Solving the puzzle

The Ecosystem Approach and Biosphere Reserves

Project Director: Peter Bridgewater
Editor: Malcolm Hadley
Editorial assistant: Pamela Coghlan
Primary contributors: Mireille Jardin, Claudia Karez, Jane Robertson Vernhes
Art and design: Ivette Fabbri
Cover photo: Worm Sorensen

Published in April 2000 by the United Nations Educational, Scientific and Cultural Organization (UNESCO), 7, place de Fontenoy, 75352 Paris 07 SP, France

Suggested citation: UNESCO. 2000. *Solving the Puzzle: The Ecosystem Approach and Biosphere Reserves*. UNESCO, Paris.

Printed by Imprimerie Landais, F-97160 Noisy-le-Grand

UNESCO thanks all those individuals and institutions who have made available their photographs for use in this booklet.

About this booklet

The ecosystem approach has been adopted by the Conference of the Parties of the Convention on Biological Diversity (CBD) as the primary framework for action under the Convention.

As requested by the Conference of Parties at its fourth meeting, principles and other guidance on the ecosystem approach has been prepared by the Subsidiary Body on Scientific, Technical and Technological Advice (SBSTTA), at its fifth meeting held from 31 January – 4 February 2000 in Montreal. This guidance material has been prepared for consideration by the Conference of Parties at its fifth meeting in May 2000 in Nairobi. It builds upon the Malawi principles, developed at a workshop on the ecosystem approach held in Lilongwe in January 1998, as well as the experience and conclusions of a number of other workshops and initiatives that have been organized on this matter in recent years.

The philosophy and actions associated with the ecosystem approach have many shared concerns with the biosphere reserve concept, promoted by UNESCO through its Man and the Biosphere (MAB) Programme and through the World Network of Biosphere Reserves, which (in April 2000) comprises 368 sites in 91 countries.

This booklet presents each of the principles considered in the discussions of CBD-SBSTTA in February 2000, and illustrates their application in several biosphere reserves. It must be stressed that, like the ecosystem approach itself, biosphere reserves consider all principles important in the effective management of ecosystems. But for simplicities sake each principle has been highlighted by particularly relevant examples from the global set of biosphere reserves.

The ecosystem approach will be seen through the lens of individuals, communities, States parties and international organizations. This publication is a snapshot of the view from the Secretariat of UNESCO-MAB of the relationship between the twelve (ecosystem approach) principles and the World Network of Biosphere Reserves. This view is likely to evolve, alongside the evolution of the principles themselves, and the World Network of Biosphere Reserves.

The ecosystem approach

The ecosystem approach is a strategy for the integrated management of land, water and living resources that promotes conservation and sustainable use in an equitable way. Thus, the application of the ecosystem approach will help to reach a balance of the three objectives of the Convention: conservation; sustainable use; and the fair and equitable sharing of the benefits arising out of the utilization of genetic resources.

An ecosystem approach is based on the application of appropriate scientific methodologies focused on levels of biological organization, which encompass the essential structure, processes, functions and interactions among organisms and their environment. It recognizes that humans, with their cultural diversity, are an integral component of many ecosystems.

This focus on structure, processes, functions and interactions is consistent with the definition of 'ecosystem' provided in Article 2 of the Convention on Biological Diversity:

> *'Ecosystem' means a dynamic complex of plant, animal and micro-organism communities and their non-living environment interacting as a functional unit.*

This definition does not specify any particular spatial unit or scale, in contrast to the Convention definition of 'habitat'. Thus, the term 'ecosystem' does not, necessarily, correspond to the terms 'biome' or 'ecological zone', but can refer to any functioning unit at any scale. Indeed, the scale of analysis and action should be determined by the problem being addressed. It could, for example, be a grain of soil, a pond, a forest, a biome or the entire biosphere.

The ecosystem approach requires adaptive management to deal with the complex and dynamic nature of ecosystems and the absence of complete knowledge or understanding of their functioning. Ecosystem processes are often non-linear, and the outcome of such processes often shows time-lags. The result is discontinuities, leading to surprise and uncertainty. Management must be adaptive in order to be able to respond to such uncertainties and contain elements of 'learning-by-doing' or research feedback. Measures may need to be taken even when some cause-and-effect relationships are not yet fully established scientifically.

The ecosystem approach does not preclude other management and conservation approaches, such as biosphere reserves, protected areas, and single-species conservation programmes, as well as other approaches carried out under existing national policy and legislative frameworks, but could, rather, integrate all these approaches and other methodologies to deal with complex situations. There is no single way to implement the ecosystem approach, as it depends on local, provincial, national, regional or global conditions. Indeed, there are many ways in which ecosystem approaches may be used as the framework for delivering the objectives of the Convention in practice.

Twelve principles have been proposed for the ecosystem approach, which are complementary and interlinked. These twelve principles are listed on pages 4–5, together with five points which have been suggested as operational guidance in applying the twelve principles of the ecosystem approach.

Text extracted from documentation prepared for the fifth session of the Conference of Parties of the Convention on Biological Diversity (Nairobi, 15–26 May, 2000), specifically 'Reports of the Subsidiary Body on Scientific, Technical and Technological Advice: Report of the fifth meeting of the Subsidiary Body on Scientific, Technical and Technological Advice' (Document UNEP/CBD/5/3, pages 78–84).

Principles of the ecosystem approach

1. The objectives of management of land, water and living resources are a matter of societal choice.
2. Management should be decentralized to the lowest appropriate level.
3. Ecosystem managers should consider the effects (actual or potential) of their activities on adjacent and other ecosystems.
4. Recognizing potential gains from management, there is a need to understand the ecosystem in an economic context.
5. Conservation of ecosystem structure and functioning, in order to maintain ecosystem services, should be a priority target of the ecosystem approach.
6. Ecosystems must be managed within the limits of their functioning.
7. The ecosystem approach should be undertaken at the appropriate spatial and temporal scales.
8. Recognizing the varying temporal scales and lag-effects that characterize ecosystem processes, objectives for ecosystem management should be set for the long term.
9. Management must recognize that change is inevitable.
10. The ecosystem approach should seek the appropriate balance between, and integration of, conservation and use of biological diversity.
11. The ecosystem approach should consider all forms of relevant information, including scientific and indigenous and local knowledge, innovations and practices.
12. The ecosystem approach should involve all relevant sectors of society and scientific disciplines.

Operational guidance for application of the ecosystem approach

In applying the twelve principles of the ecosystem approach, the following five points are proposed as operational guidance.

1.

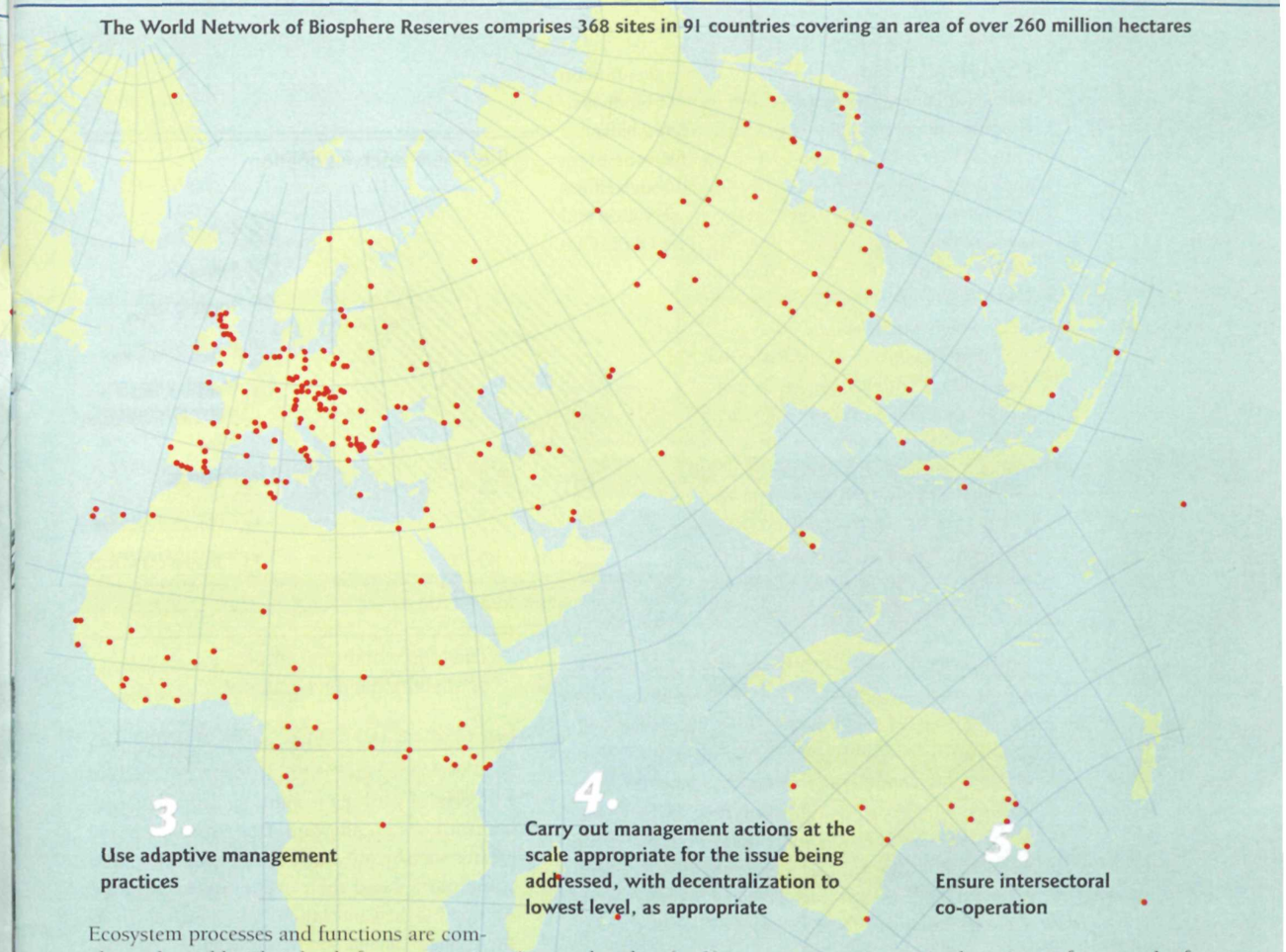
Focus on the functional relationships and processes within ecosystems

The many components of biodiversity control the stores and flows of energy, water and nutrients within ecosystems, and provide resistance to major perturbations. A much better knowledge of ecosystem functions and structure, and the roles of the components of biological diversity in ecosystems, is required, especially to understand: (i) ecosystem resilience and the effects of biodiversity loss (species and genetic levels) and habitat fragmentation; and (ii) determinants of local biological diversity in management decisions. Functional biodiversity in ecosystems provides many goods and services of economic and social importance. While there is a need to accelerate efforts to gain new knowledge about functional biodiversity, ecosystem management has to be carried out even in the absence of such knowledge. The ecosystem approach can facilitate practical management by ecosystem managers (whether local communities or national policy makers).

2.

Promote the fair and equitable access to the benefits derived from the functions of biological diversity in ecosystems and from the use of its components

Benefits that flow from the array of functions provided by biological diversity at the ecosystem level provide the basis of human environmental security and sustainability. The ecosystem approach seeks that the benefits derived from these functions are distributed equitably. In particular, these functions should benefit the stakeholders responsible for their production and management. This requires, *inter alia*: capacity-building, especially at the level of local communities managing biological diversity in ecosystems; the proper valuation of ecosystem goods and services; the removal of perverse incentives that devalue ecosystem goods and services; and, consistent with the provisions of the Convention on Biological Diversity, where appropriate, their replacement with local incentives for good management practices.



The World Network of Biosphere Reserves comprises 368 sites in 91 countries covering an area of over 260 million hectares

3.

Use adaptive management practices

Ecosystem processes and functions are complex and variable. Their level of uncertainty is increased by the interaction with social constructs, which need to be better understood. Therefore, ecosystem management must involve a learning process, which helps to adapt methodologies and practices to the ways in which these systems are being managed and monitored. Implementation programmes should be designed to adjust to the unexpected, rather than to act on the basis of a belief in certainties. Ecosystem management needs to recognize the diversity of social and cultural factors affecting natural-resource use. Similarly, there is a need for flexibility in policy-making and implementation. Long-term, inflexible decisions are likely to be inadequate or even destructive. Ecosystem management should be envisaged as a long-term experiment that builds on its results as it progresses. This 'learning-by-doing' will also serve as an important source of information to gain knowledge of how best to monitor the results of management and evaluate whether established goals are being attained. In this respect, it would be desirable to establish or strengthen capacities of Parties for monitoring.

4.

Carry out management actions at the scale appropriate for the issue being addressed, with decentralization to lowest level, as appropriate

As noted earlier (p. 3), an ecosystem is a functioning unit that can operate at any scale, depending upon the problem or issue being addressed. This understanding should define the appropriate level for management decisions and actions. Often, this approach will imply decentralization to the level of local communities. Effective decentralization requires proper empowerment, which implies that the stakeholder both has the opportunity to assume responsibility and the capacity to carry out the appropriate action, and needs to be supported by enabling policy and legislative frameworks. Where common property resources are involved, the most appropriate scale for management decisions and actions would necessarily be large enough to encompass the effects of practices by all the relevant stakeholders. Appropriate institutions would be required for such decision-making and, where necessary, for conflict resolution. Some problems and issues may require action at still higher levels, through, for example, transboundary co-operation, or even co-operation at global levels.

5.

Ensure intersectoral co-operation

As the primary framework of action to be taken under the Convention, the ecosystem approach should be fully taken into account in developing and reviewing national biodiversity strategies and action plans. There is also a need to integrate the ecosystem approach into agriculture, fisheries, forestry and other production systems that have an effect on biodiversity. Management of natural resources, according to the ecosystem approach, calls for increased intersectoral communication and co-operation at a range of levels (government ministries, management agencies, etc.). This might be promoted through, for example, the formation of inter-ministerial bodies within the Government or the creation of networks for sharing information and experience.

Biosphere reserves and the ecosystem approach

Consistent with the Articles of the Convention on Biological Diversity, a balanced approach to biodiversity conservation generally is essential. Such a balanced approach can be achieved through the ecosystem approach being adopted by the CBD, and through efforts to involve all sectors of society in the conservation and management of biological diversity. The UNESCO-MAB World Network of Biosphere Reserves is one way of involving people in biodiversity conservation.

The biosphere reserve approach links ecology with economics, sociology and politics, and ensures that good policy intentions do not yield inappropriate results. Performance and achievement is evaluated on a regular basis, and the views and desires of local communities remain paramount. Biosphere reserves are indeed special places for people and nature, and are a key help in managing our biosphere.

Biosphere reserves are areas of terrestrial and coastal ecosystems promoting solutions to reconcile the conservation of biodiversity with its sustainable use. They are internationally recognized, nominated by national governments and remain under sovereign jurisdiction of the states where they are located. They serve in some ways as 'living laboratories' for testing out and demonstrating integrated management of land, water and biodiversity, which is the embodiment of the 'ecosystem approach' being developed by the Convention on Biological Diversity.

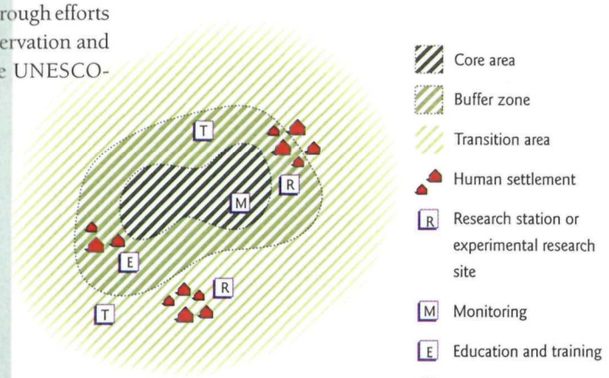
In the development of policies for implementing, managing and monitoring the World Network of Biosphere Reserves, a strategy has been developed following a major international meeting in Seville (Spain) in March 1995. Called simply the Seville Strategy, it is clear and simple, and is organized in a hierarchy of goals, strategies and actions. There are three primary goals:

- Use biosphere reserves to identify and conserve natural and cultural diversity.
- Use biosphere reserves as models of land management and of approaches to sustainable development, using appropriate incentives.
- Use biosphere reserves for research, monitoring, education and training.

These broad goals, and their subsidiary objectives, represent a global application of the ecosystem approach.

Biosphere reserves are organized into three interrelated zones, known as the core area, the buffer zone and the transition area. This zonation is applied in many different ways in the real world to accommodate geographical conditions and local constraints.

Biosphere reserve zonation



Towards working examples of sustainable development

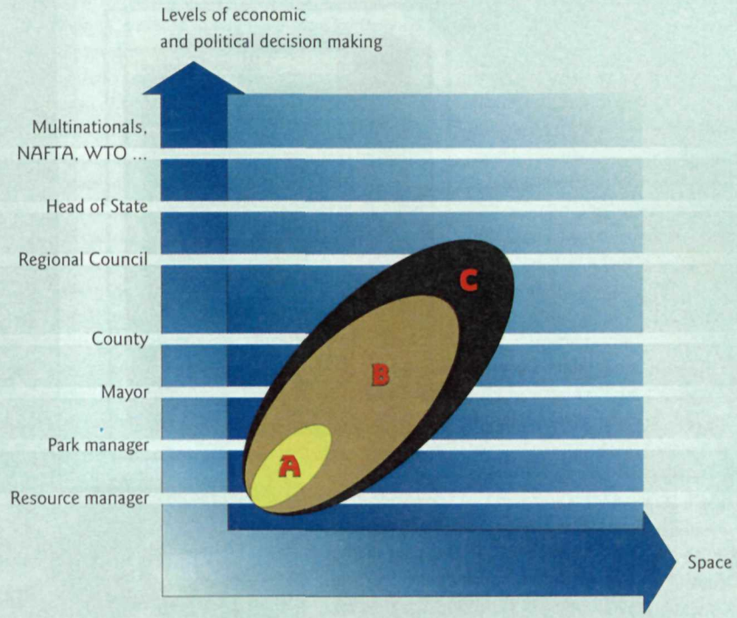
The United Nations Conference on Environment and Development (UNCED) in Rio in 1992 laid out a process of working towards sustainable development, incorporating care of the environment and greater social equity, including respect for rural communities and their accumulated wisdom. Agenda 21, the Conventions on Biological Diversity, Climate Change and Desertification, and other multi-lateral agreements, show the way forward at the international level.

But the global community also needs working examples that encapsulate the ideas of UNCED for promoting both conservation and sustainable development. These examples can only work if they express all the social, cultural, spiritual and economic needs of society and are also based on sound science.

Biosphere reserves offer such models. Rather than forming islands in a world increasingly affected by severe human impacts, they can become theatres for reconciling people and nature; they can bring knowledge of the past to the needs of the future; and they can demonstrate how to overcome the problems of the sectoral nature of our institutions. In short, biosphere reserves are much more than just protected areas. They represent a means for promoting management essentially as a pact between the local community and society as a whole.

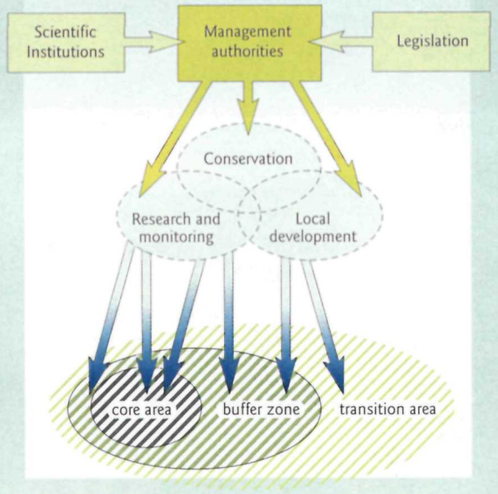
Inherent in the biosphere reserve concept are the ideas of both conservation and change – conservation of biological diversity as well as traditional ecological knowledge and resource management know-how, but also change in the way that societies use their rural environments and their natural resources. Encapsulating the idea of change are transition areas, which are intended to accommodate adaptations to society's call for sustainable development and use. These areas contain the means of production of the community. The approach is a positive and forward-looking one, which seeks to accommodate change whilst seeking a good environment and a good quality of life. At the same time, the trend towards landscape management calls for new forms of institutional co-operation and links between different levels of economic and political decision-making.

Biosphere reserves: towards large-scale landscape management



A Small biosphere reserve: single core and/or research site.
B Simple cluster biosphere reserve: conservation and research and some consideration of local community development.
C Regional unit biosphere reserve: conservation, research and rural development in a landscape context.

Nature of biosphere reserve management



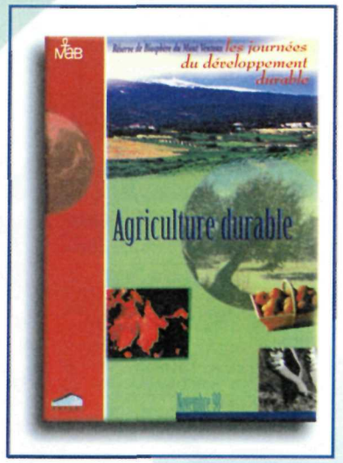
In the following pages, a statement of each of the twelve principles of the ecosystem approach and its rationale is associated with glimpses into work underway at a sampling of biosphere reserves in different parts of the world.

The overall aim is to contribute to the application of the ecosystem approach at the same time as promoting closer links between the work of the Convention on Biological Diversity and the World Network of Biosphere Reserves. The underlying motivation is to help fit the pieces of the 'ecosystem approach puzzle' together, to ensure a future where conservation and sustainable use of biological diversity is assured!

principle 1

***The objectives** of management of land, water and living resources are a matter of societal choice.*

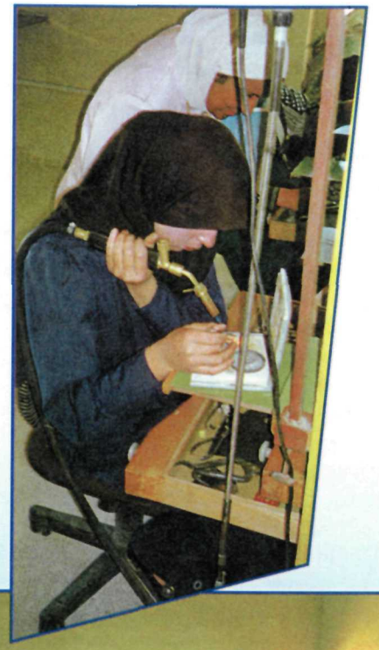
RATIONALE: *Different sectors of society view ecosystems in terms of their own economic, cultural and societal needs. Indigenous peoples and other local communities living on the land are important stakeholders and their rights and interests should be recognized. Both cultural and biological diversity are central components of the ecosystem approach, and management should take this into account. Societal choices should be expressed as clearly as possible. Ecosystems should be managed for their intrinsic values and for the tangible or intangible benefits for humans, in a fair and equitable way.*

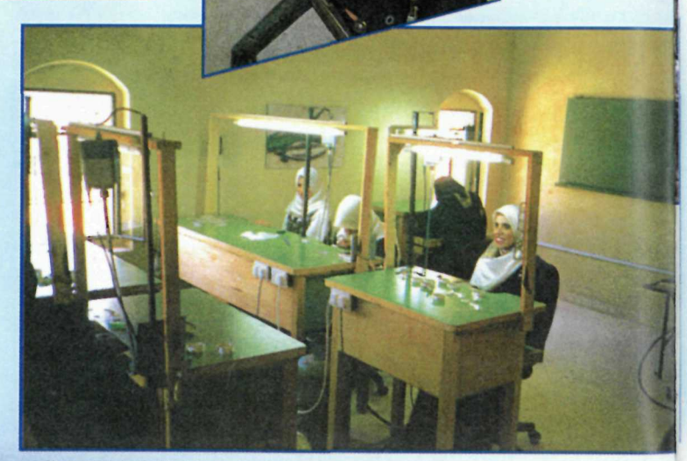


The Mont Ventoux is in many ways a mythical mountain in the Provence region in southern France. Mythical, as its bare, whitish rock summit stands out for kilometres around from the dark oak and beech forests and colourful fields of lavender and cereals. As from the eighteenth century, botanists and naturalists made inventories of its biological riches. Cyclists and mountaineers braved its steep slopes. Tourists came to throng traditional villages and buy up abandoned farmhouses.

The people of the Ventoux, under these increasing pressures, felt that their birthplace merited some 'management in its management' *('les gens du Ventoux ...voudraient dire que leur pays mérite quelque ménagement dans les aménagements')*. The structure of a *Syndicat mixte*, consisting of a grouping of representatives of the villages and of the authority of the administrative department in which the Ventoux is located, was initially set up in 1965, focusing on visitor facilities. In 1978, this *Syndicat mixte* extended its mandate to enhance the natural and cultural values. The idea of a 'park' was rejected, deemed as too constraining. It was in the 1990s that the biosphere reserve concept was adopted as a framework for action. A management board for the biosphere reserve was set up consisting of the mayors of the thirty-one villages which agreed to participate, scientists, government administrations, the French Forest Office (responsible for the management of large parts of the site) and representatives of local and private associations.

The core areas have been identified and conferred special protected status. A work plan has been developed, with a strong emphasis on local development, the protection of the natural heritage and its associated cultural values, and education and information. Recently, approaches to the implementation of a sustainable agriculture in the Ventoux have been examined in concert with a multiplicity of actors. Through means such as these, and thanks to a flexible and original management structure, the biosphere reserve concept is being applied at the concrete field level, in a way that reflects the societal choices of the local population.





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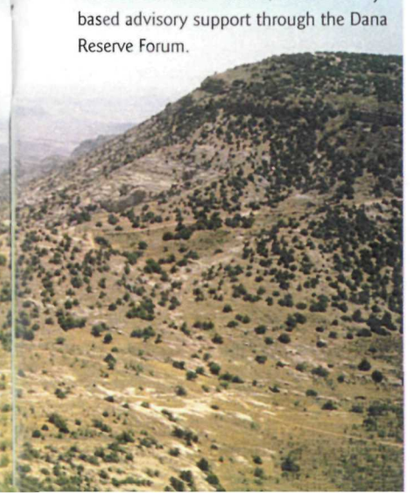
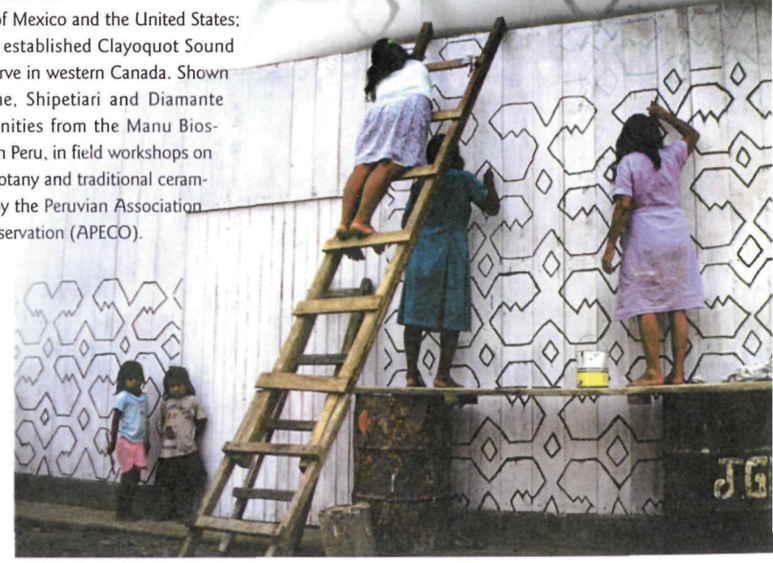
The 30.000-hectare Dana Biosphere Reserve in Jordan demonstrates the successful integration of biodiversity conservation and sustainable development with benefits to local people. At Dana, the major thrust has been the development of income-generating schemes as the principal vehicle for encouraging alternative and sustainable land uses: production and commercialization of dried health fruits and organically produced agricultural products (jams, teas, herbs, etc.); introduction of medicinal herbs as cash crops in terraced gardens; revamping of a fledgling jewellery-making initiative for creating a highly original range of jewellery based on the plants and animals of the reserve; nature-based tourism. These and other initiatives are bringing increased jobs and income to the local communities and, most importantly of all, they rely on the presence of the reserve for their success: it is the 'Dana address' and the conservation philosophy which are the biggest selling points for the products and crafts.

Underpinning the whole process has been the societal agreement to work together – Bedouins living in the reserve and local villagers, government departments, tourism and other business concerns, scientific and conservation institutions and other bodies. The reserve is managed by the Royal Society for the Conservation of Nature, with broadly-based advisory support through the Dana Reserve Forum.



In several regions of the world, the new emphasis on grass-roots, community-based conservation has been reflected in new alliances, which seek to promote effective conservation in an indigenous perspective. A growing body of case study experience has documented how indigenous peoples contribute significantly to the conservation of biodiversity. Such contributions come through their local knowledge, environmentally sensitive land use practices, and approaches to conservation and resource management which are grounded in strongly held beliefs, values, and ethics, enforced through individual conscience, social pressure, and community-based resource management institutions.

Within such a context, recent decades have seen a range of efforts to establish new kinds of land management, including protected areas, based on recognition of the knowledge of indigenous peoples and their association with place, and on consultation and co-management. In a number of countries, particularly in the Americas, biosphere reserves have provided a focus for such alliances and arrangements. These areas include: Beni (Bolivia), the home of the Chimane Indians; the Rio Platano Biosphere Reserve in Honduras, territory of the Paya and Miskito peoples; the La Amistad (Talamanca) Biosphere Reserve in Costa Rica, which includes Bribri and Cabecar indigenous lands; the Darien Biosphere Reserve in Panama, land of the Kuna, Embera and Waunan people; Colombia's Sierra Nevada de Santa Marta, homeland of the Kogi; Manu (Peru), the home of several Amazonian peoples; the Sonoran Desert Alliance on the border of Mexico and the United States; and the newly established Clayoquot Sound Biosphere Reserve in western Canada. Shown here, Tayakome, Shipetiari and Diamante native communities from the Manu Biosphere Reserve in Peru, in field workshops on applied ethnobotany and traditional ceramics organized by the Peruvian Association for Nature Conservation (APECO).



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***Management** should be decentralized to the lowest appropriate level.*

RATIONALE: *Decentralized systems may lead to greater efficiency, effectiveness and equity. Management should involve all stakeholders and balance local interests with the wider public interest. The closer management is to the ecosystem, the greater the responsibility, ownership, accountability, participation, and use of local knowledge.*

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"Surveying the interests of the various stakeholders and fully involve them in planning and decision-making regarding the management and use of the reserve' is one of the goals of the Seville Strategy for Biosphere Reserves. In the Sierra Nevada de Santa Marta Biosphere Reserve in Colombia, an innovative model has been developed to promote the conservation, protection and sustainable development of the cultural and ecological heritage of the world's highest coastal mountain – an area of 17,000 km^2 rising to a height of 5,775 m at a distance only 42 km from the Caribbean coast. The participatory devolved system has involved indigenous and peasant communities working with national and local government authorities, scientists and educators, and other stakeholder groups (such as representatives of the tourism industry), with a catalyzing function provided by the Foundation Pro-Sierra Nevada de Santa Marta, established in 1986. Activities include mechanisms for regular consultation and discussion between different institutions and communities of the region, many with different, often conflicting, interests. Scientific diagnosis and technical assessments have contributed to the elaboration of a sustainable development plan for the region, with programmes and projects in a wide range of different domains: agro-ecology, fish-farming, environmental health and decontamination, revitalization of pre-Hispanic technologies, rural housing initiatives, and so on. Among other marks of recognition, the Foundation has received the Clifford E. Messiger Prize for Conservation Achievement presented by The Nature Conservancy.

Balancing the interests of local stakeholders and statutory and non-statutory bodies of various kinds is part of the process of elaborating the management policy or plan for a biosphere reserve. A variety of such co-operative arrangements have been set up in different sites and countries.

For example, in the Dyfi Valley catchment area in central Wales (United Kingdom), the Eco Valley Partnership (Ecodyfi) was established in 1997 with objectives that stress the sustainable use of natural resources and community-based economies. Ecodyfi brings together over twenty representatives from business and the public sector, including local county councils, Snowdonia National Park Authority, farmers' unions, the Council for the Protection of Rural Wales, and the Welsh Development Agency. Ecodyfi builds on the history of ecological initiatives in the Dyfi Valley – such as a Centre for Alternative Technology at Machynlleth, Dyfi Eco Parc, windfarm development, and organic farming. The project aims to provide advice and grant aid to encourage and support sustainable initiatives. A current example of Ecodyfi's work is a three-year community renewable energy project, including the development of small-scale hydro, solar power, and biofuel initiatives. Shown above, training course for members of the Dyfi Solar Club.

In the 180,000-hectare Saloum Delta Biosphere Reserve in Senegal, grassroots village associations (often best known by their acronyms such as UGIS, APEN, SAPAD) play a critical role in mangrove restoration programmes, including the establishment of nurseries, setting up of reforestation plots, and planting programmes. Village community organizations also have a key function in combining traditional and modern practices in fisheries. Groups of 'eco-guards' have also been set up, drawn from local communities. Technical guidance and supervision for these various activities is provided through such sources as the staff and thesis students of the University of Dakar, as well as the personnel of statutory bodies such as the national agencies responsible for national parks, forestry, fishing and rural extension. These activities contribute to the integrated management plan for the Saloum Delta, which is itself underpinned by several representative committees (scientific, advisory, management).

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The world-wide trend towards devolving resource management decisions to local communities is illustrated by recent events at Siberut, one of the four Mentawai islands off the western coast of Sumatra (Indonesia), designated as a biosphere reserve in 1981. Over the years, there have been many recurring conflicts in resource use and different views on development priorities – some interests advocating widescale logging of intact forests and conversion to commercial oil palm plantations, others advising that priority be given to maintaining the integrity of the forested landscape and developing small-scale sustainable alternatives to large-scale commercial exploitation. Recently the Mentawai islands have become a new district, administratively separate from mainland Sumatra. This change is highly significant since local autonomy laws passed by the Indonesian legislation in 1999 give greater decision-making and financial control to district officials. Local governments are now allowed to keep the lion's share of revenues, so there is a powerful incentive to 'develop' natural resources on a sustainable basis.

As part of the process of addressing different perceptions and conflicts of interest, a two-day UNESCO-sponsored seminar was held in Padang, West Sumatra, in December 1999, combined with a three-day field visit to meet Mentawai communities. A wide range of interests were represented in the one hundred participants: local and national government planning and conservation agencies; national park personnel; NGOs from Siberut, mainland Sumatra and Jakarta; students and academics; companies and co-operatives; and indigenous people and community leaders.

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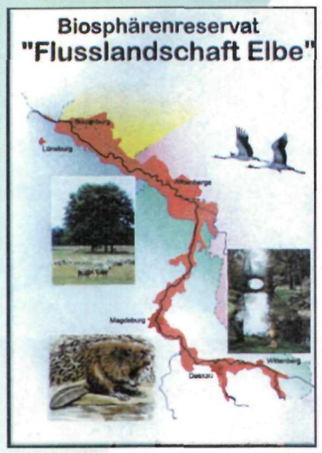
Some heated discussions ensued, with some community members actively in favour of logging and plantation co-operatives, while others vehemently opposed them. These discussions continue, with a follow-up workshop scheduled on Siberut in July 2000. Meanwhile local people are becoming more involved in the management of the national park and in developing village development plans and projects, such as growing cinnamon, coffee and cocoa on small plots of abandoned agricultural land and small-scale food processing units. In villages of the Rereiket area in South Siberut, the communities are strengthening *adat* (customary law) councils so that representatives of various clans can plan future development work together, take collective decisions and represent community interests to local government, companies and other outsiders. A community centre has been established in December 1999 by UNESCO and the National Park authorities to provide technical support to Mentawai communities in conservation, education, alternative crops, water and trade activities. Most people working for the centre are young volunteer workers both from Indonesia and overseas.

Principle 3

***Ecosystem managers** should consider the effects (actual or potential) of their activities on adjacent and other ecosystems.*

RATIONALE: *Management interventions in ecosystems often have unknown or unpredictable effects on other ecosystems; therefore, possible impacts need careful consideration and analysis. This may require new arrangements or ways of organization for institutions involved in decision-making to make, if necessary, appropriate compromises.*

The River Elbe is one of the last semi-natural river valleys in central Europe and is an international fly-way for western Palæarctic migratory birds. The conservation and sustainable use of such large-scale riverscapes has always been difficult in such human impacted regions, due to the fact that the authorities in charge of the different sections of land and water along the river course do not always have an overview of the whole river as an inter-related system, communicating from its source to the sea. In the case of the Elbe, recent history has been beneficial to all stakeholders, including the now thriving population of beavers (*Castor fiber albicus*), a symbolic species which almost died out there in the 1950s.



In 1979, the then German Democratic Republic nominated the 2,113 hectares of the Steckby Lödernsitzer Forst, in the upper reaches of the Elbe, for designation as a biosphere reserve. German reunification presented a unique opportunity to develop and implement future-oriented approaches to protection and environmentally compatible and sustainable development. Conferences of Ministers of the Länder (States) bordering the Elbe were held with a view to seeking to protect the River Elbe in the best possible way. In 1993, a process of inter-Land co-operation began, with a view to create a large-scale biosphere reserve. It received the support of the Federal Minister of Transport, responsible for fluvial transport in the Elbe, and also numerous environmental NGO organizations. The Flusslandschaft Elbe Biosphere Reserve, extending along 370,000 hectares in five Länder of the former two parts of Germany, was approved in 1997. It includes more than 100 strict nature protection areas and a series of landscape protection areas. There are some 160,000 permanent inhabitants. Local authorities, rural districts, and Land ministries as well as a number of specialized authorities at the Länder and Federal level are active in the context of their respective competencies. A Flusslandschaft Elbe working group carries out inter-Land co-operation.

Improvement of agricultural yields in one piece of land can relieve pressure on adjacent protected ecosystems. In the Mananara-Nord Biosphere Reserve in northeastern Madagascar, pilot project activities have targeted native villages of *tavystes* (highland rice cultivators) and fishing communities, with operations in such sectors as agriculture, rural infrastructure, health, education, fishing, animal husbandry, research, conservation and adventure tourism. Practical achievements have included an increase in rice yield from 1 to 3 or 5 tonnes per hectare through such means as mulching, earlier planting and harvesting, the use of zebu cattle as draught animals, and the setting-up of village seed stores.

The University of Tananarive provides the main scientific backing for the work at Mananara-Nord, whose philosophy might be encapsulated in the phrase 'rice *and* forests', not 'rice *or* forests'. The approach taken has been to relieve pressure on the biosphere reserve's core protected areas of forest, by improving the living conditions of the rural population and modifying existing resource use practices, particularly rice cultivation and fishing. There has been a deliberate policy to avoid grandiose schemes using sophisticated technologies. Rather, a systemic and participatory approach emphasizes a basket of technologies and practices that local people can understand, use and afford. Experience gained at Mananara-Nord is reflected in somewhat similar schemes that are being implemented in different climatic zones of the country.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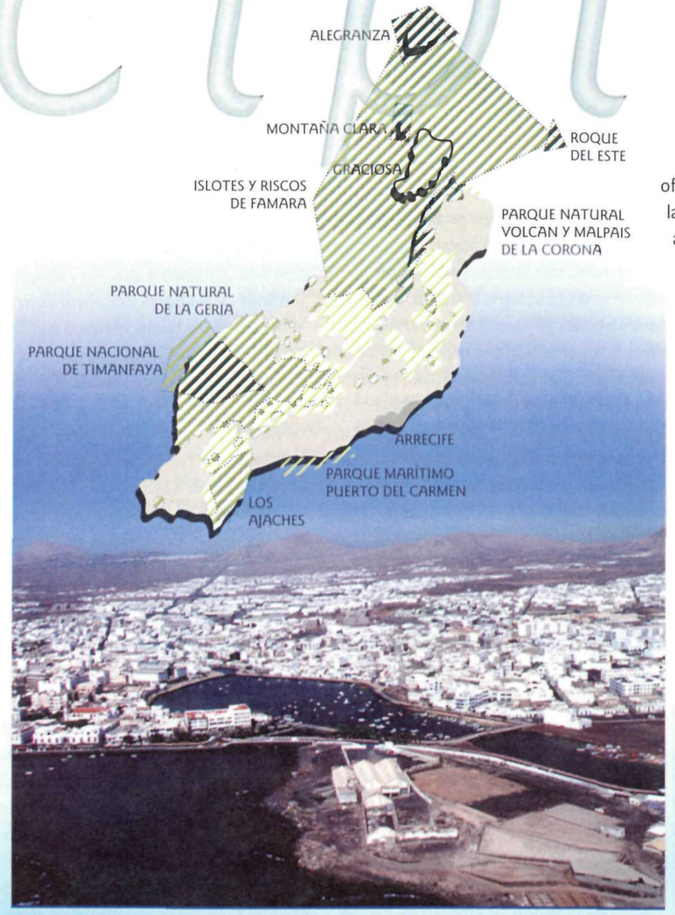
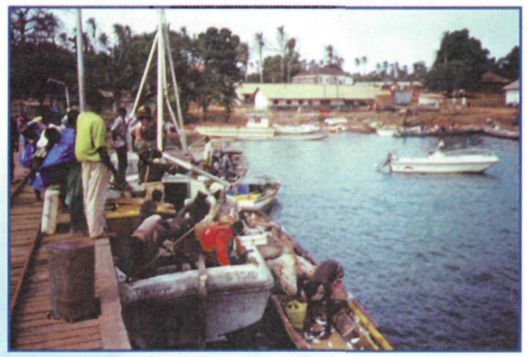


© Photos: Yann Arthus-Bertrand/Earth From Above/ UNESCO

Throughout the world, aquatic ecosystems – marine, brackish, freshwater – are greatly affected by land-based human activities of various kinds, such as coastal deforestation, transformation of wetlands, runoff of sediments and fertilizers and discharge of pollutants. Yet all too often, land and water areas are under separate jurisdictions and management authorities, making difficult a coherent approach to regional ecosystem complexes.

In several island and coastal biosphere reserves, in particular, a real effort is being made to consider adjacent land and marine ecosystems as an ensemble, with different areas zoned for different functions and purposes and core protected areas identified in both terrestrial and marine ecosystems. In the 'whole island' biosphere reserve of Lanzarote in the Canary islands of Spain, the core area is focused on the volcanic Parque Nacional de Timanfaya, with six nature parks in the buffer zone. The biosphere reserve also includes 38.000 hectares of contiguous marine systems.


© L. Brigand

In Guinea Bissau, the Boloma-Bijagos Archipelago Biosphere Reserve consists of some 88 islands with a small area of the mainland and the surrounding marine area. Over the total land and marine area of 110,000 ha, some four different zones have been defined (core, buffer, transition and regeneration), with a biological research station on the island of Bubaque and a long-term management plan developed by the National Research Institute (INEP) in collaboration with the World Conservation Union (IUCN).

Recognizing *potential gains from management, there is usually a need to understand and manage the ecosystem in an economic context. Any such ecosystem-management programme should:* ***(a)*** *Reduce those market distortions that adversely affect biological diversity.* ***(b)*** *Align incentives to promote biodiversity conservation and sustainable use.* ***(c)*** *Internalize costs and benefits in the given ecosystem to the extent feasible.*

RATIONALE: *The greatest threat to biological diversity lies in its replacement by alternative systems of land use. This often arises through market distortions, which undervalue natural systems and populations and provide perverse incentives and subsidies to favour the conversion of land to less diverse systems. Often those who benefit from conservation do not pay the costs associated with conservation and, similarly, those who generate environmental costs (e.g. pollution) escape responsibility. Alignment of incentives allows those who control the resource to benefit and ensures that those who generate environmental costs will pay.*

Placing a social and financial value on ecosystem services is one way of justifying conservation measures and a holistic approach to environmental management. One topical area concerns the changes in water run-off and supply to adjacent areas that may result from a change in management in catchment areas. An example is provided by Kogelberg Biosphere Reserve in Western Cape province, the first biosphere reserve in the Republic of South Africa and the first stage of a proposal to create a large-scale biosphere reserve in the fynbos (Cape shrubland) biome. The Kogelberg area is an important source of the water supply to the city of Cape Town, situated some 40 km away. The periodic clearing of alien weed species is an important management practice in maintaining streamflow from catchment areas. In South Africa, as in many other countries, there are increasing constraints on management interventions, due to multiple demands on scarce financial resources. Whence one reason for researchers modelling the likely consequences of discontinued management on the water supply. Results suggest that the cover of alien plants would increase from an initial estimate of 2.4% to 62.4% after 100 years. Invasion of catchment areas would result in an average decrease of 347 m^3 of water per hectare per year over 100 years, resulting in average losses of more than 30% of the water supply to the city of Cape Town. In individual years, where large areas would be covered by mature trees, losses would be much greater.

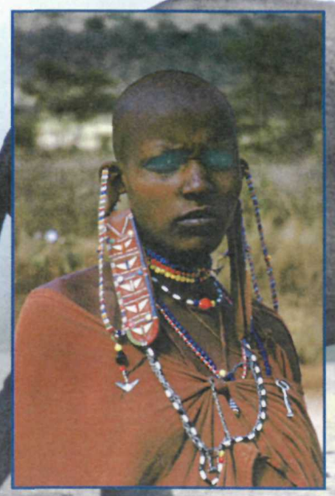
Mimetes hottentoticus

In addition, invasion of fynbos vegetation by alien plants would cause the extinction of many endemic plant species, increase the intensity of fires, destabilize catchment areas with resultant erosion and diminished water quality, and decrease the aesthetic appeal of mountain areas. The overall conclusion is that the control of alien weed species is necessary to avert such adverse impacts. The costs of control operations can be justified by the savings achieved in maintaining adequate water run-off from stable catchments in the long term.

© Photos: Amida Johns

With the increasing economic importance of wildlife and nature tourism, a challenge for many national authorities is how best to channel some of the revenues generated by tourism to promote biodiversity conservation and sustainable use. An example is provided by Amboseli Biosphere Reserve, which lies at the border of Kenya and Tanzania in a semi-arid area renowned for its diverse and numerous wildlife. The core zone of the biosphere reserve is formed by Amboseli National Park (area 39,200 hectares) with buffer and transition areas covering some 444,000 ha. The major underlying issue in ecosystem management is that of exacerbated conflicts in resource use, with sharpened competition of cattle and wildlife for water and grass.

Since the early 1990s, a scheme for sharing revenues from tourism with local Maasai pastoralists has been operated by the Kenya Wildlife Service, based on the proportion of the Amboseli migratory wildlife accommodated by each of the adjacent group ranches, particularly during the wet season. The community-based approach to wildlife conservation has included community training in wildlife management skills, the establishment of cultural centres and other ways and means of generating income, and support to education through such incentives as school-fee bursaries. Long-term challenges include ways of encouraging 'project ownership' and community empowerment.



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4

Management in an economic context calls for the systematic search of errors and shortcomings. In this vein, critical assessment of strengths and weaknesses of concrete field projects can be invaluable in improving measures for biodiversity conservation and sustainable development. Clearly, the process of assessment is a delicate and inevitably subjective one, and what is practicable and feasible in such a process varies from one socio-cultural setting to another.

In Asia, countries taking part in the East Asian Biosphere Reserve Network (EABRN) have used their periodic meetings to organize field evaluations of the individual biosphere reserve hosting a particular meeting. This procedure has proven beneficial both to the visiting group and the host site. Since the launching of the network in 1994, group evaluations have been undertaken of the biosphere reserves of Changbaishan (China), Wolong (China), Mount Sorak (Republic of Korea), Yakushima Island (Japan), Bogd Khan Uul (Mongolia) and Jiuzhaigou (China), with an assessment of the Sikhote-Alin Biosphere Reserve in the Far East region of the Russian Federation scheduled for the seventh meeting of EABRN in Vladivostok in September 2000.

Approaches to environmentally sound tourism is a shared concern in many of the biosphere reserves in East Asia, and descriptions and recommendations on incentives and disincentives in tourism development feature in the individual reports of the various EABRN meetings, published by the UNESCO Office in Jakarta. Shown right, images of tourism on Yakushima Island in Japan, a World Heritage site as well as biosphere reserve which hosted the fourth meeting of EABRN in October 1996. In the cool temperate forest zone (800-1,700 m) of the island, one-thousand-year-old sugi trees (*Cryptomeria japonica*) are a popular tourist attraction.

© Photos: J. Thorsell, IUCN

***Conservation** of ecosystem structure and functioning, in order to maintain ecosystem services, should be a priority target of the ecosystem approach.*

RATIONALE: *Ecosystem functioning and resilience depends on a dynamic relationship within species, among species and between species and their abiotic environment, as well as the physical and chemical interactions within the environment. The conservation and, where appropriate, restoration of these interactions and processes is of greater significance for the long-term maintenance of biological diversity than simply protection of species.*

© Photos: R. Herrera and I. Fabbri, UNESCO

A basic challenge for sustainable agriculture and forestry is to make better use of available physical and biological resources. Approaches to this challenge include reducing the use of external inputs, regenerating local resources more effectively, and integrating a wide range of low-cost management technologies that build on services provided by nature. In the biosphere reserves of Guanahacabibes and Sierra del Rosario in western Cuba, long-term basic studies on forest functioning and succession has led to a functional classification of forest systems which provides a solid basis for improved approaches to tropical resource management. The work has entailed assessments at various scales, including improved understanding of landscape functioning, the holistic management of functional groups of tropical trees, and the functional characterization of the symbiosis between mycorrhizae (root fungi) and forest trees. Researchers from the Institute of Ecology and Systematics have demonstrated that the transplantation of microbial diversity seems to be both effective and economic, and is based on the use of different strains of native inocula obtained from a range of forest soils in developing mycorrhizal-based ecotechnologies for use in tropical afforestation. Among the practical applications of this knowledge is the development of biofertilizers containing different species mixtures of mycorrhizae, for use in different agricultural and forestry systems.

Bringing degraded land and water areas back into 'productive' use is a major challenge to ecosystem managers in many parts of the world, especially in regions where there is strong human pressure on land and water resources. Can Gio Biosphere Reserve is the largest area of rehabilitated mangrove in Vietnam. The 71.000-hectare reserve encompasses a continuum of coastal habitats, from the sea to the outskirts of Vietnam's largest industrial city (Ho Chi Minh), including mangroves, seagrass meadows and agricultural croplands. Among the challenges of the biosphere reserve is to explore and demonstrate ways in which mangrove rehabilitation and conservation can be combined in a sustainable way with aquaculture and fisheries management, including the use of parts of the reserve as spawning and nursery grounds. At Can Gio, the most common reforestation method is direct planting of viviparous seeds. Rapid growth is reflected in this photograph of seedlings of *Rhizophora apiculta* one year after planting. From a slide programme of environmental education for Vietnamese children (*Know Your Mangroves*), produced by the International Society for Mangrove Ecosystems (ISME).

© ISME

Implementation of the ecosystem approach calls for the translation of complicated concepts, jargon and knowledge on ecosystem structure and functioning into understandable and practical guidance. Similarly, the Seville Strategy for Biosphere Reserves encourages the involvement of local communities, school children and other stakeholders in education and training, and the production of visitors information about individual reserves and their importance for the conservation and sustainable use of biodiversity.

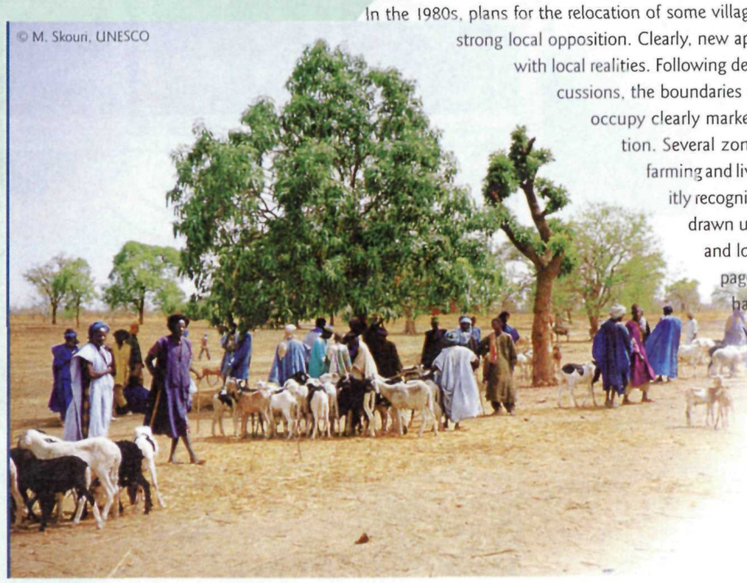
In the Urdaibai Biosphere Reserve in the Basque Region of northern Spain, a variety of educational and information materials have been prepared, for different audiences. Booklets for small businesses and households describe and illustrate examples of 'clean production' practices and technologies, with contrasting comparisons of 'before and after', 'efficient and inefficient', and so on. A cartoon of an enthusiastic but unknowledgeable young explorer provides a mini-guide for children to the plants and animals, the landscapes and waterscapes, of Urdaibai.

principle 6

***Ecosystems** must be managed within the limits of their functioning.*

RATIONALE: *In considering the likelihood or ease of attaining the management objectives, attention should be given to the environmental conditions that limit natural productivity, ecosystem structure, functioning and diversity. The limits to ecosystem functioning may be affected to different degrees by temporary, unpredictable or artificially maintained conditions and, accordingly, management should be appropriately cautious.*

As in many national parks and associated reserves established in Africa in colonial times, more recent events and trends at the Boucle de Baoulé in western Mali have been at odds with the reserve boundaries and management proscriptions drawn up in the 1950s. Since that time, several villages have grown up in the conservation area, the grazing resources have been increasingly used by transhumant herders, and there has been extensive burning of vegetation by both resident farmers and temporary pastoralists. In the 1980s, plans for the relocation of some villages for conservation purposes were abandoned in the face of strong local opposition. Clearly, new approaches were required to bring reserve management in line with local realities. Following detailed ecological surveys and intensive consultations and discussions, the boundaries of the reserve have been altered to give each village rights to occupy clearly marked land outside the areas set aside for ecosystem rehabilitation. Several zones have been designated for herd use, with mixed areas for farming and livestock also set aside. Transhumant corridors have been explicitly recognized between core protected areas, and 'participatory contracts' drawn up between the national institution responsible for the reserve and local communities. Most recently, in January 2000, a new 130-page management plan for the Boucle du Baoulé Biosphere Reserve has been published by the Ministry of Environment of Mali, with the support of UNESCO-MAB, UNDP and the MAB National Committee of Mali.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Plant diversity in arid environments is low compared with most other biomes. Yet the number of species in a given area is not necessarily a good measure of either their functional or economic importance. In the Wadi Allaqi Biosphere Reserve in Egypt's Southeastern Desert, 127 species of vascular plants have been recorded, with an 'importance value' being attributed by local communities to each species for seven different use categories. Two main uses are in grazing (65%) and as medicinal plants (45%). Around 20% are edible and 18% are used as fuel. As part of conservation programmes for medicinal and fodder plants, declining or endangered species have been collected and propagated in special areas, providing a means for continued harvesting. Crucial to the success of that programme has been recognition of the environmental conditions that limit natural productivity and that underpin ecosystem structure, functioning and diversity. Shown below, preparation of land for cultivation of medicinal plants in the transition area.

© Photos: I. Springuel

The need for appropriate caution in ecosystem management is reflected by experience in the Trebon Basin Biosphere Reserve in the southern part of the Czech Republic. This mostly flat region has been influenced and modified by human activities for more than eight centuries. The result is a diverse semi-natural countryside – a mosaic of more than 500 artificial fishponds, deciduous and coniferous forests (45% of the territory), meadows, fields and wetlands crossed by numerous small streams, canals and dykes. Though greatly modified by people, the area provides habitat for a large number of plant and animal species. Species native to both the northern tundra and warm continental lowlands live in close proximity here, as well as species associated with extremely wet and extremely dry biotopes.

The delicate balance of habitats and species at Trebon has suffered during the last quarter of the twentieth century from intensive human impacts. Some traditional human activities (agriculture, forestry, fish farming, extraction of sand, gravel and peat) were practised insensitively, using modern technologies that did not respect the natural ecological limits and carrying capacity of the landscape. Disrupted water regimes, eutrophication and visual spoliation of parts of the countryside were among the negative consequences, which have been at least partially redressed in the last ten years or so. The Trebon Basin Biosphere Reserve Administration and the Czech Academy of Sciences' Institute of Botany, are key bodies in helping to promote appropriate management – articulating links and encouraging co-operation between local and central government, local communities and resources users, and the scientific and educational communities. Trebon has been recognized as a biosphere reserve since 1977. Parts of the area are also listed among wetlands of international importance within the Ramsar Convention.


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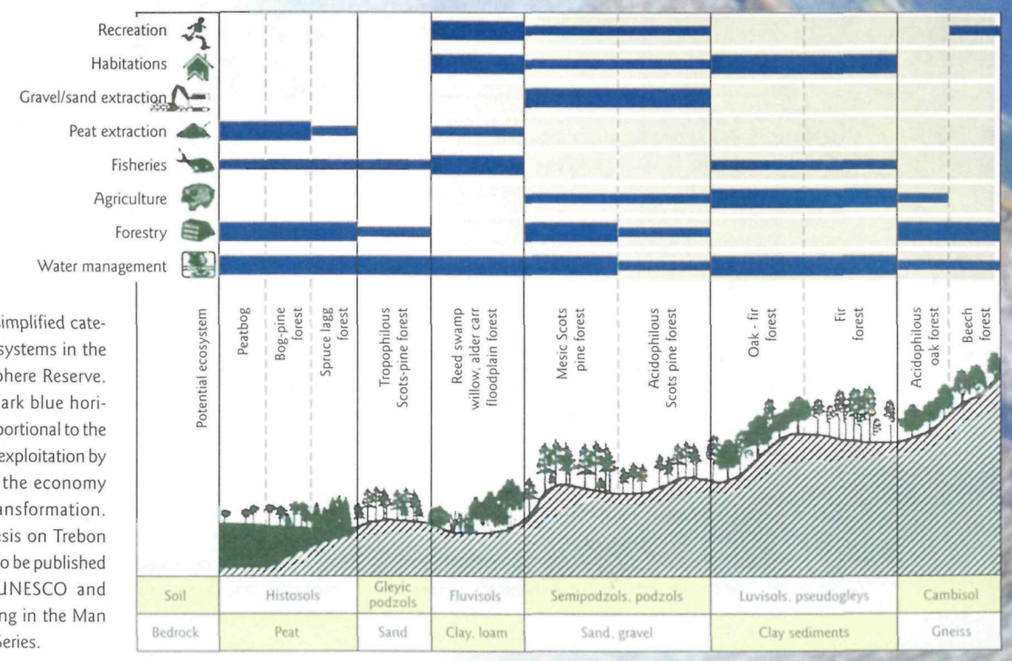
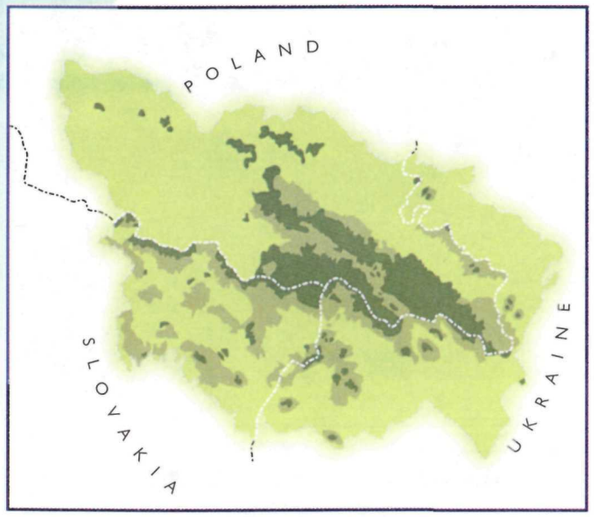


Shown right, a simplified catena of potential ecosystems in the Trebon Basin Biosphere Reserve. Thickness of the dark blue horizontal stripes is proportional to the estimated degree of exploitation by various sectors of the economy and ecosystem transformation. From a new synthesis on Trebon Biosphere Reserve, to be published in late 2000 by UNESCO and Parthenon Publishing in the Man and the Biosphere Series.

The ecosystem approach
should be undertaken at the appropriate spatial and temporal scales.

RATIONALE: *The approach should be bounded by spatial and temporal scales that are appropriate to the objectives. Boundaries for management will be defined operationally by users, managers, scientists and indigenous and local peoples. Connectivity between areas should be promoted where necessary. The ecosystem approach is based upon the hierarchical nature of biological diversity characterized by the interaction and integration of genes, species and ecosystems.*

Recent years have seen an increasing interest in transboundary protected areas, for a variety of environmental, economic and political reasons, including the need to make more effective the management of shared ecosystems. Ecological systems often cut across the frontiers between countries, calling for transboundary co-operation if indeed management is to be approached and undertaken at an appropriate scale for ensuring the ecological integrity of the area and maintaining an adequately diverse and sufficiently large gene pool. Within the World Network of Biosphere Reserves, examples of formally recognized transfrontier reserves in Europe are Krkokonse/ Karkonosze (Czech Republic-Poland), Vosges du Nord-Pfalzerwald (France-Germany), Tatra (Poland-Slovakia) and Danube Delta (Romania-Ukraine).



There is also one trilateral biosphere reserve – the East Carpathians, located at the intersection of Poland, Slovakia and Ukraine, at the watershed of the Baltic and Black Sea basins. The 208.900-hectare reserve is made up principally of a complex of national and landscape parks in the three countries: in Poland, Bieszczady National Park, Cisniansko-Wetlinski Landscape Park and Dolina Sanu Landscape Park; in Slovakia, Poloniny National Park; in Ukraine, Nadsians'ki Regional Landscape Park and Uzhans'ki National Nature Park. The idea of creating the transborder biosphere reserve dates from 1991 with the signature of an agreement by the Ministers of Environmental Protection of the three countries. Since that time, the three countries have worked together on the design of the trilateral reserve, including the coherent, co-ordinated zonation of core, buffer and transition areas. The inauguration of the reserve took place in June 1999, with a scientific seminar and the release of a 60-page booklet on the reserve.

Promoting connectivity between large blocks of protected forest is a special challenge in the Maya Biosphere Reserve in the Peten region of Guatemala, which has seven core areas – four national parks and three wildlife reserves. Equal in size to all seven core areas is the reserve's multiple-use zone, an 800.000-hectare expanse of tropical forest dedicated to the sustainable harvest of zate palms, chicle gum, allspice and timber. A southerly located buffer zone has been rapidly changing from a forested landscape with scattered agricultural patches to an agricultural landscape with increasingly fragmented forest. In turn, the multi-unit Maya Biosphere Reserve in Guatamala forms part of the broader Selva Maya, together with such areas as the biosphere reserves of Calakmul, Montes Azules and Sian-Ka'an in Mexico and several forest reserves in Belize. Within such a sub-regional perspective, several different types of biological corridors have been proposed, to provide dispersal linkages between protected areas, to prevent isolation of protected areas within the region and to facilitate management schemes of various kinds.

One approach to setting priorities in conservation is to identify 'biodiversity hotspots', where exceptional concentrations of endemic species are undergoing exceptional loss of habitat. According to one recent (February 2000) article in the journal *Nature*, as many as 44% of all species of vascular plants and 35% of all species in four vertebrate groups are confined to twenty-five hotspots comprising only 1.4% of the land surface of the Earth.

Among the world's biodiversity hotspots, Brazil's Atlantic Forest is now restricted to some 91.900 km^2, some 7.5% of the original estimated extent of 1.227,600 km^2. With remnants of Atlantic Forest stretching along a distance of more than 3,000 km parallel with the coast, there is special need for a large-scale response to ecosystem conservation and management. Responding to this challenge, a wide range of management, scientific and community organizations have joined together in setting-up the Mata Atlantica Forest Biosphere Reserve System. This special large-scale type of biosphere reserve comprises about 29,000 km^2, extending over fourteen Brazilian States. The focal point for institutional co-operation is the Conselho Nacional de Reserva de Mata Atlantica, with the Instituto de Pesquisas de Mata Atlantica as the principal motor for scientific research. Among the priorities in ongoing work is increased attention to management in zones surrounding the core protected areas.

© H. Castro

Principle 8

Recognizing *the varying temporal scales and lag-effects that characterize ecosystem processes, objectives for ecosystem management should be set for the long term.*

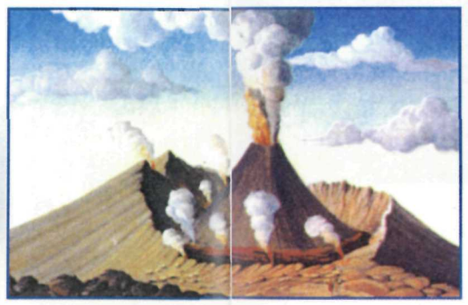
RATIONALE: *Ecosystem processes are characterized by varying temporal scales and lag-effects. This inherently conflicts with the tendency of humans to favour short-term gains and immediate benefits over future ones.*

© R. Herrmann

Dendrological studies at the Oka River Valley Biosphere Reserve in the southern Moscow area is an example of one of the regular scientific tasks carried out at Federal nature reserves (Zapovedniki) in the Russian Federation. The results of inventories such as this are recorded in the *Letopis Prirodi*, which means Chronicles of Nature – the title of both the programme that guides scientific work in Zapovedniki, as well as the title of the yearly publication in which the research is compiled. These Chronicles present data on regular natural occurrences (from climate to bird migrations), changing natural processes, relationships between natural and abiotic components, and the effect of human activity on these natural systems. In some Zapovedniki, the *Letopis Prirodi* have been continued for over fifty years. As a result, decades of environmental change have been recorded according to a standardized, uniform method. The accumulated data are one of the great achievements of the system of the former Soviet Union's Nature Reserves. They provide a means for tracking temporal change and contributing to the setting of long-term objectives for ecosystem management. The challenge is to take best advantage of this patient and fastidious work and continue it, while at the same time ensuring that such invaluable reference sites are integrated into the changing socio-economic context and transition economy and into regional and global schemes for the monitoring of environmental change.

In many regions of the world, large-scale physical change is a frequent occurrence – through such phenomena as earthquakes, volcanic eruptions, hurricanes and cyclones, and prolonged droughts and flooding – and the assessment of risks and lag-effects associated with such phenomena clearly needs to figure prominently in the long-term plans for ecosystem management in the areas affected.

One example are the volcanic eruptions of Vesuvius in the Appenine chain of southern Italy, where eighteen periods of small and medium scale activity were recorded from 1631 to 1944. Shown here, an artist's impression of three of these eruptions, from a recent (1999) book on the biosphere reserves of Cilento-Vallo di Diano and Vesuvius. The Vesuvius Biosphere Reserve covers 13,500 ha and includes the Vesuvius National Park and its transition area on the adjacent coastal strip.



Another example is La Amistad Biosphere Reserve in Costa Rica and Panama, located at the confluence of the Cocos, Caribbean and Nazca plates in the Cordillera de Talamanca, where a major earthquake has occurred on average every 2.25 years in the three and a quarter centuries since local records have been kept.

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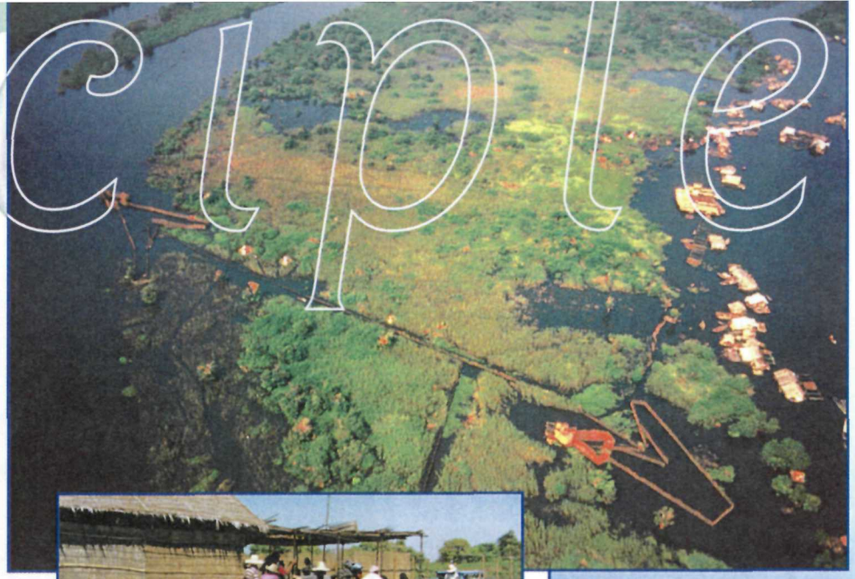

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Seasonal changes in ecosystem conditions and their effects on adjacent areas are perhaps nowhere more evident than in the annual cycle of Tonle Sap Great Lake in Cambodia, the largest freshwater lake in Southeast Asia. In the dry season, it is a shallow lake with a surface area of 2,500 km^2. When the monsoon begins in June-July, the swollen waters of the Mekong river force the Tonle Sap river to reverse its flow northwards, feeding the Great Lake. In September, the height of the monsoon, the lake swells to five times its size, covering an area of about 12,000 km^2 with a maximum depth of 8–10 m. As the Tonle Sap expands, the floods leave fertile silt that gives life to one of Asia's largest rice bowls. The lake's fisheries are one of the most productive in the world, providing Cambodian people with more than 60% of their protein intake.

This marked seasonal pattern in water regime provides the basic framework for adaptive ecosystem management of the Tonle Sap Lake, within which the government is seeking to develop long-term planning and long-term goals at the same time as addressing immediate and critical needs such as hunger, poverty and shelter. As part of this process, Tonle Sap was designated as a biosphere reserve in 1997. A Technical Co-ordination Unit for Tonle Sap has been set in the Ministry of Environment, whose tasks include the promotion of interministerial co-operation at the national level and donor co-ordination at the international level, in working towards a pragmatic and viable strategy for the conservation and sustainable development of the ecosystems, biodiversity and cultural integrity of the Tonle Sap watershed. Challenges include the development of protocols and mechanisms by which different groups of users can solve conflicts of resource use.

Management
must recognize
the change is inevitable.

RATIONALE: *Ecosystems change, including species composition and population abundance. Hence, management should adapt to the changes. Apart from their inherent dynamics of change, ecosystems are beset by a complex of uncertainties and potential 'surprises' in the human, biological and environmental realms. Traditional disturbance regimes may be important for ecosystem structure and functioning, and may need to be maintained or restored. The ecosystem approach must utilize adaptive management in order to anticipate and cater for such changes and events and should be cautious in making any decision that may foreclose options, but, at the same time, consider mitigating actions to cope with long-term changes such as climate change.*

principle 9

In the coming decades, changes in global climate and regional environments are likely to have important repercussions on the abundance and distribution of particular groups of the biota. One important issue in conservation biology is the extent to which individual protected areas will continue to provide sufficient space for the *in situ* conservation of present-day biota, under conditions of rapid environmental change.

In the Astrakhanskiy Biosphere Reserve in the lower Volga Delta, analysis of historic vegetation maps produced by aerial photography and satellite imagery has been used to describe the response of vegetation to substantial changes in the level of the Caspian Sea during the twentieth century, from −26 m (1930) to −29m (1977) below global sea level to −26.66m in 1996. A six-person team of researchers from Astrakhanskiy Biosphere Reserve, Moscow State University, and the International Institute for Aerospace Survey and Earth Sciences (Enschede, the Netherlands) have reported that the sea level drop in the earlier part of the twentieth century was followed by rapid progression of the vegetation. The subsequent rapid sea-level rise in the 1980s did not however result in similarly rapid regression of the vegetation. This partial irreversibility of the vegetation response to sea-level change is explained by the wide flooding tolerance of the major emergent species, *Phragmites australis*. Floating vegetation increased in extent, most likely due to the increased availability of more favourable conditions, particularly for lotus (*Nelumbo nucifera*), a tropical plant reaching its northernmost distribution in the Volga Delta. This species (shown below) increased in distribution from 3.5 hectares in the 1930s throughout the entire Volga Delta to several thousands of hectares in the Astrakhanskiy Biosphere Reserve alone in the 1980s.

The reported sea-level changes swept the ecosystems in the Astrakhanskiy Biosphere Reserve back and forth within the reserve boundaries over distances of tens of kilometres. At longer time scales, ten-fold greater sea-level change has been reported. The ecosystems for which the reserve is renowned might be pushed completely out of the reserve under these conditions. In this vein, the research team question whether the current reserve will be sufficiently large to guarantee conservation of the biota in the lower Volga Delta at longer time scales. The research emphasizes that change is incessant and inevitable, and that management needs to be correspondingly adaptive and flexible.

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Providing a logistic base for long-term ecological research is one of the principal functions of a number of the sites contributing to the World Network of Biosphere Reserves. Indeed, the research base aspect has been of signal importance in the designation of certain biosphere reserves. An example is Luquillo Experimental Forest and Biosphere Reserve in northeastern Puerto Rico, where research records date back more than a hundred years and long-term observation plots provide baselines for studying ecosystem response to difference patterns of disturbance, including natural treefalls, landslides and selective cutting as well as hurricanes. The long-term plots provide insights not only about the magnitude of the damage caused by different disturbances – such as Hurricane Hugo (September 1989) – but also the long-term changes in forest structure and species composition during post-disturbance recovery

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Over the last four decades, the rural landscapes of Europe have been radically modified as a result of urban expansion but primarily because of changes in agriculture. These changes have been marked by vastly increased intensification of production in some areas. At the same time, particularly in the more marginal areas, 'extensification' has taken place with land being taken out of production permanently or temporarily set aside. In different parts of Europe, various conditions and factors have served as the driving forces for such developments.

In North Karelian Biosphere Reserve in Finland, the changing rural economy has seen the population decline from 7,300 in 1960 to 1,800 today. Until the 1970s, small-scale farming combined with lumbering was the main source of income for the local population. The mechanization and re-organization of forestry destroyed this combined livelihood. Structural change was so rapid that people did not have the time to seek new income models to replace those that were destroyed. Small farms became deserted and a large proportion of the population moved away. Among the driving forces leading to this situation were conflicting interests within the national forest sector, including private forest owners, peripheral forestry-work villages, groups of local forest users, centres of wood, pulp and paper manufacturing, exporting harbour towns, and local woodworkers' unions.

Addressing such changes in the rural economy often calls for new alliances of stakeholders, linked to changes in legislation at the national level. In Finland, one set of opportunities has been opened by a decision of the Council of State on Measures promoting the research and conservation of biological diversity. The aim is to promote co-operation between ministries and to define their respective responsibilities in the implementation of the Convention on Biological Diversity. The respective national plan is valid from 1997–2005 and provides a basis for long-and short-term planning, decision-making and international initiatives. It outlines a set of proposals for promoting the maintenance and sustainable use of biological resources and the allocation of sectoral responsibilities and resources. For regions such as North Karelia, it has provided a stimulus for stakeholders to explore and test the job-creating potential of modern environmental protection and the sustainable use of biological diversity, while also trying to restore and maintain some typical landscape features such as open hill-top fields with berry fruits.

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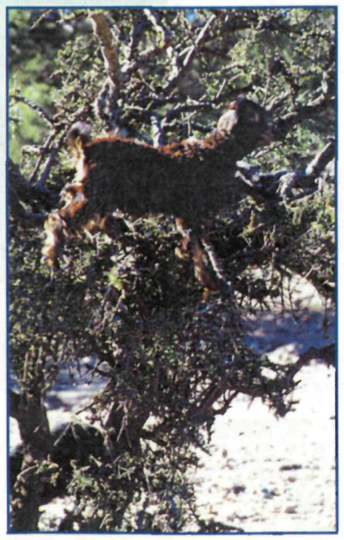
principle 10

The ecosystem approach *should seek the appropriate balance between, and integration of, conservation and use of biological diversity.*

RATIONALE: *Biological diversity is critical both for its intrinsic value and because of the key role it plays in providing the ecosystem and other services upon which we all ultimately depend. There has been a tendency in the past to manage components of biological diversity either as protected or non-protected. There is a need for a shift to more flexible situations, where conservation and use are seen in context and the full range of measures is applied in a continuum from strictly protected to human-made ecosystems.*

The argan tree (*Argania spinosa*) is endemic in the Souss Plain of Morocco. Notoriously difficult to regenerate, it provides good timber, forage and, above all, seeds rich in edible argan oil in a harsh climate with uncertain rainfall. The tree has given its name to the 2.5 million-hectare Arganeraie Biosphere Reserve, where a programme of replanting of argan trees is combined with the production of argan oil and commercialization of new products from the tree. The planting work is undertaken by village sections of the Water and Forest Service (*Eaux et Forêts*) of Morocco, in close co-operation with village NGO associations. The main driving force for commercialization is the Union of Women's Co-operatives for the Production and Commercialization of Argan Oil and Ecological Products (UCFA). The founding co-operatives of the UCFA result from like-minded women deciding to work together in producing the argan oil and other products such as honey *(amlou)* and marketing these products in the best possible conditions, including strict quality control. The work is underpinned by a project on the conservation and the development of the Argeneraie. This project has completed its first five-year phase, with a field evaluation in late March 2000. Among the likely directions of future work are the redevelopment of techniques for terrace cultivation, now fallen into disrepair, and the need to promote more research and development into the regeneration of the argan tree.



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Mexico has played a crucial role in the development of the biosphere reserve concept. In the late 1970s, reserves such as Mapimi and Machilia served as sites for testing approaches to the conservation of biological diversity and its use in projects of local socio-economic development. The long-term association of specific research institutes with individual biosphere reserves is another feature of Mexican biosphere reserves, of which there are now eleven, located throughout the biogeographical regions of the country.

Sian Ka'an forms part of the extensive barrier reef system along the eastern coastline of Central America and includes coastal dunes, mangroves, marshes and inundated and upland forests. The site has been described as the largest effective nature reserve in Mexico, because forest cover remains intact and it is likely that all vertebrate species characteristic of the Yucatan region are present. The reserve is of great cultural value with its twenty-three recorded Mayan and other archaeological sites. Some 800 people, mainly of Mayan descent, inhabit the reserve. The reserve is jointly managed by the Mexican government's Secretaria de Desarrollo Urbana y Ecologia (SEDUE), Quintana Roo's state government, the Research Centre of Quintana Roo (CIQRO) and Amigos de Sian Ka'an, a non-governmental conservation group.

Achievements to date include the control of immoderate tree felling, a significant reduction in commercial hunting and indiscriminate use of forest products in the core area (a key asset conferred by its 'biosphere reserve' status), the establishment of ecological guidelines for the relocation of Colonia Punta Herrero (a settlement considerably damaged by cyclones), and the employment of local inhabitants from Chunyaxche as reserve workers for wild fauna captive breeding projects.

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The principal threat is from development associated with tourist facilities. Forest exploitation is generally limited to the collection of useful wild plants and hunting for subsistence, although there is some over-exploitation of valuable timber species. Abandonment of traditional fishing practices in favour of more commercial ones may in time threaten the marine components of the reserve. Consequently, to help develop the balance of conservation and sustainable use activities, monitoring is being undertaken in evaluation of marine resources and experimental agricultural plots. This monitoring involves both indigenous and non-indigenous populations in the reserve.

The Clayoquot Sound Biosphere Reserve on the western coast of British Colombia in Canada is a newly established reserve with some of the most exciting developments in sustainable resource use and management found anywhere in North America. First Nations and local other communities, private parties and various levels of government all have defined roles and responsibilities in planning, management, research, inventory and monitoring activities in the biosphere reserve. Of the total area of nearly 350,000 hectares (265,705 ha terrestrial, 84,242 ha marine), about one-third (110,281 ha) comprises core protected areas, in the form of one national park reserve, sixteen provincial parks and two ecological reserves. The terrestrial core areas include tracts of some of the last remaining intact coastal temperate rain forest in North America. The transition and buffer areas provide diverse opportunities for sustainable economic and human development, as local communities shift from a primary dependence on logging and fishing to a more balanced and diversified regional economy that also includes tourism, aquaculture and value-added marine and forest products.

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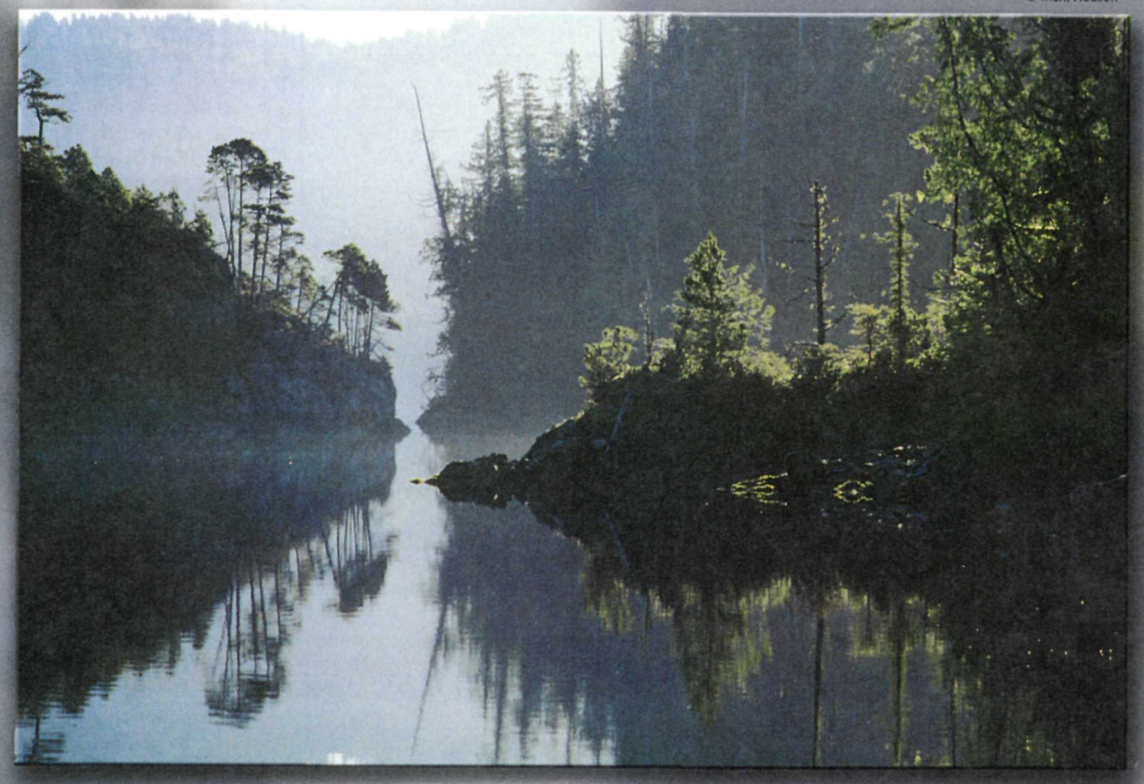


In terms of management, all of the current economic planning and resource management processes in the region are being led by, or directly involve, local First Nations and non-aboriginal communities. The Clayoquot Sound Biosphere Reserve Charter serves as an encompassing policy statement, under which a mosaic of approved plans, policies and processes form the basis of management within the reserve. The Clayoquot Biosphere Trust, which was legally established on 21 March 2000, is supporting new community-based initiatives and partnerships with external institutions to promote research, education and training consistent with biosphere reserve functions and themes.

principle 11

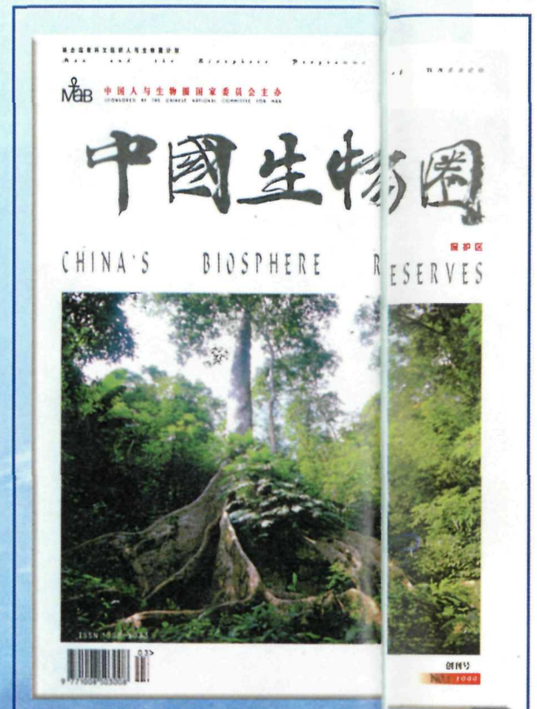
The ecosystem approach *should consider all forms of relevant information, including scientific and indigenous and local knowledge, innovations and practices.*

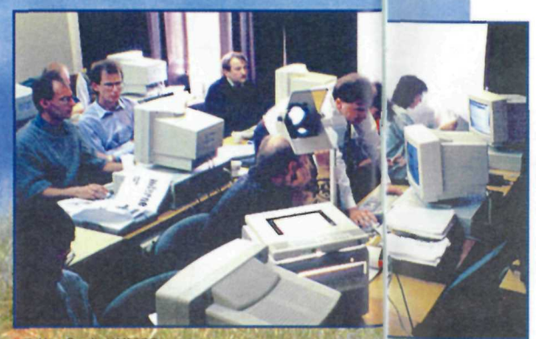
RATIONALE: *Information from all sources is critical to arriving at effective ecosystem management strategies. A much better knowledge of ecosystem functions and the impact of human use is desirable. All relevant information from any concerned area should be shared with all stakeholders and actors, taking into account,* inter alia, *any decision to be taken under Article 8(j) of the Convention on Biological Diversity. Assumptions behind proposed management decisions should be made explicit and checked against available knowledge and views of stakeholders.*

Connecting traditional knowledge systems and modern science was one of the prominent themes of the World Conference on Science, organized by UNESCO and the International Council for Science (ICSU) in Budapest (Hungary) in June 1999. As part of the Declaration adopted by the Budapest conference, clause 26 states "that traditional and local knowledge systems as dynamic expressions of perceiving and understanding the world, can make and historically have made, a valuable contribution to science and technology, and that there is a need to preserve, protect, research and promote this cultural heritage and empirical knowledge."

An example of incorporating traditional knowledge in present-day management is provided by Uluru-Kata Tjuta Biosphere Reserve, which represents an outstanding example of Australia's arid ecosystems and the cultural interactions of people and the environment. The monoliths of Uluru and Kata Tjuta are of outstanding scientific and cultural significance. The major threats to the park appear to be from ecosystem modification due to the impacts of introduced mammals such as rabbits and cats and the direct impact of tourism on the environment. Traditional practices of landscape management, including through burning, are now in place. Indeed, Aboriginal burning practice is included in the plan of management, removing a potential threat to landscape degradation from the period of 'burning is bad' influenced by non-Aboriginal thought.

For Uluru-Kata Tjuta National Park, the combined scientific approach of the biosphere reserve is very complementary to the World Heritage cultural landscape designation. The importance of Aboriginal ownership of the land, and promulgation of their management practices, is an excellent example of melding people, cultural tradition, language and management to produce a living landscape, which espouses the conservation of biological diversity. In this case, tourism visitation also presents this *mélange* to a wider world audience.





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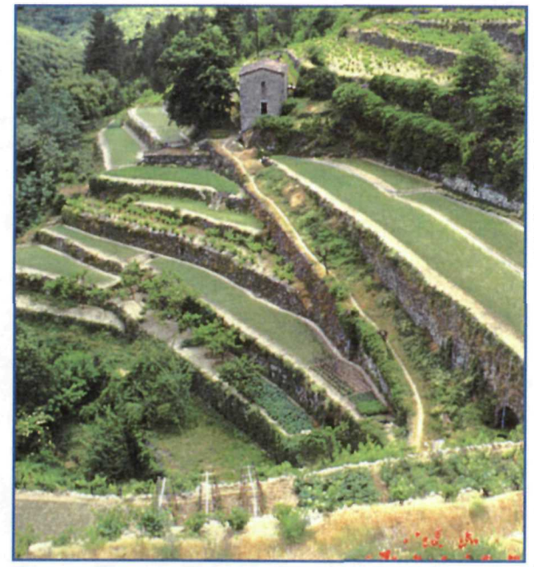
Organizing forums and other information exchange mechanisms for biosphere reserve managers is one of the goals of the Seville Strategy, which needs to be addressed at a whole series of levels and scales and cover a wide range of relevant information – 'scientific' and traditional, technical and non-technical. One example is the China Biosphere Reserve Network (CBRN), whose aims include the upgrading and strengthening of the more than 900 nature reserves in China, building on the experience gained in the sixteen internationally recognized biosphere reserves in China as well as elsewhere in the World Network of Biosphere Reserves. Among the products of the CBRN is a quarterly journal *China's Biosphere Reserves*. Financed through the subscriptions of network members, the journal includes regular sections on innovations in protected area management, approaches to generating additional funding for site activities, research challenges, recent developments from the world network, and introductions to selected protected areas in China.

Reinforcing national and site capacities in electronic networking is another dimension of information exchange. Collaborative activities to upgrade capacities have included an agreement between UNESCO, the Washington-based NGO Conservation International and the company Intel, to develop electronic networking capability in twenty-five biosphere reserves in developing countries. Another initiative has entailed the provision of computer-mediated communication technologies and associated training to protected areas in five central European countries. This Global Environment Facility (GEF) – UNESCO/MAB initiative built on a larger GEF project, designed to reinforce national efforts for conserving biological diversity in Belarus, Czech Republic, Poland, Slovakia and Ukraine. Shown left, a sub-regional training programme organized with UNESCO at the University of Warsaw in Poland on data-base development, geographic information systems and networking technologies.



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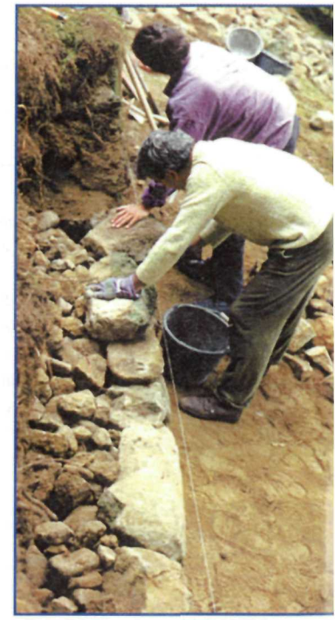
Making use of indigenous knowledge and traditional sustainable land use practices is a key component in the successful management of a biosphere reserve. There is ample evidence that local communities have much to tell ecosystem managers that cannot be obtained from purely scientific sources and that there is much to be gained from seeking to maintain and revive such practices, particularly in areas of low intensity agriculture. For example, in the Cévennes Biosphere Reserve in southern France, a project is underway to promote the revival of dry stone walls as a technique in the construction of terraces and associated agricultural structures characteristic of the upland Mediterranean landscapes of southern Europe.



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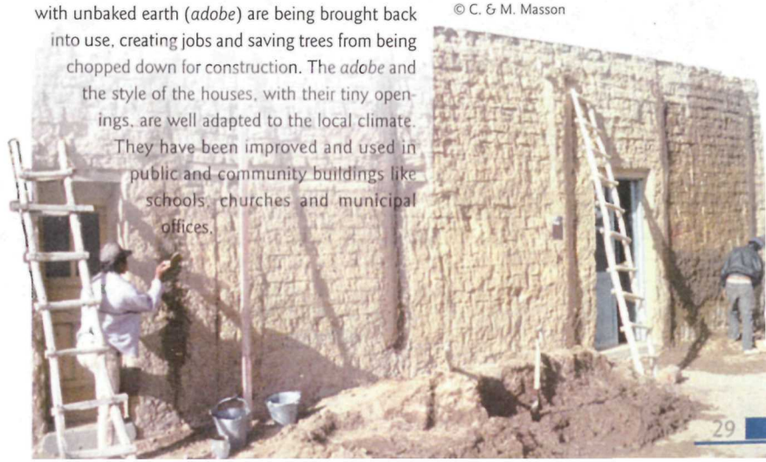
In Pozuelos Biosphere Reserve in northern Argentina, traditional methods for building with unbaked earth (*adobe*) are being brought back into use, creating jobs and saving trees from being chopped down for construction. The *adobe* and the style of the houses, with their tiny openings, are well adapted to the local climate. They have been improved and used in public and community buildings like schools, churches and municipal offices.



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principle 12

The ecosystem approach *should involve all relevant sectors of society and scientific disciplines.*

RATIONALE: *Most problems of biological-diversity management are complex, with many interactions, side-effects and implications, and therefore should involve the necessary expertise and stakeholders at the local, national, regional and international level, as appropriate.*

The Fitzgerald River Biosphere Reserve in Western Australia is one of the older reserves in the World Network (designated as a biosphere reserve in 1978) and as currently constituted has only a core area included in its design. But the local rural population surrounding the national park have appreciated the need to refocus their activities to ensure both long-term survival for their agricultural activities, as well as long-term survival for the strategic nature conservation asset that is the biosphere reserve, as it is currently recognized.

This is an example of an application of the biosphere reserve concept in action, a concept that can reach effectively beyond the strict legal or semi-legal status of a reserve in a formal sense to include legitimate desires and actions of local communities. If in the future there is a desire to include a broader area under the reserve status, this can be achieved. But in terms of Principle 12 it beautifully illustrates how the ecosystem approach must include all sectors of society to be effective immediately, and in the longer term.

The notion that science should inform public policy decisions is a popular one, but actually bringing science to bear on policy debates, and developing a shared vision of ecological and societal sustainability, can be difficult. The debate over South Florida provides a case where policy-makers, natural scientists and social scientists have been brought together to generate specific strategies for restoring a healthy Everglades while also preserving the social and economic structures of South Florida.

In Florida, the cumulative pressures of rapid population growth, extensive housing and leisure developments along the south-eastern coast, and the conversion of wetlands to agricultural lands, have had far-reaching consequences on the treasured natural resource of the Everglades. In recent years, much attention has focused on the South Florida ecosystem by policy-makers, scientists and resource managers. As part of this concern, the US-MAB has conducted an independent scientific study to define ecological sustainability in the context of regional watershed-based ecosystems.

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Five years of planning and research activities involving over 100 scientists has led to the elaboration of generic ecosystem management principles and the application of these principles to the ecological and societal systems of South Florida. The US-MAB case study has also provided lessons that can be applied to other ecosystem management activities. The most important lessons relate to how to facilitate the unusually interdisciplinary and integrative work necessary for applying conceptual ideas of ecosystem management and ecological risk assessment to solving real-world environmental problems. Among the ingredients of success was recruiting a team of scientists and decision-makers who could expand beyond their individual perspectives to do truly integrative thinking. In addition to mobilizing the right team, several specific process steps were important in applying ecosystem management principles: utility of a particular case study with its specific issues, analyses and potential solutions; utility of specific scenarios for analysis; importance of questioning existing assumptions; development of a shared scientific vision; availability of critical technological tools (e.g. GIS-based database system); timeliness of the case study and its societal importance and possibilities for making an impact on the decision-making process; flexibility and the need to be opportunistic and adaptive in project development.

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Sinharaja in the lowland wet zone of Sri Lanka is a site where a real effort is being made to develop and integrate the multiple functions of the biosphere reserve concept and to involve multiple stakeholders and partnerships. In seeking to reconcile the often conflicting interests of conservation and development, there is an involvement and presence of government, particularly through the Forest Department which operates the main field base and is responsible for the elaboration and implementation of the management plan for Sinharaja. Approaches to improved rural development and local livelihoods include enrichment planting using primary forest timber and non-timber species in *Pinus* stands in the buffer zone of the reserve, exploring the potential of locally esteemed non-timber species for domestication, and encouraging young people from adjacent villages to guide visitors around Sinharaja.

Sinharaja fulfils an important training and education function, reflected in the inclusion of Sinharaja in ecology curricula of pre-university and university courses in the country (e.g. questions specifically on Sinharaja are set periodically in terminal examinations of secondary school and university students). In this vein, about half of the total number of annual visitors are schoolchildren and students. There is an education centre, equipped with posters and exhibits. Training workshops of several days duration are organized for selected groups, including school teachers, officers of various environmental related departments, journalists, rural leaders, university students.

Research provides essential underpinning for the activities of conservation, integrated rural development, training and education. Crucial here is the long-term commitment of a core group of dedicated university-based researchers to working at Sinharaja. Research combines process work and more focused problem-oriented projects incorporating biological and socio-economic studies, and co-operation has been developed with researchers based in prestigious tertiary institutions abroad. Among other spin-off benefits, these links facilitate the training of post-graduate students from Sri Lanka in specialized institutions having access to techniques not yet available in the country.

A range of other institutional links have been developed with national governmental departments, research and training institutions and non-governmental bodies (e.g. March for Conservation, IUCN-Sri Lanka), as well as with outside technical bodies and financial sources, including the Global Environment Facility (via IUCN) and the MacArthur Foundation. Although the flow of financial and other support remains a continuing concern and challenge, the diversity and very nature of linkages such as these are important for the long-term viability of Sinharaja as a multifunctional site for conservation, community development, research, education and training.

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A stylized 'ankh',

the ancient Egyptian

sign for life,

has been incorporated

into the symbol

of the Programme

on Man and

the Biosphere (MAB)