is discussed.

Phenolic Compounds Content as a Measure of Genetic Diversity in Conifers

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Abstract

Phenolic compounds are present in all plant tissues and are considered the most stable chemical characters in plants. They are not hormones themselves, though they may effect plant growth by interaction with one of the major class of plant hormones such as the auxins. Phenolics are also significant in providing resistance to various fungal, bacterial and viral infections, functioning not only as preformed antifungal compounds but also as phytoauxins formed postinfectionally.

Individual trees belonging to three coniferous species *(Pinus sylvestris, Abies alba* and *Pseudosuga menziesii)* were investigated according to the phenolic compounds content. Taxifolin polymorphism was examined in Scots pine populations. Six other compound frequencies (mericetin, quercitin, laritricin, kaemferol, isorhamnetin, and syringetin), detected chromatographically (HPLC), describe intraspecific diversity as well as interspecific differences between *Abies alba* and *Pseudotsuga menziesii.*

Forest Biodiversity from the Soil Biological and Biochemical Pedogenetic Processes

Gilles Lemieux

Abstract

Over the last 100 years, understanding of forest ecosystems behaviour only dealt with the hypogeous ecosystems description in a completely productivist manner for man`s consumption. Our last 20 years work has brought us to the conclusion that the living soil is fundamentally responding to the evolution of the hypogeous as a bank containing the memory, the food and the energy accumulated during the previous life of the forest ecosystem.

Trying to enhance depleted forest soils by adding chipped twigs in the first 10 cm produced an outstanding response we can only begin to understand. We now know that we are dealing with a biological process based on the enzymatic activity of Basidiomycetes breaking apart large molecules of lignin through lignoperoxidase enzymatic activity enhancing trophic chains as well as soil structure based on aromatic remaining rings.

This is fundamental for the establishment of the quality of the food chains responsible for energy storage and the management of many minerals such as nitrogen, phosphorus, iron, manganese, etc... At this point, diversity is a vital contribution to a better use and convenient biological storage of both chemical and biochemical nutrients and other biological soil managers.

key words:
soil, biology, biochemistry, enzymatic activity, Basidiomycetes, nutrient management, trophic chains

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The Impact of the Three Gorges Hydroelectric Project on and the Preservation Strategies for the Biodiversity in the Affected Region

Ma Chuo, Han Jin

Abstract

The impact of the Three Gorges Hydroelectric Project on the plant diversity in the reservoir region was assessed based upon field surveys of the plant species and vegetation surrounding the reservoir area that will be influenced by this project. The reservoir area harbors more than 190 plant families (except Bryophytes), 1012 genera, and 3012 species (including 29 sub-species, 286 varieties and 16 forms). Of these, 37 endemic species can only be found in the reservoir region, 47 species, including 22 endangered species, 20 rare species and 5 threatened species, have been listed in the "Plant Red Data Book of China". Vegetation types in the reservoir area, except for those found in the cultivated land, have 89 formations. The coniferous forests are most widely distributed, while broadleaf evergreen forests are only scattered in the central parts of the mountain. The plants belonging to 120 families, 358 genera and 550 species that are at present distributed under the flooded line (185m) in the reservoir will be affected by the project, based on their current distribution range from the established database. Moreover, 27 community types in the potentially flooded area will be eliminated from the area as well, since the original habitats of some species will be destroyed after the reservoir is filled with water. Flooding will directly lead to the extinction of species and community types in the region unless preservation strategies are to be taken. Even if it is assessed solely based on the loss of natural vegetation and the destruction of the habitats that are currently cultivated, the economic loss caused by flooding will be severe.

keywords:
biodiversity, Three Gorges Hydroelectric Project, preserving strategies, impact of the hydroelectric project

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Can Miniature Forests Ameliorate Loss of Biodiversity?

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Abstract

The human demands on forests have been so terrible in recent years, that loss of tree cover has resulted in erosion of the available medicinal plants from those areas. Creation of miniature forests of 8-25 acres has been thought to ameliorate the depletion of biodiversity. These man made forests need intense knowledge for the introduction of plant species. The disadvantage is that while they can create temporary abodes to animal and bird species, they usually become death traps to the hapless small mammals. In my experience, the most valuable groups are solely ground dwelling mammals. In the 8 acre forest that I have created, I was happy to note the arrival of the barking deer - an endangered species of small mammals. Our happiness was shortlived for some neighbours, on spotting the animals, killed them for food.

Miniature forests can provide sustenance to many species of life forms except solely ground dwelling mammals. If a chain of such miniature forests can be created with sufficiently wide corridors, some actions can be taken to protect these animals, too.

From Tree to Region: Evaluating Tree Species Diversity in Tropical Rainforests, Examples from French Guyana

J.-F. Molino, D. Sabatier, P. Birnbaum & M.-F. Prevost

Introduction

Our knowledge of tree species diversity in tropical rainforests comes from two different approaches. The first one is taxonomic and floristic surveys, based on the study of herbaria collections, and the second one is field inventories on permanent or semi-permanent plots.

Floristic studies are still incomplete in most parts of the tropical world. Many plant families strongly need to be accurately revised, species unknown to science are frequently collected and have to be described and named. Such works give estimations of species richness at regional, national or continental scales but according to the disparity of collection densities they do not account for the geographical variations of both species richness (i. e. number of species) and diversity (i. e. the properties of the species mixture).

Fig. 1: Emergent tree near an old gap, Montagne Cacao. Example of canopy structure generated by natural disturbance.

On the other hand, exhaustive field inventories give true measures of species diversity but are hardly possible on large surfaces (for tree species studies, plots range usually from 1 to 20 ha, very rarely up to 50-100 ha). Data collected show not only high levels but also important variations of tree densities and species richness (e. g. in French Guyana, 450 to 800 individuals/ha and 130 to 200 species/ha, for trees with DBH – diameter at breast height – above 10 cm [4, 6]), but also that inventoried plots are never large enough to allow any extrapolation of the results to a larger scale.

In other words, tree species diversity, which is an aspect of tropical rainforests heterogeneity, is very high at all scales, but also very variable, and we do not know how to measure or estimate it at intermediate scales (10 to 10 000 km^2).

But it is just at these intermediate scales that there is a great need of information today, either for biodiversity conservation or for forest management purposes.

Since the mid-80s, our team of ORSTOM's botanists have conducted ecological studies in French Guyana, through field inventories of forest trees. A census of the tree community covering about 30 ha has been made in various locations all over the country, but particularly in two research stations, Piste de St. Elie's (5°18'N, 53°3'W) and Les Nouragues (4°5'N, 54°40'W). The numerous botanical vouchers collected during this work have been deposited in Cayenne's Herbarium (CAY), contributing to the global floristic knowledge of the region (see Flora of the Guianas series and Flora Neotropica monographs).

Starting from these basic works, we now aim at investigate intermediate scales using new methods and tools. Hereafter our goal is to present, at each scale of study, the relevant aspects of tree species diversity and the problems to be solved to achieve a multi-scale evaluation method.

Local level

The main factor determining the qualitative and quantitative characteristics of the species mixture around a tree is local dominance (i. e. the outnumbering of one species over others). Unevenness of local dominance, which results in different specific dispersion patterns and variations in species mixture, has a lot of causes, among which the most often cited is disturbance (mortality and structural disorganization) [4] (Fig.1).

Plot level

Rainforest tree species are often very reactive to faint environmental variations. Such a fine tuning leads to short-distance changes in community composition [5].

This drift generates between-community (β) diversity which is combined at the plot level with within-community (α) diversity.

Then it is almost impossible to measure independently α and β diversity. In practice, to point out spatial variations of the species mixture within a plot, one has to discretize the whole diversity into pinpoint values measured on adjacent small surfaces (Fig. 2a & b).

Comparison between observed and theoretical variations in local diversity values emphasizes the importance of local dominance, which reflects uneven dispersion of some species.

Interpreting local-scale images of the forest is a major challenge and the real blocking point on the way to regional-scale evaluation of biodiversity.

Among many interrelated/correlated data collected from within the forest ecosystem in a 3-D space (Figs.2 & 3), which are visible from above, on a 2-D image (Fig. 4).

Is biodiversity well correlated to one (or more) characteristics of forest canopy's remote views?

Landscape level

Between-plots comparison of species richness emphasizes the different sources of β diversity, both environmental (topography, variations in water availability and/or microclimate) and historical (distribution and frequency of perturbations, rhythm and nature of subsequent regeneration [1, 2]) (Fig. 5).

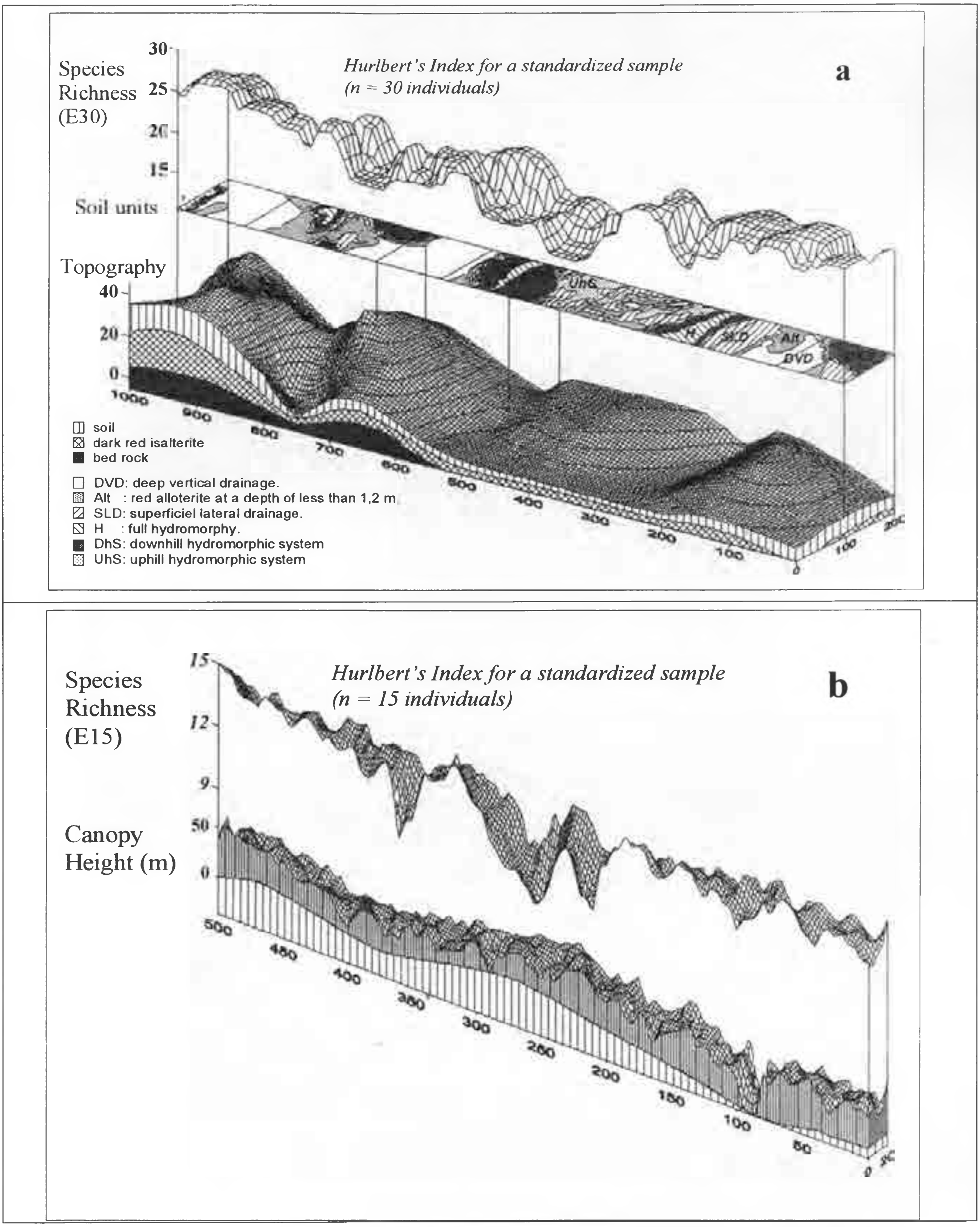

Fig. 2: Variations of tree species richness are not obviously linked to environmental changes. Examples from an undisturbed forest Piste de St. Elie. a: 10 ha plot, trees with DBH > 10 cm, edaphic factors. b: 1 ha plot, understorey trees with 2 cm < DBH < 10 cm, comparison with canopy upper surface.

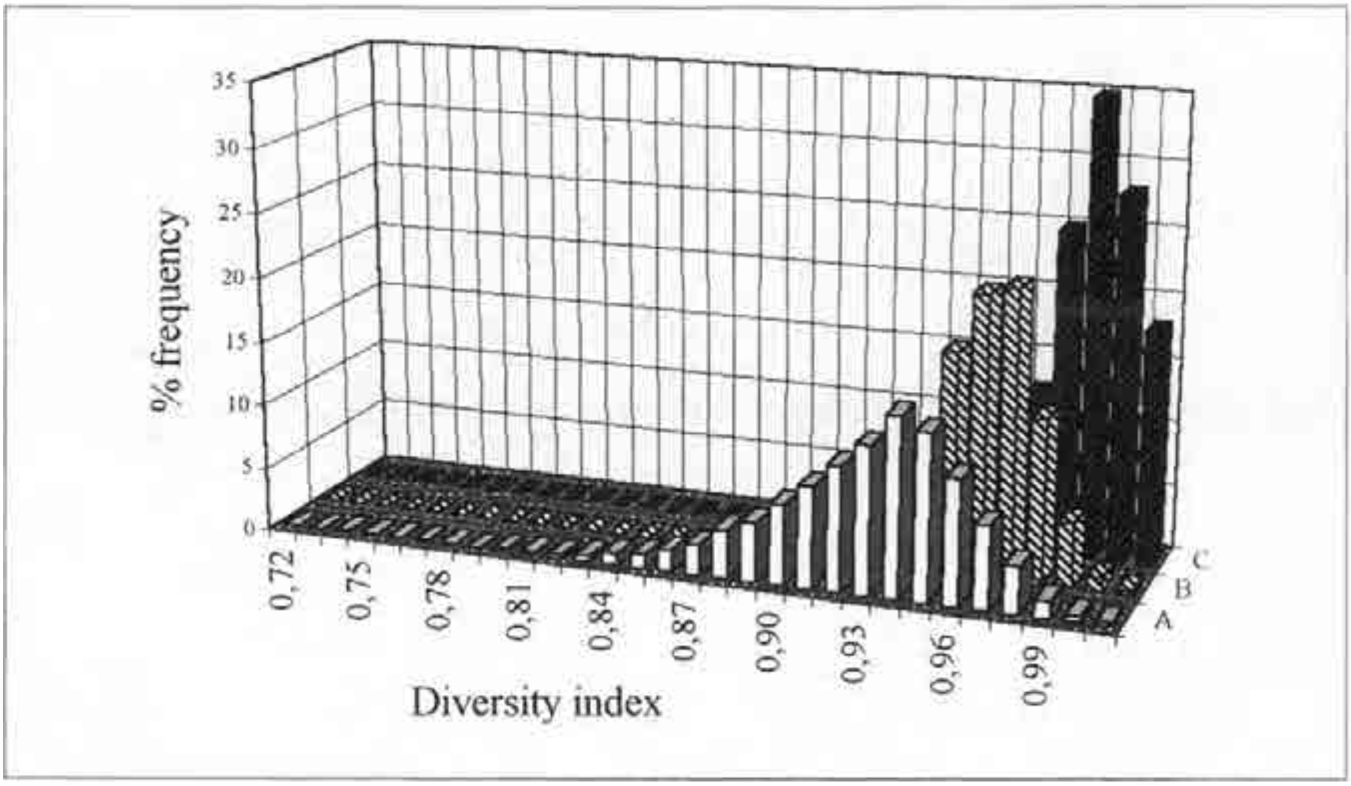

Fig. 3: Distribution of the local diversity values. A: Observed Hurlbert's Index values (see Fig. 2A). B: Theoretical values for a random species dispersion model (weak local dominance). C: Theoretical values for an over-dispersion model (no local dominance).

Fig. 4: Both structural and radiometric heterogeneity of the canopy roof reflect species diversity. Comté flat, near Nancibo.

The expression of these factors on the canopy in terms of roughness, grain of crowns or spectral variations can be more or less easily mapped on a picture (Fig. 6), following patterns scarcely perceptible at plot level.

Regional level

The main challenge at regional scale (Fig.7) is to identify biogeographical units, i. e. areas in which all landscape units share the same patterns of variations and have a common floristic potential. Understanding the rules underlying these patterns is part of the evaluation method.

Conclusion

There is today an urgent need for new methods of biodiversity evaluation at landscape and regional scales. Field studies on limited areas are still necessary, but we should now find a way to extrapolate

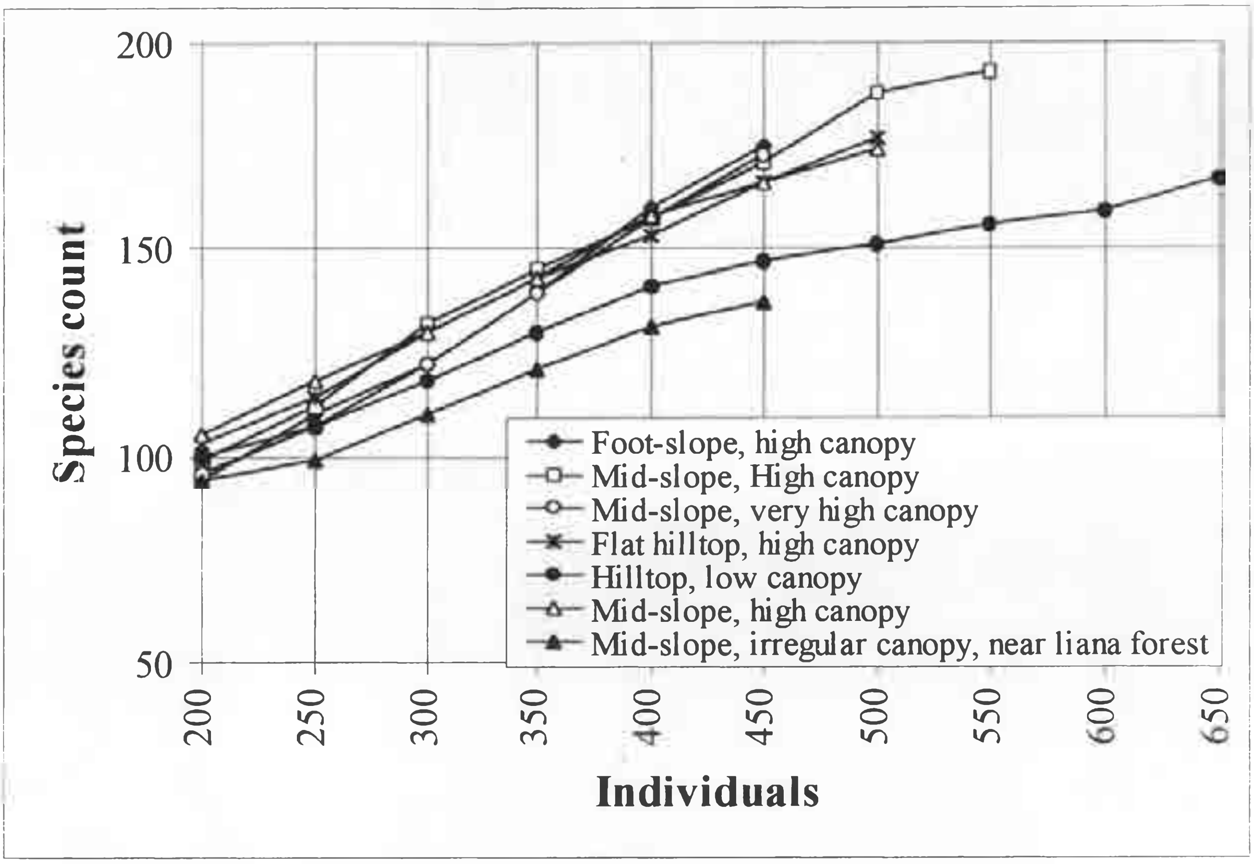

Fig. 5: Changes in species richness among seven 1-ha plots distributed along a topographic gradient, Les Nouragues station. Liana forest represents a high degree and frequency of perturbation.

from these scattered, local-scale measures to regional-scale evaluations, which necessarily involve remote-sensing and modeling tools.

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Fig. 6: Patterns of structural and radiometric heterogeneity of the canopy roof reflect changes in the tree community related to edaphic factors as well as recent or historical events. Inini region, near Dorlin.

Fig. 7: Landsat view of Sinnamary Basin, 17/08/1988 (data processing: A. Minghelli, Maison de la Télédétection, Montpellier).

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Functional Role of Biodiversity in Forest Ecosystems of Caucasus

Mikhail V. Pridnya

Abstract

The structural organization of forest ecosystems is largely determined by following functional population and coenotic mechanisms.

Centuries-old exchange of the genetic information, forming integrated genetic funds of populations of the dominants in ecosystems, causes its organization. The subordinated circles are connected by population systems and coenotic mechanisms and are adapted by the vital forms and cycles of development to the environment formed by dominants. In populations of sympatric species the spatial structure of populations, species, phytocoenosises and formations prevails.

The special role in forming of phytocoenosises and formations as organized components of ecosystems and landscapes belongs to the phenomena of constitution (incumbation) of circles of vegetation, which are brightly expressed in a subalpine belt on Caucasus. Incumbation of circles are characteristic for the east beech, common birches, high-mountainous maple, Rhodoretums = Caucasian and yellow, bilberry heath = Caucasian and ordinary, and also subalpine tall herbaceous vegetation.

The differentiation of populations of Caucasian fir on phenotypes of different efficiency forms structural elements of phytocoenosises, in which the circles are allocated dominant and subordinated within the limits of one coenopopulation. The similar phenomenon is revealed and in populations of a number of grassy species (Synskaja, 1948). Thus the high productivity phenotypes occupy positions of the leaders, whose growth submits to the law of rank behaviour, rather than the formation coenocells being caused.

At a number of the vital forms the organization of populations raises by formation of extensive durable clones (rhodoretums, aspen), and also – by self-inoculations between copies *(Parrotia persian)*.

The organization of ecosystems is defined by volume and structure of the phenotypical and coenotypical information, in this aspect the decoding of a role of a biodiversity of Colches and Girkanian tertiary relict centres is important. Taxons of different geological age of a number of ecosystems are reliable objects for revealing laws of functional organization of ecosystems. A saturation by them of a number ecosystems: Girkanian, Colches, Mediterranean and boreal, is natural

scientific basis to the decision of a problem of evolution, of the different forms of a biodiversity.

The laws of flows of energy on pasturable and soil cycles and mechanisms sinergetics on ontogenetics and ecosystem, levels together with the marked above functions of a biodiversity, allow to build system of revealing, monitoring and checking of its preservation in dynamic modern ecosystems.

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Diversity of Medicinal Plants in Bangladesh and their Uses as a Resource

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Abstract

There is growing interest in medicinal plants and traditional medicine within the last decade. With the increasing use of medicinal plants in many countries, and with the accelerating destruction of natural resources in the tropics, it has become clear that the exploitation of medicinal plants must be accompanied by conservation measures, otherwise these plants become depleted as resources or may even face extinction. Bangladesh has a rich heritage of medicinal plants. Geographically, the location of Bangladesh is very unique; it is a short stretch of land between the Himalyan mountains and the Bay of Bengal, and a fertile deltaic region criss-crossed by the Ganges, the Brahmaputra, the Meghna and their network of tributaries. Naturally, Bangladesh has a rich forest resource having diversified ecosystems, such as in mangrove forest, hill forests, plainland forests, unclassed state forests, village groves etc. More than 200 plants growing in the forests are found to have medicinal values. We visited different Ayurvedic and Unani manufacturing firms in Bangladesh and enlisted the names of plants being used as raw materials. 110 plants are extensively used by these manufacturing firms to produce crude drugs. At present, there are many Ayurvedic and Unani manufacturing firms in Bangladesh, of these nine are quite big and supplying the major bulk of the traditional medicines in the market. These manufacturing firms exploit the nature by collecting the medicinal plants indiscriminately for their raw materials. So the conservation of these plants is needed for their sustainable use. An inventory of 200 medicinal plants with their uses is given in this paper and a biotechnological approach for their conservation is also mentioned.

Impacts of Market Pressure on the Genetic Diversity of the Yew *(Taxus)*: A Forest Bioresource for Therapeutic Taxanes

Stanley Scher

Introduction and background

For many centuries, the yew *(Taxus)* suffered declining populations from economic pressures, such as habitat loss as forested lands were replaced by expanding agriculture, and during the period when resilient yew wood was exploited for constructing long bows. Over the last several decades, forest management activities replaced natural forests with even-aged plantations, contributing to the further decline of yew abundance; short-rotation forestry selected against slow-growing *Taxus* species. Road building, clear-cut logging, and forest fragmentation increased access to ungulate browsing. Clear cutting followed by slash burning of understorey shrubs and saplings in the tree regeneration layer selected against temperature-sensitive *Taxus* species. The thin yew bark conferred vulnerability to prescribed burning and further reduces *Taxus* populations.

The recent discovery of paclitaxel (Taxol) – an anticancer agent – in the bark and other tissues of Pacific yew *(Taxus brevifolia)* and other yew species adds another dimension to the environmental and anthropogenic threats to the viability of these slow-growing, long-lived conifers. Currently, commercial production of paclitaxel and other taxane-based anticancer agents depends upon the access to reliable and sustainable sources of bioactive taxanes or their proximate precursors from yew species.

This report addresses the direct, indirect, and cumulative impacts of large-scale bark harvesting on Pacific yew, a non-renewable resource, and related forest management activities on the genetic diversity of this species in the temperate forests of western North America, and urges conservation measures to protect its gene pool from further degradation.

Direct, indirect, and cumulative impacts are defined by the National Environmental Policy Act as follows:

- Direct effects occur at the same time and place as the cause;
- Indirect effects appear later in time or farther removed in distance, but are reasonably foreseeable;
- Cumulative effects may result from incremental impacts when added to other past, present, and reasonably foreseeable future actions.
- Cumulative impacts can also result from individual minor, but
- collectively significant actions taking place over a period of time.

Impacts of bark harvesting on Pacific yew populations

Intensive use and management of yew species as a source of medicinal agents poses risks to fragmented yew populations. Present guidelines developed by the United States Department of Agriculture (USDA) Forest Service and the British Columbia Ministry of Forests in Canada require yew bark stripping for taxol production prior to commercial timber harvesting on clear cuts (Daust 1992; El-Kassaby and Yanchuk 1995). Accordingly, *Taxus* abundance on forested lands diminishes with the progress of timber harvesting.

Studies with *Taxus* and other heavily exploited conifer populations provide evidence that the greatest risks to genetic diversity appear at the level of the gene pool (Millar and Libby 1991; El-Kassaby and Yanchuk 1994; 1995). Negative (dysgenic) selection from highgrading – harvesting the largest yew trees on a site, leaving the inferior trees to regenerate the stand – represents a direct impact on the gene pool.

Marked reduction in the breeding population contributes to inbreeding, expression of recessive genes, and depression of viability in future generations – an indirect effect. Evidence for inbreeding in Pacific yew has been detected in British Columbia (El-Kassaby and Yanchuk 1994). Recent reports with fragmented populations suggest that inbreeding can drive small, spatially isolated populations to extinction (Kaiser 1998).

Impacts of related forest management activities

Introduction of non-local nursery-grown seedlings or rooted cuttings into native habitats during artificial reforestation may also contribute to disrupting the genetic structure, and changing genotype frequencies in future generations. Pacific yew cuttings collected from localities throughout its range were rooted at several nurseries in western North America for artificial reforestation initiatives, but impacts on genetic structure of native populations has not yet been reported (Daust 1991; Mitchell 1997; Kaplow and Scher 1998).

Commercial nurseries and large-scale plantations of yew cultivars and hybrids in northeastern, and mid-western United States, as well as federal land management agency counterparts – USDA Forest Service and US Department of the Interior, Bureau of Land Management – in the Pacific northwestern United States, British Columbia, CA, in Europe and Asia pose a potential impact on the gene pool of native yew species. Pollen clouds from yew hybrids cultivated at 10,000 individuals per acre represent a potentially serious threat to the genetic architecture of native populations in the surrounding forests. Taken together, the direct and indirect effects of large-scale bark harvesting and cumulative impacts of related forest management practices call attention to the need for bold conservation efforts to diminish further erosion of the *Taxus* gene pool.

Conserving the genetic integrity of native yew populations

Inventories of yew abundance by diameter class in remaining stands or studies of regeneration on harvested sites appear to be lacking. We urge actions to restore yew abundance to pre-harvest levels, insure a wide range of age and size classes, encourage the development of alternative, non-destructive, renewable, semisynthetic and other sustainable approaches to maintain long-term viability of this economically valuable, non-timber bioresource.

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Key Words:
Genetic diversity, non-timber forest bioresource, Pacific yew, *Taxus brevifolia,* native populations, cultivars, hybrids, paclitaxel, taxol, taxane, anticancer, negative selection, dysgenic, highgrading, artificial reforestation, plantations, habitat loss, short-rotation, clear-cut logging, forest fragmentation, ungulate browsing, regeneration, gene pool, genetic architecture, inbreeding, semisynthesis, sustainable development, long-term viability.

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Sustainable Use of the Galip Nut *Canarium indicum* and Rainforest Conservation on Siassi, Papua New Guinea

Klaus Schilder

With a total forest cover of more than 80% of its land mass Papua New Guinea currently belongs to one of the most densely forested areas. Community-based agroforestry systems, owned and operated by traditional resource holders, can contribute substantially to the protection and conservation of such forests in developing countries (Asher 1995). The Siassi Environment Foundation (SEF), a local NGO on the island of Siassi of the northern coast of PNG, is, supported by the Rainforest Forum Northern Bavaria, aiming at a sustainable rural development by using the Galip nut *Canarium indicum.* The integration of environmental awareness campaigns in remote areas with the implementation of a long-term strategy for the sustainable use of community-owned forests as an alternative to industrial logging is at the center of the effort of the project partners. According to general experience in Melanesia a successful conservation concept always has to include the right for sustainable economic development. With the present project we therefore aim at providing a sustainable and renewable source of income for the communities involved.

In summer 1995 9 village communities through the SEF jointly founded the "Galip nut project" to create an economic alternative to the imminent logging of a large part of the concession area on Siassi. At the same time the SEF and its legal assistant are trying to file a law suite to immediately halt further deforestation on the island. The Galip nut is a proteinaceous product from the rainforest. Its high acceptance among the local population renders it an ideal source of income for the village communities on the local market (Bourke 1996). On the neighboring Solomon Islands these nuts have now been successfully marketed for years. Ripe nuts are purchased by the SEF from the village families during the season from September to December at a guaranteed price. The nuts are processed in a small facility that was built in 1997. Nuts are cracked and pealed, then roasted and packed in 50 or 100 g units for retail on the local city markets. From November to December 1996 a student team from the University of PNG, Port Moresby, conducted a survey to evaluate the distribution and density of *Canarium indicum* on the island. Mean overall density is 15.2 trees per hectare, a density similar to that found for other *Canarium* species in the South Pacific. In 1995 a total of about 1000 kg of nuts was purchased from two villages, in 1996 another 1500 kg. Part of the harvest was distributed through the Lutheran Health Service in Lae. After deduction of total costs the SEF received a net gain of 13.7 US$ per 30 kg packaging unit. These funds are used by the SEF to provide school fees, teaching materials or to finance small community projects.

The right of indigenous communities for a self-determined development is integral part of the conservation concept. The Galip nut as a novel NTFP (non-timber forest product) has a high market potential on the local and global scale. In addition to the community-based sustainable use of NTFPs the development of certified eco-timber production by means of portable sawmills will provide a broad basis to the communities for a sustainable ecological, economic and social development and for risk minimization on Siassi.

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A Special Biotope in a *Pinus halepensis* Forest in Chalkidiki – N. Greece

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Abstract

In this study a valuable biotope, which has been identified in Kassandra Peninsula - Chalkidiki, is described and analysed for evaluation as special protected area. An inventory of flora and fauna has been carried out. The dynamic and evolution of the ecosystem is also discussed. A preliminary study for biotope's evaluation for recreation and environmental studies has been done. Finally, management measures and recommendations are reported in this work for declaration of biotope as Natural Protected Area for recreation, environmental studies and conservation of biodiversity.

1. Introduction

It is known that the overexploitation of the natural resources in our planet, particularly after the second world war, resulted in disturbance of terrestrial and watery ecosystems, extinction of valuable species of flora and fauna and degradation of the natural environment. All these activities have negative impacts, even threatening the human life. As a result the last years an international 'ecological reaction' has risen, expressed in international resolutions (Strasbourg 1990, Rio 1992, Helsinki 1993) with three main objectives:

1. To prohibit and control human activities which cause negative impacts on the ecosystems and intervene the natural rules.
2. To rehabilitate degraded ecosystems and restore their natural status.
3. To identify natural areas which have not been disturbed by human activities and posses special ecological and cultural characteristics, important aesthetic and recreational components of the landscape, covered by rare species of flora and fauna, and in general have scientific interest.

Based on the third objective, the law of Natural Protected Areas (PNA) has been established which includes terrestrial or watery areas with special ecological characteristics. These areas are under special legal status of management.

The objectives of this work is to describe and evaluate a special biotope named 'Mavrobara', which has been identified in Kassandra Peninsula in Chalkidiki (Greece), to analyze the forest ecosystem which dominates the area, and possibly to declare the biotope as Natural Protective Area (NPA).

2. Description of the area – Analyses of natural environment

The study area is located at 40° 00′ 5″ Latitude and 23° 30′ 5″ Longitude and covers an area of 50-60 ha. Its distance from Polychrono Village is about 3 km and the area belongs to the public forest of Polychrono. The area is distributed altitudinally from 200 to 260 m with exposures mostly northern and average inclination of 30%. Geologically, the area of Kassandra consists of strata of neogenic formations (loam, sandstone, limestone) (Marinos et al., 1970). The dominated rocks of the broader area are marl, alluvia, sands and marl limestones. The bedrock of the study area consists of sedimentary white marls and the soil is deep to moderately deep. The area of 'Mavrobara' is considered to have been formed by a geological plunge of the bedrock. The climate of the area of Kassandra Peninsula is of mediterranean type with hot and dry summers and

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mild winters. A summary of the climatic parameters of the meteorological station of Kassandra (altitude: 50 m, Latitude: 40° 03', Longitude: 23° 25'), based on observations of the last decade, is shown in Table 1 (FRI., 1997).

The forest soils of the broader area of Kassandra are mainly sandy-clayey-loamy and clayey-loamy with high proportion of clay. Characteristic of the soils of Kassandra is the high pH (usually 7.0-8.4) which results in release of big amount of free carbonates (up to 55%) (Tsitsoni, 1991). The soils of the study area are moderately deep to deep, clayey to sandy-clayey, loosen and easily eroded. In the area, the length of the streams is small and surface water(apart from the small ponds) rarely appears during the dry season. However, the study area which is a part of the broader hydrological basin, plays an important role in the water perception and runoff and enrichment of the streams of the lower elevations with groundwater. Thus, the study area is important from hydrological view since contributes directly to the water-supply of the Polychrono Community and the broader area.

3. Land use – Present management status of the area

The suggested protected area belongs to the State. The main land uses in the broader area are forestry, agriculture, apiculture, farming and recreation. In general, the land uses are not well defined. The management of *Pinus halepensis* forests is not well organized and the management plan for the broader area is not fully applied. The dominant forest species is *P. halepensis*. From the understorey species, important are the species *Quercus ilex* and the noble broadleaves (e.g. *Fraxinus ornus, Sorbus torminalis).* The understorey is composed of trees and bushes as mentioned above. In general, when forest management is applied, it is recommended to favour the noble species. The silvicultural system is the uneven-aged. Data of the standing wood volume for various diameter (DBH) classes are shown in Table 2 (Klonaris, 1991).

The risks from human activities are higher in summer due to many visitors which visit the area and might cause environmental problems and disturbance of some fauna species (e.g. turtles).

In the broader area, stock-breeding is restricted and depends (to about 30%) upon the understorey and ground vegetation. In general, grazing in the study area is restricted due to the dense understorey and the thickness of the climbers which obstruct the feeding and movement of the animals. Game management in the surrounding area is exercised under some control (according to the rules of 1996).

The inhabitants of Kassandra Peninsula number to 15,000 and the tourists during the period July-August to about 250,000. In the greater area there are beautiful sea-shores which tourists visit for about six months a year. The main occupation of the local people is tourism and the income is high to moderate. Recreation is an increasing use of the forests of the peninsula and soon will need regulation. The use of the area for beauty and recreation is in general moderate. However, many tourists visit the area mainly to observe the turtles which live in the small ponds. The signing, however, is temporary and information about the biotope and appropriate facilities in the area for recreation and environmental studies does not exist.

In the area of Polychrono there is a prehistorical settlement called Neromiri and as well as newer settlements there exist in the localities of Hellinika-Palini. In the ancient times the area used to have many naval stations controlled by the Athenians, Korinthians and Eretrieis.

Tab.1:. Climatic data of Kassandra meteorological station.

Mean annual precipitation	602 mm
Mean annual air temperature	16.3 °C
Hottest month	July
Coldest month	January
Mean maximum air temp. of the hottest month	30.2 °C
Mean minimum air temp. of the coldest month	4.7 °C
Annual temperature range	25.5 °C
Q2 Emberger	81.2
Bioclimatic type	Subhumid with mild winters

4. Analysis and description of the forest ecosystem – flora

The dominant forest species is Aleppo pine *(Pinus halepensis* Mill.). The forests of Aleppo pine belong to the dry mediterranean ecosystems and are found naturally in the forest vegetation type of evergreen broadleaves – *Quercetalia Ilicis. P. halepensis* is distributed in the sub-type of *Oleo-Ceratonion,* particularly in *Oleo – Lentiscetum* growth sub-division, and as well as in the *Quercion ilicis* sub-type, more specifically in *Adrachno-Quercetum ilicis* sub-division, where it meets the optimum of its growth (Dafis, 1976; Athanasiadis, 1986). Aleppo pine is easily adapted to the postfire environment, usually shows rich regeneration after fire and its presence and distribution depends upon fires (Dafis, 1987). In the study area the forest of *P. halepensis* is considered to be in the final stage (Climax) of a postfire succession. In the particular environment, due to the adequate soil humidity, *P. halepensis* is mixed with *Quercus ilex* and in some cases there is a displacement of *P. halepensis* by *Q. ilex.* For the same reason there is a good growth of the climbing species which in many cases climb to over half or more of *P. halepensis* and *Q. ilex* trees.

From the broadleaves important species found is *Q. ilex,* which in some sites of the study area is a co-dominant species with Aleppo pine. Other important species are *Q. pubescens* and *Fraxinus ornus.* Sporadically individuals of *Sorbus torminalis, Carpinus orientalis, Ulmus campestris* and *Cercis siliquastrum* can be found in humid sites and along the streams. In the understorey the following species have been identified: *Pistacia lentiscus, Quercus ilex, Q. coccifera, Phillyrea media, Arbutus unedo, A. adrachne, Myrtus communis, Prunus spinosa, Crataegus monogyna, Paliurus aculeatus, Pyracantha coccinea (Crataegus pyracanta), Pistacia terebinthus, Pirus amygdaliformis, P. communis, Juniperus communis, Olea europea, Erica arborea.* Also the climbers *Smilax aspera, Clematis flamula, C. vitalba L., Vitis vinifera* and *Hedera helix* are often found and in many cases climb on Aleppo pine trees. The natural regeneration of the pine is restricted on sites where there is no dense understorey and ground vegetation. The silvicultural system is uneven-aged and the ecological complex is stable.

Tab. 2: Standing wood volume of the pine forest in 'Mavrobara'.

Mean volume m³/ha Diameter class					Mean annual increment (m³/ha)
I 10<d<20	II 22<d<34	III 36<d<48	IV 50<d	Total	
5.00	18.00	42.00	25.00	90.00	4.75

The study area of the biotope is classified into the site type I (Ôsitsoni, 1991). This site type is found on good sites and mostly on N, NE and NW exposures and usually in the understorey dominate the species *Q. ilex* and *F. ornus*. The ground vegetation consists of mesophyta species with moderate ecological range and can be found on relatively good sites (Constantinidis, 1990; Tsitsoni, 1991). In the overstorey Aleppo pine is the dominant species while in the understorey the following species are common: *Pistacia lentiscus, Smilax aspera, Phillyrea media, Quercus coccifera, Asparagus acutifolius, Lonicera implexa, Cistus incanus, Lonicera etrusca, Anthylis hermanniae, Calicotome villosa, Clematis flamula, Q. pubescens, Myrtus communis.*

The characteristic woody species of the site type I are the following: *Quercus ilex, Fraxinus ornus, Cercis siliquastrum, Hedera helix, Colutea arborescens, Thymus sibthorpii.* From the ground vegetation, characteristic species are: *Rubia peregrina, Brachypodium retusum, B. pinnatum, Carduus pycnocephalus, Carex flacca, Astragalus monspessulanus.* The key herb species found are: *Calamintha nepeta, Carex distans, Galium aparine, Viola arvensis, Aremonia agrimonoides, Poa memoralis, Pteridium aquilinum.*

A list of species, identified in the study area and classified according to Tutin et al.(1964-1980), is shown in Table 3.

5. Fauna

For ecological evaluation of the ecosystem of 'Mavrobara', besides vegetation, the fauna and particularly amphibious and birds of prey, are also important. A preliminary inventory of important species of fauna has been carried out and the following species have been observed in the broader area (Tab. 4).

6. Discussion – Conclusions – Recommendations

The main tree species of the forest ecosystem in 'Mavrobara' is Aleppo pine. There are also other important tree species, mentioned above, with higher predominance of *Quercus ilex*. The age of the pine forest is 40-80 years and the structure (stratification) of the vegetation is multistoried. There are many symbiosis, some decayed old trees and in general the forest shows high naturalness and is considered to be in the final succession stage (Climax). Apparently this status of the forest can be explained by the following events:

- The forest has not been burnt in the last decades (last 50 years).
- The forest has not been managed on economical basis by the local forest service.
- The grazing pressure is low.
- There is a small pressure for conversion of forest land to agricultural land.

The ecological value of an ecosystem is as high as the ecosystem approaches to the succession stage of Climax. As much mature is an ecosystem as higher is its biodiversity for the following reasons (Odum, 1971):

- The total organic matter is higher.
- The species biodiversity is higher.
- The stratification is higher and more complete.
- The size of organisms is bigger.
- The life cycles are longer and more complicated.
- The cycles of nutrient elements are more closed and completed.
- The qualitative production exceeds the quantitative.
- The internal symbiosis is more developed.
- The information is much more higher.

As it is concluded from the above, the area of 'Mavrobara' is a valuable biotope, ecologically and recreationally. The biotope is a natural core where valuable genetic resources can be protected and possibly used for human needs in the future (Spanos, 1998). The ecosystem is something special for the Peninsula of Kassandra, which is famous for its sea-shores. Therefore, it should be further evaluated and properly protected (Spanos et al., 1997a). The benefits for the biotope and in general for the broader area will be multiple: ecological, scientific, economical and cultural (Trakolis et al., 1996; Spanos et al., 1997b). However, at present time the following actions should be done:

- To be declared as Natural Protected Area and officially protected.
- A management plant must be organized for the following purposes:
  - To protect and to make known the biotope.
  - To provide facilities for recreation and environmental studies to the visitors.

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Tab. 3: List of species (flora) found in the area.

A. TREE AND BUSHES	**Rhamnaceae**	**Cistaceae**
GYMNOSPERMAE	Paliurus spina-cristi	Cistus incanus
Pinaceae	**Rosaceae**	Cistus monspeliensis
Pinus halepensis	Crataegus monogyna	Cistus salvifolius
Cupressaceae	Prunus spinosa	**Lamiaceae (Labiatae)**
Juniperus communis	Pyracantha coccinea (Crataegus pyracantha)	Origanum heracleoticum
ANGIOSPERMAE -	Pyrus amygdaliformis	Thymus sibthorpii
DICOT.	Pyrus communis	Thymus capitatus
Anacardiaceae	Rosa canina	**Leguminosae**
Pistacia lentiscus	Rosa sempervirens	Anthyllis hermanniae
P. terebinthus	Rubus ulmifolius	Calycotome vilosa
Cotinus coggygria	Sorbus torminalis	Colutea arborescens
Betulaceae	B. CLIMBERS	Coronila emerus ssp emeroides
Carpinus orientalis	**Araliaceae**	Coronila cretica
Ericaceae	Hedera helix	Spartium Junceum
Arbutus unedo	**Caprifoliaceae**	Trifolium campestre
Arbutus adrachne	Lonicera caprifolium	Trifolium repens
Erica arborea	Lonicera implexa	**Rubiaceae**
Erica manipuliflora	**Liliaceae**	Rubia peregrina
Fagaceae	Smilax aspera	**Violaceae**
Quercus ilex	**Ranunculaceae**	Viola ssp.
Q. pubescens	Clematis flammula	ANGIOSPERMAE - MONOC.
Q. coccifera	C. vitalba	Liliaceae
Lauraceae	**Vitaceae (Ampelidaceae)**	Asparagus acutifolius
Laurus nobilis	Vitis vinifera	Ruscus aculeatus
Leguminoseae	C. LOW BUSHES AND HERBS	**Poaceae (Gramineae)**
Cercis siliquastrum	PTERIDOPHYTA	Aremmonia agrimonoides
Myrtaceae	**Hypolepidaceae**	Brachypodium sylvaticum
Myrtus communis	Pteridium aquilinum	Dactylis glomerata
Oleaceae	ANGIOSPERMAE - DICOT.	Poa memoralis
Fraxinus ornus	**Asteraceae (Compositae)**	**Thymelaeaceae**
Olea europea var. oleaster	Cirsium arvense	Thymaelaea tortonraira
Phillyrea media	Cirsium creticum	

Tab. 4: List of species of fauna found in the area.

A. MAMMALS	INSECTIVORA	D. REPTILES
CARNIVORA	**Talpidae**	**Testudinata**
Mustelidae	Talpa caeca	Testudo hermanii boettgeri
		(Mediterranean turtle)
Martes foina	B. BIRDS (no data)	Emys orbicularis
		(European Pond Terrapin)
Meles meles	C. AMPHIBIANS	Mauremys caspica
		(Stripe-necked Terrapin)
LAGOMORPHA	**Caudata**	**Sauria**
Leporidae	Salamandra salamandra	Anguis fragilis
Lepus europeus	**Anura**	Lacerta viridis
RODENTIA	Bombina variegata	L. trilineata
Sciuridae	Bufo bufo spinosus	Podacris erhardii
Sciurus vulgaris	B. viridis	P. muralis albanica
VESPERTILIONIDAE	Rana graeca	**Ophidia**
Vespertilionidae	R. temporaria	Coluber
Myotis blythi		Natrix tessellata
Myotis oxygnathus		Vipera ammodytes meriodionalis
Nyctalus noctula		

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The Role of Traditional Use in the Conservation of Forest Ecosystem Biodiversity in the Baikal Region

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Abstract

1. The lake Baikal Siberia.
– Natural environmental traditions in the Baikal region people's religions. - The history of specially protected areas founded since Chingiz-Khan times untill the present. Shamanism. Buddism.

– Overview of the Baikal Region forest fund. The rebirth of traditional use of nature by native people. Examples: sacred groves (shaman's burial places); Kaiser-adler – sacred bird of Mongolians.

2. The rebirth of traditional use of nature – the basis of sustainable forestry and biodiversity preservation in the lake Baikal region forest ecosystems. – Contemporary forestry management methods in the Republic of Buryatia.

– Foundation of the sustainable forestry model on the basis of traditional use of nature by the lake Baikal Siberia natives (russian-american project). – Sacred places – points of ecological framework supporting biodiversity in the centre of the Europe-Asia area (Baikal Siberia).

The role of the lake Baikal Region biodiversity preservation for sustainable development in the Europe-Asia area.

– Problems and objectives with the lake Baikal Region forest ecosystem biodiversity preservation. – Organization of ecologically responsible forest use on the territory of World Heritage (the lake Baikal coastal protected strip).

– Sacred places – a new category of especially protected nature territories.

– Preservation of virgin forests; forestry keeping to the basis of traditional use of nature by the lake Baikal Region natives- guarantee of biodiversity preservation, diminution of the risk of the Europe-Asia area disstabilization, contribution to diminution of global warming.

Woodlands Pattern and Territorial Diversity in Madrid

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Abstract

Biodiversity deals with the pattering of ecosystems in space, which can be correlated with ecological processes. The present research applies two indices of pattern derived from information theory and fractal geometry. Using a digitized land use map, the indices are measured both for the whole province of Madrid, and for three different zones within it. The territorial diversity is measured, as well as the proportion of this diversity that is given by the forests. Different levels of detail have been also compared, calculating the indices for 11, 166 and 650 land units at each zone.

1. Introduction

Territorial diversity is concerned with relationships between ecological processes and spatial pattern, particularly at large scales. Ecological processes such as plant succession, biodiversity, foraging patterns, predator-prey interactions, dispersal, nutrient dynamics, and the spread of disturbance all have important spatial components (Turner, M. G. and Gardner, R. H., 1991; Forman, R. T. T., 1997).

Biodiversity refers to the variety of life forms, specially the number of species, but including the number of ecosystem types and the genetic variation within species: the effect of patch size on species number has been much studied; the structure of the mosaic strongly affects crop growth and erosion on a farm, biodiversity and aesthetics in a park, wood production and fish in a forest, wildlife movement and extinction in a refuge, water and livestock production on a ranch, and ecological characteristics of a town. (Forman, R. T. T., 1997).

Quantitative analysis of these relationships requires the development and use of quantitative measures of landscape pattern. A wide variety of pattern indices may be necessary to accommodate the many different data types and formats used by landscape ecologists and to measure different aspects of pattern. (Turner, M. G. and Gardner, R. H., 1991).

2. Description of the research

Two indices of pattern have been developed, one based on information theoretic measures (Shannon, C. E. and Weaver, 1962) and one on fractal geometry (Mandelbrot, B., 1983).

The aim of the research has been to measure the landscape diversity in the province of Madrid (800,000 hectares) and the proportion of this diversity that is given by the forests, based on the Shannon index and the fractal dimension. The indexes have been calculated both for the whole province and for three different zones in Madrid (Zone 1-North; Zone 2-Middle; Zone 3-South), as shown in the map below.

Another important aim of the research was to compare the results of applying the indexes at different detailed levels within the land use map (different number of land units), in order to determine how far should we go for the better measuring of diversity. The work has been done for three levels: the first one with 11 land units, the second one using 166 units, and the third and most detailed level with 650 land units.

3. Description of the Land Use Map

This map, which has been used as the basis of the work, was created digitizing over SPOT satellite images (20x20 m resolution), with the assistance of color aerial photos on 1:18,000 scale searching for as much detail as possible, and with the checking work of travelling around the area on several field trips.

The result was a legend with 650 categories at its maximum detail, although they can be gathered together on six different levels, as it can be shown in this example:

6. Pine forests
6.a. *Pinus sylvestris*
6.a.1. Natural or partially natural forests
6.a.1.a. Rocks not seen (< 5%)
6.a.1.a.1. 20-50% canopy cover
6.a.1.a.1.a. Presence of pastures

Three of these levels (1st, 3rd and 6th) have been compared on this research.

4. Landscape diversity indexes used

Two indexes have been used in order to measure the territorial diversity of Madrid province:

- Shannon Diversity Index

$Ð = - {}^{m}P_i Ln P_i$

Pi = surface proportion of landscape unit i

m = number of different types of landscape units

Measures the extent to which one or a few land uses dominate the landscape. Maximum values observed on ecosystems are close to 5.3. A community with two species equally frequent would have a value of 1 (Turner, M.G., 1989; Calatayud, T., 1997).

- Fractal dimension

$\mathrm{Log}P \approx (1/2)\, d\, \mathrm{Log}A$

d = fractal dimension

A= Area

P = Perimeter

It is an index of the complexity of shapes on the landscape. Its estimation is based on the regression of LogA in relation to Log P. Values vary between 1 and 2: simple geometric forms have values close to 1 (Calatayud, T., 1997).

5. Results of applying the indexes in Madrid Province

Shannon index has been calculated both for the whole province and for the three zones separately, with the following results:

The maximum value has been calculated considering all land use types were present in equal proportions (O'Neill et abl., 1988), in order to have a reference to which compare the figures obtained, (Fig. 2).

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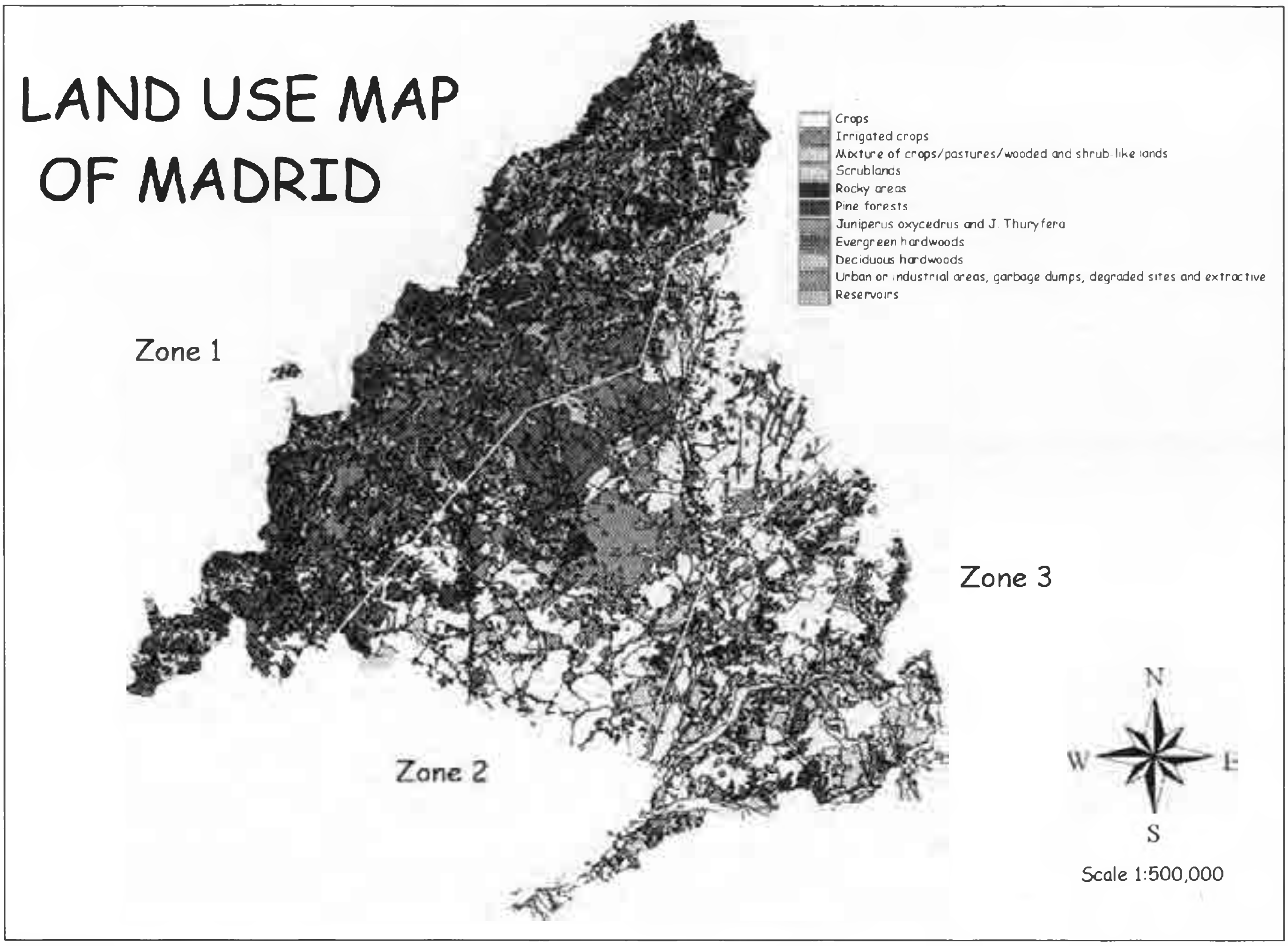

Fig. 1: Land Use Map of Madrid.

The values considering the maximum detail (650 landscape units) are very high, close to the maximum values observed on ecosystems (5.3), and also close to the maximum for this zone (6.4). An important difference is shown between these and the values for 166 or 11 landscape units. The highest detail, the highest diversity is shown. Nevertheless, if the aim was only to compare diversity between different zones, such a detail is not necessary, and lower levels would be sufficient.

Zone 1 is the mountain range that crosses Madrid from Northeast to Southwest, and the diversity is quite higher there.

Diversity contributed by forest areas is especially relevant in Zones 2 and 3, where the proportion of diversity contributed is quite higher than the proportion of the area occupied by them. In zone 1, the forested area is very similar to the proportion of diversity contributed (Fig. 3).

Fractal index shows the shape of the land units' border (Fig. 4). Values are low, which means we are in a zone highly human influenced. These results can also be due to the digitizing process, where the person in charge may tend to draw simpler lines than the ones in Nature. They also bring up the slight difference between the three detail degrees, what is to say that the borders have simple geometric forms no matter if we are talking about 11, 166 or 650 units.

Fractal dimension shows slightly higher values for forested areas (Fig. 5), especially in Zones 2 and 3, which means that these areas are less human influenced than the rest.

6. Conclusions

- Diversity index shows a very high value for Madrid province (5). Maximum diversity is shown in Zone 1, which is the most mountainous and forested one.
- For the whole province, forested areas represent the 30% of the total diversity (forested surface ≈20%), and this is especially underlined at Zones 2 and 3, where total diversity is lower than in Zone 1.
- Fractal dimension analysis shows that Madrid has a high human influence, as the index shows low values (close to 1), which means that the landscape exhibits simple patterns. The distinction between different detailed legend categories, as well as the different zones (1, 2 and 3), doesn't give much information, as the number or location of land units make no difference regarding their simple geometric shapes.
- Nevertheless, the fractal index reveals slightly higher values when is applied only to forest areas, especially in zones 2 and 3. In these zones forests represent areas with less human influence within the whole.

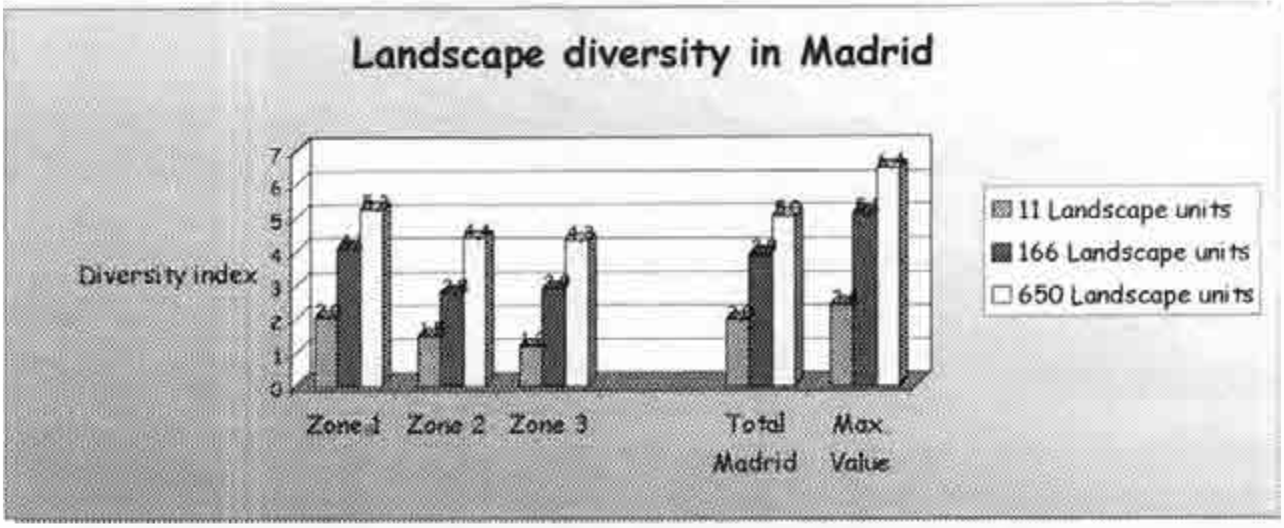

Fig. 2: Landscape Diversity in Madrid.

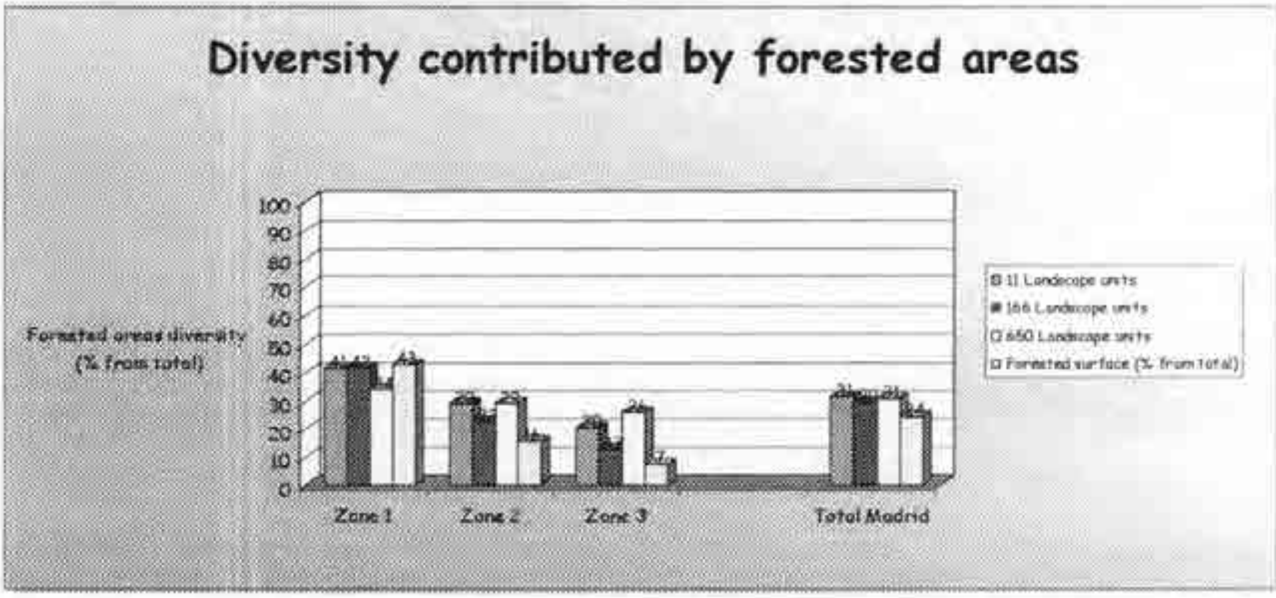

Fig. 3: Diversity Contributed by Forested Areas.

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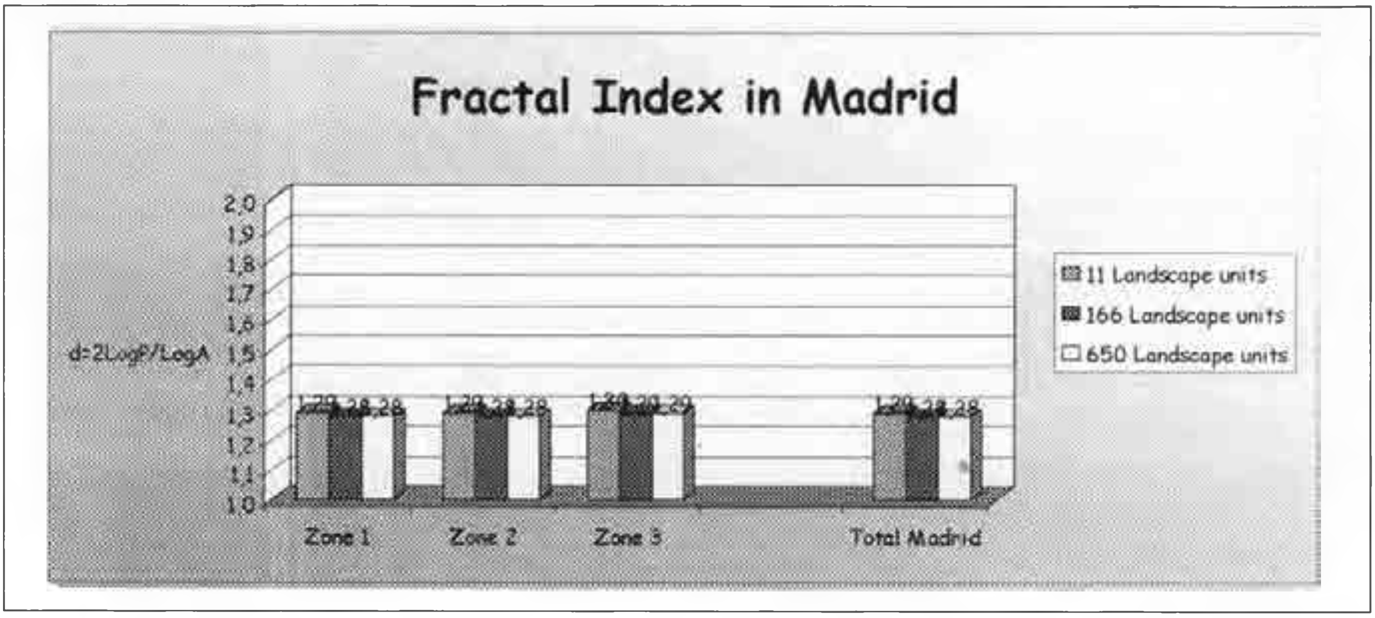

Fig. 4: Fractal Index in Madrid.

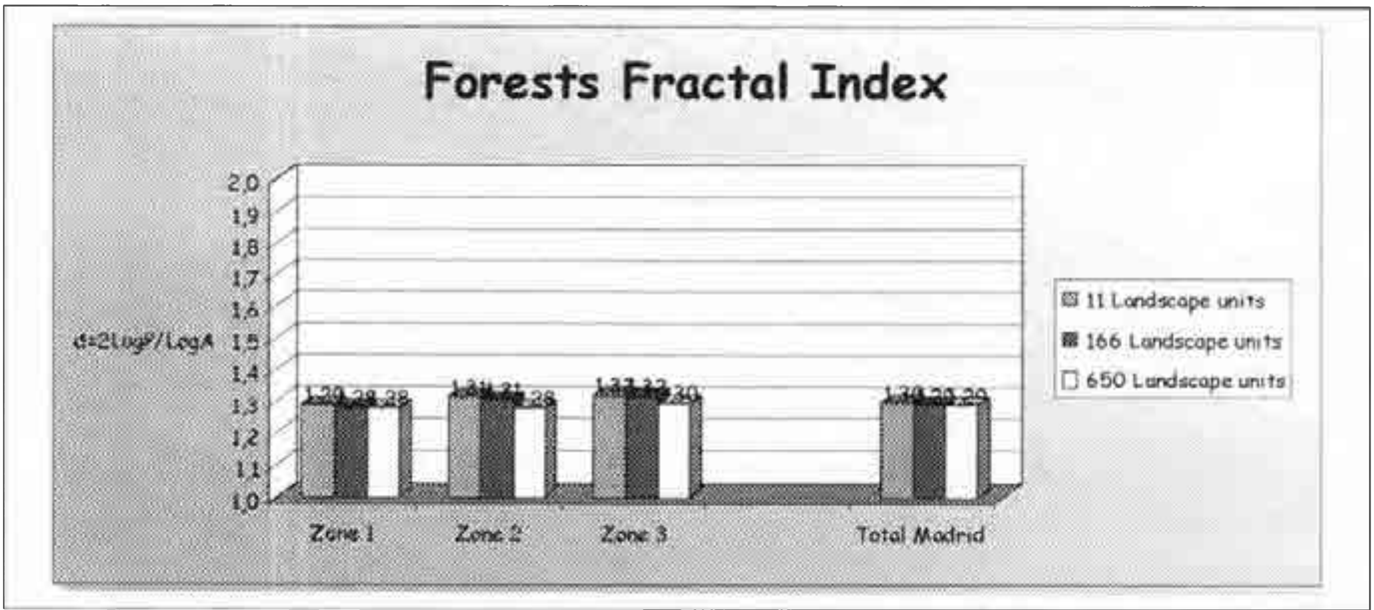

Fig. 5: Forests Fractal Index.

Analysis of High Resolution Satellite Data for Recording Composition and Structure of Forests

C. Werner, B. Coenradie & H. Kenneweg

Abstract

The use of satellite remote sensing data for analyzing forested areas has been limited due to insufficient ground resolution. Data of conventional systems do not contain detailed information about structure and composition which are important factors to describe the condition of the stands. A new generation of optical satellite systems with high ground resolution (less than 6 m^2) enable a more detailed evaluation of these features. The Indian Remote Sensing System (IRS-1C/D), which has been ready for operation since December 1995 and the German MOMS-02-Sensor (Modular Optoelectronic Multispectral Stereo Scanner), which is still an experimental system, are representatives of these modern satellite sensors.

In the first part of this report, the results of the analysis of MOMS-02 image data of a tropical rain forest area in Mindanao, Philippines, will be presented. To find out the potential of the newly developed sensor, different methods of image analysis were applied, compared and evaluated.

Because of the intensive logging activities, the forests of the test site are mainly composed of secondary forest stands, which are partially severely degraded. Importance was therefore attached to the registration of the condition of the forest stands, which can be described by structure (density, age, vertical layering).

The spectral and textural properties of the MOMS-02 image data enable a detailed analysis of the vegetation stands. The crowns of adult rain forest trees of the upper canopy can be identified. Mature long-living trees, young trees and pioneers can be differentiated, an important fact for the description of the vegetation structure. The application of different image analysis methods and the combination in a GIS allow a detailed description of composition, density and vertical structure, which are important parameters for the examination of the conditions of the forest stands.

Furthermore, the analysis of vertical structure in a GIS may enable the estimation of areas with high regeneration potential of primary forest tree species. Combining the classification results with topographic data allows the identification of areas with high erosion risk.

The second part of the presentation includes the description of the experiences of two ongoing projects in Eastern Germany, where the applicability of Indian IRS-1C image data for forestry and landscape planning will be analyzed. This includes the examination of different image processing methods and the evaluation in a GIS.

The first results show that digital image processing methods allow a detailed differentiation of composition, structure and condition of forests. Boundaries of forest stands can be identified with high accuracy.

The classification results are a suitable instrument for analysis in a GIS. Minimal areas, different shape of stands, distance measures for habitat network planning and the estimation of the degree of naturalness of the vegetation stands are examples for the applicability of these satellite remote sensing data

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