

PRINCIPLES FOR A CODE OF CONDUCT FOR THE MANAGEMENT AND SUSTAINABLE USE OF MANGROVE ECOSYSTEMS



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Front Cover

Pristine Mangrove, Sematan, Sarawak, Eastern **Malaysia**. Photo by: Donald J. Macintosh, cenTER Aarhus

Degraded mangrove, Ca Mau Province, Lower Mekong Delta, **Vietnam**. Photo by: Thomas Nielsen, cenTER Aarhus

Woman carrying mangrove fuelwood in **Ghana**. Photo by: Donald J. Macintosh, cenTER Aarhus

The homes of mangrove dwelling fishermen, within the mangroves of Punta Soldado, the **Colombian** Pacific coast. Photo by Hernando Bravo

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PREFACE

The term “mangrove” usually refers to a tidally influenced wetland complex, consisting of mangrove forests, tidal flats, salt flats and other associated habitats within the intertidal zone of tropical and subtropical latitudes. The intertidal wetland is composed of a mosaic of interacting components linked by flows of water, sediments, nutrients, organic matter and animal populations that move among its component elements. Mangroves can also occur in areas without a tidal regime e.g. in some choked coastal lagoons and in the supralittoral zone. Mangrove also designates the marine tidal forest that includes trees, shrubs, palms, epiphytes and ferns (Tomlinson, 1986).

Mangrove ecosystems were estimated to cover 181,000 km² worldwide in 1997 (Spalding *et al.*, 1997) but a more recent estimate indicates that the figure may now be below 150,000 km² (see www.fao.org/forestry/mangroves for details). The best developed mangroves grow along humid sheltered tropical coastlines; for example, in the delta systems formed by major rivers like the Ganges-Brahmaputra, Irrawaddy and Niger, and on coastlines protected by large land masses for example, the Malacca Straits, Borneo and Madagascar. Such areas are often strategic sites for dense human settlements and receive high population pressure. Conversely, there are some open coastlines with extensive mangrove cover and very few people, for example in the state of Maranhao, Brazil.

For much of history many people have regarded mangroves as wastelands, but the scale of human impact on mangroves has increased dramatically in recent years, with many countries showing losses of 50-80% or more, compared to the mangrove forest cover that still existed even 50 years ago. For example the Philippines has lost 75% of the mangrove area that existed in the 1950s (Primavera, 2000). Mangrove ecosystems have been degraded or converted into agriculture, aquaculture, industrial or urban development. The livelihoods of many local coastal communities have been diminished or totally lost by the destruction or degradation of mangroves.

Recently however, society has begun to appreciate the benefits of mangroves and there is a growing awareness of their values e.g. through providing coastal protection, subsistence livelihoods for coastal dwellers and in sustaining commercial fisheries. There are also increasing efforts by governments, NGOs and local communities around the world to conserve, rehabilitate and manage mangroves sustainably, but the literature and success stories are still limited.

Recognising the importance of conserving mangrove forest ecosystems worldwide, the World Bank commissioned a desk review “Mainstreaming Conservation of Coastal Biodiversity through Formulation of a Code of Conduct for Sustainable Management of Mangrove Forest Ecosystems”. This review builds on the findings from an on-going “Shrimp Farming and the Environment” collaborative program supported by the Bank-Netherlands Partnership Program with, the Worldwide Fund for Nature (WWF), the Food and Agriculture Organisation of the United Nations (FAO) and the Network of Aquaculture Centres in Asia-Pacific (NACA). This program included “A Thematic Review of Coastal Wetlands and Shrimp Culture” (World Bank, 2002; Macintosh *et al.*, 2002a, b; Lewis *et al.*, 2003). One of the recommendations made as follow up actions from the consortium was to explore the opportunities for preparation and agreement of a ‘code of conduct’ for mangrove management, which should provide basic principles for management of mangrove forests. The consortium recommended further that the code should be developed through a strong consensus building and open process, involving the various stakeholders concerned with mangroves.

Formulation of these “Principles for a Code of Conduct for the Management and Sustainable use of Mangrove Ecosystems” is based on existing knowledge, experience and needs. The Principles presented identify key linkages and co-ordination needs among government departments, NGOs, nearby communities, researchers or research institutions and entrepreneurs who have an interest in the conservation of mangrove ecosystems and sustainable use of mangrove resources. It recommends key legislation and enforcement mechanisms (e.g., governmental and/or community-based) considered necessary to ensure the effective conservation, protection and sustainable use of mangroves.

Both the long-term (development) objective and the specific objective of this document are summarised in the box below.

The long-term development objective is to arrest and reverse the recent and rapid destruction of mangrove ecosystems, to improve their management, and to conserve biodiversity in these critical natural habitats.

The specific objective in developing a Principles for a Code of Conduct for the Management and Sustainable use of Mangrove Ecosystems is to provide a tool for the effective management of mangrove ecosystems for local and national governments, resource managers, NGOs, traditional authorities and communities, donors and development agencies, and conservation groups.

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This document is the product of consultations with many people across the world and in the forum of three regional workshops: a South and Southeast Asia Regional Workshop held, at the Asian Institute of Technology, Bangkok, Thailand, October 2002; an Africa Regional Workshop, held at the Centre for African Wetlands, University of Ghana, Ghana, February 2003; and a Central and South American Regional Workshop, held at Labomar, Fortaleza, Brazil, March 2003. We would especially like to mention the people who helped organise the regional workshops: in Thailand Ms. Arlene Nietes-Satapornvanit, in Ghana Professor Christopher Gordon and Mr. Jesse Ayivor and in Brazil Professor Luiz Drude de Lacerda, Professor Carlos Artur Sobreira Rocha and Mr. Ariel Vaisman.

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INTRODUCTION

Traditionally, local communities in mangrove ecosystems collected fuelwood, harvested fish and other natural resources. However, in recent decades many coastal areas have come under intense pressure from rapid urban and industrial development, compounded by a lack of governance or power among environmental institutions. Mangroves have been overexploited or converted to various other forms of land use, including agriculture, aquaculture, salt ponds, terrestrial forestry, urban and industrial development and for the construction of roads and embankments. Mangroves can be affected by several different activities simultaneously, or over time as land use patterns change. Table 0.1 provides a summary of the main threats to mangroves by region of the world. The threat is estimated to be from low to high and whether it is deemed to be increasing or decreasing.

Table 0.1: A summary table indicating the range and scale of the threats to mangroves, in the three major tropical regions of the world.

Threat	South and Southeast Asia	Africa	Central and South America
Natural disasters	Low-High <i>Increasing</i>	Medium <i>Increasing</i>	High <i>Increasing</i>
Population pressure	High <i>Increasing</i>	High <i>Increasing</i>	Low-Medium <i>Increasing</i>
Over-exploitation by traditional users	High <i>Increasing</i>	Medium <i>Increasing</i>	Low <i>Stable-Decreasing</i>
Forestry	High <i>Stable</i>	Medium <i>Increasing</i>	Low <i>Stable</i>
Agriculture	High <i>Decreasing</i>	High <i>Increasing</i>	Low <i>Stable-Decreasing</i>
Aquaculture	High <i>Increasing</i>	Low <i>Increasing</i>	High <i>Increasing</i>
Salt Production	High <i>Decreasing</i>	High <i>Stable</i>	Low-Medium <i>Decreasing</i>
Mining	Low-Medium <i>Decreasing</i>	Medium <i>Increasing</i>	Low <i>Decreasing</i>
Urban and industrial development	High <i>Increasing</i>	Low <i>Increasing</i>	Medium-High <i>Increasing</i>
Tourism	Low-Medium <i>Increasing</i>	Low <i>Increasing</i>	Low-Medium <i>Increasing</i>
Hydrological diversions e.g. dams	Medium-High <i>Increasing</i>	Localised Medium-High <i>Increasing</i>	Low-High <i>Increasing</i>
Coastal pollution	Medium-High <i>Increasing</i>	Low <i>Increasing</i>	Medium-High <i>Increasing</i>
Management shortcomings	Medium-High <i>Decreasing</i>	High <i>Stable</i>	Low-High <i>Stable</i>

Compiled by participants at the three regional workshops held to prepare the draft versions of these principles.

Over and above loss of mangrove area, mangrove habitats have also declined in terms of biological diversity, forest structure and economic value, due to excessive harvesting of the most valuable trees. This has commonly caused a shift in the forest composition towards smaller trees and secondary growth as the larger trees were removed. The main factor leading to the loss of mangrove biodiversity

is habitat loss caused by conversion or progressive degradation of the forest, water pollution and withdrawal. Even off-site activities can lead to mangrove degradation through siltation and changes in water flow and water quality, especially salinity change and changes due to pollution. Contaminants may be directly toxic to some marine organisms and their effects may be instantaneous or cumulative. Introduction of exotic species can also cause loss of habitat and biodiversity through competition with native species. It is also recognised that climate change now poses additional threats to mangrove ecosystems as mangroves occupy marginal land areas that would shrink significantly under the influence of projected sea level rise (UNEP, 1992). Many of the problems and causes of mangrove loss stem from failures in policy, management and enforcement of protection measures. These need to be dealt with urgently.

Recognition of the environmental, social and economic impacts associated with the decline and degradation of mangroves are now being addressed through legislative, management, conservation and rehabilitation efforts aimed at mitigating the negative impacts of development on mangrove ecosystems. These include the introduction of new legislation and new governing bodies with clearer administrative or advisory roles on environmental issues; stronger conservation status for some mangrove areas of outstanding value (e.g. as Biosphere Reserves) or recent determination to address the under-representation of mangroves in Ramsar sites; and more emphasis on public awareness raising and education. However, many of the current management policies adopted are still sectoral in nature, which frequently leads to conflict of interests, and to continuing unsustainable exploitation of mangrove resources. An integrated approach to coastal area and riverbasin/watershed management through coherent policy development and concerted action is increasingly being regarded as the best way to achieve conservation and sustainable use of mangrove and other coastal resources.

The development of Principles for a Code of Conduct for the Management and Sustainable Use of Mangrove Ecosystems is thought necessary to guide States¹, mangrove managers, global and regional financial institutions, aid agencies involved on marine and coastal global and regional development issues and NGOs, as to the best measures. The Principles for a Code of Conduct are designed to assist as a tool for mangrove management. The Principles for a Code of Conduct are global in scope and are directed towards all persons concerned with the conservation and sustainable management of mangrove biodiversity resources, such as foresters, fishers, those engaged in processing and marketing of mangrove products, local, national, regional and global organizations, whether governmental or non-governmental, and local communities. The Principles for a Code of Conduct provide principles, guidelines and recommended practices applicable to the conservation and management of all mangrove ecosystems, supported by examples of management experiences from different countries. It also covers the integration of mangrove management within coastal zone and river basin management.

It is also recognized that there are already certain programmes and initiatives currently in existence supported through various National, International and State Agencies that already address some of the issues related to conservation and sustainable utilisation of mangrove resources. The Principles for a Code of Conduct are to be interpreted and applied in accordance with other applicable rules of international law, including the respective obligations of States pursuant to international agreements to which they are party, and in the light of the 1992 Rio Declaration on Environment and Development and Agenda 21 adopted by the United Nations Conference on Environment and Development (UNCED), and the more recent World Summit on Sustainable Development (WSSD) in Johannesburg, 2002. At the WSSD an action plan was agreed to establish a worldwide ecologically representative network of Marine Protected Areas (MPAs) by 2012. This MPA network will contribute to the protection of mangroves as it will include coastal areas.

Together with other relevant declarations and international instruments/agreements, such as the Ramsar Convention on Wetlands of International Importance and in particular Resolution VIII 32 "Conservation, integrated management, and sustainable use of mangrove ecosystems and their resources", the Convention on Biodiversity (CBD), Jakarta Mandate, the International Tropical

¹ The term 'States' is used to refer to the authority responsible for mangrove management, be it Federal, Central, Regional, Provincial or Local Government and their departments and agencies, and traditional institutional structures (e.g. Chiefdoms, Village Councils).

Timber Organization Mangrove Workplan (2002-2006), Food and Agriculture Organization (FAO) Mangrove Forest Management Guidelines and Code of Conduct for Responsible Fisheries, UNEP-GPA (Global Programme of Action for the Protection of the Marine Environment from Land-based Activities), the Forest Principles² adopted at UNCED, the Mangrove Charter developed by ISME (International Society for Mangrove Ecosystems), CITES, WHC, UNFCCC, CMS, UNCLOS, CCD (see Acronyms and Terminology for details). These Principles for a Code of Conduct are designed to provide support to such on-going activities and guidance for pipeline activities, e.g. the Africa Process and NEPAD (New Partnership for African Development).



Figure 0.1: The Food and Agriculture Organisation (FAO) Code of Conduct for Responsible Fisheries (left and bottom) and the International Tropical Timber Organisation (ITTO) Mangrove Workplan 2002-2006 (Photo by Elizabeth Ashton, cenTER Aarhus).

This document is intended to guide (1) progress towards adopting a Principles for a Code of Conduct for the Management and Sustainable use of Mangrove Ecosystems ; and (2) to assist in the creation of mechanisms for adequate legislation and the development, implementation and monitoring of coordinated policies for the protection of mangrove resources. The main themes that the Principles for a Code of Conduct address concern measures to improve Mangrove Conservation through Policy, People and Practices (See LFA Table 0.2). Conservation policies cannot succeed unless there is also consideration given to the problems of people and production. Mangrove restoration and conservation policies must increase livelihood options for local communities and, together with the introduction of best practices (ownership and sustainability), promote sustainable conservation of mangrove biodiversity.

² Full Title: Non-legally binding authoritative statement of principles for a global consensus on the management, conservation and sustainable development of all types of forests.

Table 0.2: Logical Framework Analysis: Objectives for mangrove ecosystem management

OBJECTIVES	INTERVENTIONS (Activities Required)
<p>Development Objective</p> <ul style="list-style-type: none"> Conservation <p>To arrest and reverse the recent and rapid destruction of coastal mangrove ecosystems, to improve their management, and to conserve biodiversity in these critical natural habitats</p>	<ul style="list-style-type: none"> Directly protect pristine mangrove areas* Protect the hydrological regimes supporting mangrove ecosystems Protect mangroves from destruction, degradation and other significant human impacts Promote natural regeneration where mangrove ecosystems have the capacity for self-renewal Rehabilitate degraded mangrove ecosystems Protect and enforce mangrove buffer zones Protect and enhance cultural and social values Promote and improve sustainable traditional management techniques Support co-management with local communities Capacity development or environmental education Raise awareness among stakeholders, public Increase participation of local people in decision-making Promote empowerment of local communities Recognise the full values, traditional, indigenous or local resource use systems and allow for them in decision-making
<p>Immediate Objectives</p> <p>1. Policy</p> <p>Innovate and disseminate appropriate policies and strategies for management and conservation of mangrove resources and ecosystems and have them adopted and implemented in focal regions and countries</p>	<ul style="list-style-type: none"> Improve and reform governance structures to provide for integrated management and conservation Adopt policy reforms for sustainable management and conservation (from research and experience) Strengthen and harmonise regulations enabling the sustainable harvest of mangrove resources Restructure property right regimes to protect mangrove resources and ecosystems Promote use of economic incentives by governments and the private sector Disseminate information for better policy decisions Empower local people and promote participation in management of coastal resources Strengthen and safeguard traditional knowledge and common-use rights Promote research on mangrove ecosystems, species and genetics Promote Rule of Law through legal frameworks and enforcement of laws that support sustainable practices Recognise local knowledge systems. Develop methods for local knowledge systems reviews focused on co-management Strengthen, safeguard rights of common-use Provide for environmental performance bonds and pollution taxes to make available environmental mitigation and restoration
<p>2. People</p> <p>Improve food security, livelihoods and</p>	<ul style="list-style-type: none"> Improve livelihood opportunities by providing alternative sources of income

quality of life of those people dependent on mangrove resources and ecosystems	<ul style="list-style-type: none"> ▪ Strengthen capacity of stakeholders ▪ Identify and resolve ownership issues ▪ Promote sustainability of livelihoods ▪ Provide Communication, Education and Public Awareness support ▪ Be sensitive to equity and gender issues ▪ Promote fair trade of mangrove products
3. Practices Promote more sustainable utilisation of mangrove resources such as timber, fuel wood, fish, molluscs and crustaceans	<ul style="list-style-type: none"> ▪ Identify and improve the use of best management practices for mangrove ecosystems through research, education and incentives for compliance by resource users ▪ Promote more sustainable utilisation of mangrove resources for commercial use, while protecting the livelihood of subsistence users ▪ Identify and promote alternative sustainable uses of the resources ▪ Promote interdependent land use, and maintenance of landscapes that meet multiple, nutritional, ecological, cultural and economic objectives

** It should be noted that although some countries already have legislation protecting mangrove forests e.g. **Brazil** and **Thailand**, effective protection of mangrove ecosystems requires concerted action as the threats to mangroves come both directly and indirectly from many sources and sectors (see Table 0.1). For example, disruption of the hydrological regimes that support mangroves represents a serious indirect threat that is often overlooked or ignored.*

PRINCIPLE 1 OBJECTIVES OF MANGROVE ECOSYSTEM MANAGEMENT

The fundamental objective of mangrove ecosystem management is to promote conservation, and where necessary restoration or rehabilitation and sustainable use of mangrove ecosystems and their associated habitats to benefit local to global populations.

- 1.1 The term mangrove ecosystem usually refers to a tidally influenced wetland complex, consisting of mangrove forests, tidal flats, salt flats and other associated habitats within the intertidal zone of tropical and subtropical latitudes. Mangroves can also occur in areas without a tidal regime e.g. in some choked coastal lagoons and in the supralittoral zone.
- 1.2 The fundamental objective of mangrove management is to promote conservation, restoration or rehabilitation and sustainable use of mangrove ecosystems and their associated habitats, supported where necessary by ecological restoration and rehabilitation. The term “sustainable use” is defined in Box 1A according to the convention on biological diversity (CBD). States and stakeholders can achieve this objective by:
 - 1.2a Taking the precautionary approach to the management of mangrove ecosystems.
 - 1.2b Regarding mangroves as an integral part of the coastal zone rather than as isolated units. This represents a holistic and integrated approach to mangrove management such as the CBD’s Ecosystem Approach (EA) or Integrated Management Approaches (e.g. Coastal Zone Management or Watershed management frameworks) or the Ramsar’s Wise Use approach following its “Frameworks for Managing Wetlands of International Importance and other Wetlands” (e.g. salt flats, salt marshes and coastal lagoons) as well as their watershed, adjacent and coastal ecosystems, and transboundary areas (See Box 1A).
 - 1.2c Identifying and protecting biodiversity hot spots and endangered species and habitats associated with mangrove ecosystems of importance for critical ecological processes (such as salt flats and mud flats that support long-distance migrants/migratory birds).
 - 1.2d Recognising and supporting the special needs of traditional mangrove communities and local mangrove resource users. It is essential to involve local people, local communities and indigenous groups in the management of coastal wetlands and to recognise their needs, as well as their local management practices including access rules to common use resources.
 - 1.2e Mitigating adverse environmental impacts on mangrove ecosystems caused by human activities and natural phenomena, and mitigating against adverse environmental impacts on local communities and other mangrove resource users.
 - 1.2f Monitoring of mangrove ecosystems is important for a number of reasons: (1) to provide an early warning of unpredicted impacts, (2) the information obtained can be used for impact management; (3) to check that mitigation measures have been implemented properly; and (4) to check that mitigation measures are effective.
 - 1.2g Rehabilitating or restoring areas of destroyed or degraded mangroves through natural regeneration, assisted if necessary by active intervention, including restoration of the hydrological regime and/or planting mangroves.
 - 1.2h Enhance sustainable mangrove resource utilisation, by encouraging appropriate local management practices and by promoting non-intrusive activities.

Box 1A: Definitions of Sustainable Use and the Ecosystem Approach (EA)

The CBD definition of sustainable use: "Sustainable use entails the introduction and application of methods and processes for the utilization of biodiversity to prevent its long term decline, thereby maintaining its potential to meet current and future human needs and aspirations."

Article 10 of the Convention sets the sustainable use agenda as follows:

- integrate consideration of the conservation and sustainable use of biological resources into national decision-making;
- adopt measures relating to the use of biological resources to avoid or minimize adverse impacts on biological diversity;
- protect and encourage customary use of biological resources in accordance with traditional cultural practices that are compatible with conservation or sustainable use requirements;
- support local populations to develop and implement remedial action in degraded areas where biological diversity has been reduced; and
- encourage cooperation between its governmental authorities and its private sector in developing methods for sustainable use of biological resources.

An ecosystem is a dynamic complex of plant, animal and micro-organism communities and their non-living environment interacting as a functional unit. The ecosystem approach (EA) is a strategy for the integrated management of land, water and living resources that promotes conservation and sustainable use in an equitable way. It is based on a collaboratively developed vision that integrates ecological, economic and social factors. It is applied within a geographic framework defined by ecological boundaries. The EA integrates ecological protection and restoration with human needs to strengthen the essential connection between economic prosperity and environmental well being. The approach provides the framework that draws together national, local and community-based management practices to achieve the ultimate goal of a healthy and sustainable environment. It requires agencies to be sensitive to the needs and rights of landowners and to work with them toward common goals. Twelve Principles were recommended for application of the EA under the CBD (Decision V/6) see *Terminology* for further details.



Figure 1.1: A 100 ha area in Gazi Bay, **Kenya** was clear-cut in the 1970s to provide fuelwood for the chalk industry. In 1994, 7 ha were replanted with *Rhizophora mucronata* (photo left). Five years later in 1999 (photo right) the trees had reached a height of 4 m and survival was greater than 80% (Photos by James Kairo, KMFRI, Kenya).



Figure 1.2: Destroyed mangrove in Los Micos, in the northeastern region of Ciénaga Grande de Santa Marta, close to Sevillano, on the **Colombian** Caribbean coast (Photo by Francisco Pinto-Nolla, Colombia).

Box 1B: Salt Flats, salinas, apicums, albinas and coastal sabkhas: Threatened components of mangrove wetlands

Salt flats are hypersaline flatlands partially or totally devoid of vascular vegetation. Salt flats have diverse origins they may be inland or coastal. Coastal Salt Flats are often extensive, and become a dominant landscape feature on gently dipping coasts with marked tidal rhythms and dry climate where the Potential Evapotranspiration (PET exceeds Precipitation throughout the year, or where there are prolonged dry seasons. They are characterized by very low gradient slopes and tidal flooding by Spring or Equinoctial Tides. These extensive floodable areas act as natural evaporating basins and high salinities develop in the substrate. Salinity levels rise beyond the physiological tolerance of most plant species (pore water salinity level above 100), and the substrate appears bare but microbial films become dominant. During the dry season these flats are also subject to extreme drying, and during any month may be affected by alternating periods of flooding by Spring tides followed by drying. These salt flats are referred to as salt barrens, salt flats, salinas, salitrales, sabkhas, sebkhas, and by various local names such as apicums and albinas, tannes, among many. Coastal salt flats usually develop between the Mean High Water Spring (MHWS) line and the upland tidal boundary. Saline lagoons and salt flats are extremely productive due to the activity of microbial mats. They are extremely important food sources to migratory shorebirds such as plovers and sandpipers and some migratory waterfowl. The mangroves that line these saline ponds and salt flats provide a habitat for nesting populations of herons, pigeons and many songbirds. Salt flats are threatened by the disruption of processes that maintain their ecological character and integrity. This includes water diversions that reduce runoff inputs of water and the direct or indirect effects of urban, and industrial expansion, and coastal development and infrastructure such as roads marinas, harbours, airports, as well as reclamation for agriculture and aquaculture (fish and shrimp farms). The greatest modern threat to salt flats is the expansion of aquaculture and conversion of salt flats into shrimp ponds. Tidal flats and salt flats are important elements of many migratory routes, such as the Australasian Flyway, the West Pacific Flyway, the Central Asian-Indian Flyway, the African-Eurasian Migratory Flyway, and the Atlantic and Pacific Flyways.

Source: [MAP Guidance document on Salt Flats]



Figure 1.3: Giant Rhizophora mangrove in Esmeraldas, Ecuador (From the poster. Los Manglares más Altos del Mundo, Conserva el Bosque de Majagual en Esmeraldas, Ecuador)

- 1.3 States and all those engaged in mangrove management should adopt measures for the sustainable use of mangrove resources based on sound knowledge, supported by appropriate policy, legal and institutional frameworks.
- 1.4 Conservation and other management measures at all levels should take into account traditional knowledge and cultural values, local legal rights and sustainable management systems, and protect local communities from outside pressure on mangrove resources. Such measures should be designed to ensure the long-term sustainability of mangrove resources.

Short term considerations should not compromise this goal.

- 1.5 The following general actions are recommended to strengthen mangrove management:
 - 1.5a States should establish, within their respective competence and capacity, effective mechanisms to conduct mangrove assessments (i.e. inventories and monitoring) and establish a mangrove management plan based on the resource assessment process. Ensure that the management plan is prepared within the framework of any existing integrated coastal area management plan and prepared in a participatory manner.
 - 1.5b Give due recognition, publicity and effective dissemination to government legislation, as well as local community guidelines/laws/traditions, protecting mangrove ecosystems.
 - 1.5c Explain the purpose of conservation measures to the users of mangrove resources (transparency) to facilitate their compliance and thus gain increased support for the effective implementation of such measures.
 - 1.5d Exercise political will to ensure effective enforcement of the legal framework for mangroves, including issuing appropriate local ordinances (See also 3.3 and 3.4).
 - 1.5e Institute Communication Education and Public Awareness (CEPA) programmes to develop awareness among the different sectors/stakeholders (in particular local decision makers) regarding the value of mangrove goods and services. Media and education programmes should be used to promote wider and deeper understanding of the importance of mangrove ecosystems.
 - 1.5f Promote greater cooperation and action agreements for mangroves (e.g. partnerships, stewardships) between States, NGOs, the private sector and community-based organizations, to enhance public awareness of policy issues and site-specific conservation problems. It

should be noted that local organisations and NGOs can work effectively with schools and colleges, and with the general public, through campaigns and media events, to promote mangrove conservation efforts.

- 1.5g Before committing funds for development projects e.g. roads, housing, tourism facilities, ports, dams and irrigation systems. National Agencies and international organisations (e.g. development banks) should consider carefully the full value of mangroves and their ecological sensitivity relative to the direct and indirect impacts of the proposed development. Participatory and Independent Environmental Impact Assessments should be carried out before any proposed development is approved.

Figure 1.4: Examples of Information, Education and Public Awareness materials supporting the sustainable management of mangroves



A: (Photo by Elizabeth Ashton, cenTER Aarhus).



B: (From SCF (UK) Brochure for children on Mangrove Protection).

In many countries throughout the world school children have produced paintings of mangroves, which have been compiled into books e.g. for Vietnam (A bottom left) and into calendars e.g. by the Mangrove Action Project (A top right). In Vietnam the "Big Book" is used by teachers to teach school children about the importance of mangroves for protecting seadykes (A top left). In Colombia the Ministry of Environment and ITTO have published five booklets to educate the public about mangrove ecololgy, management and conservation. One is a general booklet "Salvemos Nuestros Manglares" (A bottom right) and the others are specific booklets about the Pacific coast and the Caribbean coast mangroves. Save the Children Fund UK have produced a brochure for Vietnamese children on Mangrove Protection (B) and this and other Vietnamese books are used to teach school children basic nature conservation.

PRINCIPLE 2 PRECAUTIONARY APPROACH TO MANAGEMENT

The overall approach to mangrove management should be a precautionary one, but a lack of scientific information should not be used as an argument for postponing, or failing to conserve mangroves or to manage them sustainably.

- 2.1 States should apply the precautionary approach to conservation and management of mangrove ecosystems (see Box 2A). Management should include consideration of the traditional knowledge, beliefs and customs of local communities. Application of the precautionary approach is often a low-cost option when compared to the huge costs and risks of failure associated with mangrove restoration. This concern is particularly important for developing countries where resources for restoration or mitigation of negative environmental and socio-economic impacts may not be available.

Box 2A: Precautionary Approach: Definition and Application

A decision to take action, based on the possibility of significant environmental damage, even before there is conclusive, scientific evidence, that the damage will occur (European Commission, 1999. Integrating environmental concerns into development and economic cooperation. Brussels).

Principle 15 of the Rio Declaration on Environment and Development states that:

"In order to protect the environment, the precautionary approach shall be widely applied by the States according to their capabilities. Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation." (Jakarta Mandate, 1995).

The Precautionary principle acknowledges that: (1) People have a duty to take anticipatory action to prevent harm; (2) The burden of proof of harmlessness of a new technology, process or activity lies with the proponents, not with the general public; (3) Before introducing a new technology, process, or starting a new activity, people have an obligation to examine "a full range of alternatives" including the alternative of doing nothing; (4) Decisions applying the precautionary principle must be "open, informed, and democratic" and "must include all affected parties"; (5) it is easier and more effective to avoid harm than restore (Reference to be added).

Box 2B: Migratory Birds (Shorebirds)

There are 214 species of shorebirds (sandpipers, plovers, oystercatchers, avocets, and stilts) worldwide. Shorebirds use a wide variety of habitats, including interior and coastal wetlands such as mud flats and salt flats. These wetlands are essential features of the landscape, providing feeding sites where migratory shorebirds can stop to feed, rest, and gather energy while en route between breeding and wintering grounds. Habitat conservation is of key importance for the reproduction and survival of shorebirds in their breeding and wintering grounds, as well as in stopover sites along migratory routes or flyways. Migratory routes are diverse and include many countries between Alaska and Tierra del Fuego, southern South America, and the Caribbean basin. Because many shorebirds are long-distance migrants, international collaboration is needed to manage and conserve their populations. Conventions such as Ramsar and the Western Hemisphere Convention provide mechanisms to promote the international collaboration needed to conserve shorebirds and their habitats.

- 2.2 States should identify existing mangrove areas for preservation, conservation or sustainable utilisation based on their location, ecological characteristics and values (see Tables 2.1 and 2.2).
- 2.2a Where pristine or near pristine mangroves still exist, immediately adopt protection and conservation management measures. Such efforts should remain in force until there are sufficient data to allow a comprehensive assessment of the impact of alternative forms of management (e.g. via an independent Environmental Impact Assessment).
- 2.2b Protect critical mangrove areas for biodiversity conservation, to maintain all endemic and rare species, including their habitats and the ecological processes that support them. The IUCN

Red List of Threatened Species defines and lists all critically endangered, endangered, vulnerable and near threatened species (Box 2B gives examples from mangrove ecosystems).

Box 2C: Examples of endangered mangrove-associated animal species

The Bengal Tiger in the Sundarbans of **India** and **Bangladesh**, is the best known species of a large endangered mammal associated with mangroves. Despite a dramatic decline in its numbers the Bengal tiger has received some protection in mangrove reserves established in India and Bangladesh, these include three Wildlife Sanctuaries covering almost 140,000 ha in the Bangladesh Sundarbans from 1977.

Manatees and Dugongs are vulnerable throughout tropical regions. In some areas they have become extinct due to overhunting and accidental death in fishing nets. Loss of mangrove and seagrass habitats has been another major cause for the serious decline in the populations of these sea mammals (Alvarez-Leon, 2001). In the Saloum Delta, **Senegal** there is a local campaign by NGOs to increase awareness about the need to protect manatees.



Figure 2.1: Bengal Tiger, Sundarbans, **India**
(Photo by B. Roychowdhury, Forest Department, India).



Figure 2.2: Manatee in the Saloum Delta, **Senegal**
(Photo by Abdoulaye Diame, WAAME, Senegal).

- 2.2c States should control and carefully regulate the introduction of alien/exotic species and genetically modified organisms into mangrove ecosystems. For guidance refer to the Convention on Biological Diversity (CBD) guidelines on alien/exotic species (see Box 2C) and the Global Invasive Species Program, which along with IUCN, has developed some specific legal recommendations for dealing with invasive organisms (see IUCN Guidelines for the prevention of Biodiversity loss caused by alien invasive species, 2000). Examples are given in Box 2D but Principle 11.8 specifically refers to species for aquaculture.

Box 2D: Convention on Biological Diversity (CBD) Guidelines on Alien/Exotic species

Article 8(h) CBD

Prevent the introduction of, control or eradicate those alien species which threaten ecosystems, habitats or species (CBD, 1992).

Invasive alien species are species introduced deliberately or accidentally outside their natural habitats where they have the ability to establish themselves, invade, out-compete natives and take over the new environments. Intentional introductions include species for aquaculture or forestry; accidental introductions such as organisms accompanying those introduced for economic purposes (viruses, parasites); escapees from aquaria, zoos and other scientific facilities or through fouling of ship hulls or ballast waters.

The threat to biodiversity due to introduction of alien species is considered second only to that of habitat loss (<http://www.biodiv.org/programmes/cross-cutting/alien>).

Box 2E: Examples of alien/exotic introductions into mangrove ecosystems

Nypa fruticans (nipa palm), a mangrove species native to Southeast Asia, was brought from **Singapore** to **Nigeria** in 1906. It was introduced along the coasts of Calabar and Oron in eastern **Nigeria** to control erosion. However, the nipa palm spread westwards to the State of Ondo, where it invaded extensive areas and displaced valuable indigenous mangrove species, such as *Rhizophora* and an important palm, *Raphia*. It also posed other serious ecological and socio-economic threats by invading fish nursery and feeding grounds. (Contrary to the situation in Southeast Asia, nipa palm is not utilised by the local people of **Nigeria**). The Federal Ministry of Environment has developed an intervention, the “Nypa Palm Control Programme” to control the spread of this invasive species. Under this programme, the objective is to remove the nipa palm and replace it with native mangrove species. Tilapias introduced to Asia from Africa for aquaculture purposes (various introductions were made from 1946 on) have now colonized extensive brackishwater areas with mangroves even though it is a freshwater group of fishes. Similarly, in **Colombia** two freshwater fish species were introduced: the Red Tilapia (*Oreochromis* sp.) from Africa for cage aquaculture and the snake skin gourami (*Trichogaster pectoralis*) from Asia for ornamental aquaria, but they escaped and have now colonised the Magdalena River and lagoon near Bogota replacing native fish species. Today, both the tilapia and gourami have become dominant species in the local fishery.

- 2.2d In areas designated for forest utilisation e.g. production forest, states should adopt a precautionary approach, especially where information/experience on sustainable forestry practices is not available or is limited.
- 2.2e States should incorporate mangrove ecosystems in landscape-level integrated management plans. Identify landscape capabilities (opportunities) and constraints. Inventory habitats and identify special environments. Assess capability and capacity and assess cumulative impacts of landscape-level development. Adopt stringent precautions where compatible economic development activities in mangrove ecosystems are planned (EIAs at local and landscape or regional levels). Avoid activities (e.g. industry, urban development, agriculture and aquaculture) within intertidal areas that involve loss of mangrove ecosystem and associated habitats integrity. The potential negative impacts from tourism should not be overlooked.
- 2.2f Adopt strict protection and conservation management measures for mangroves and associated habitats (for example: greenbelts, buffer zones) where natural phenomena (such as typhoons/tidal surges/cyclones and natural geomorphic erosion processes), have a significant adverse effect on the coastline. Mangrove forests mitigate the effects of storms by absorbing wind and wave forces, and by stabilising sediments, thereby reducing the risks of disasters. Similarly, erosion-prone coastlines and riverbanks should be protected with legally designated mangrove green belts.



Figure 2.3: Mangrove protection belt (1 km wide) of *Kandelia candel* planted in the Red River Delta, **Vietnam** (Photo by Don Macintosh).

A mangrove protection belt in association with coastal sea dykes in the Red River Delta, **Vietnam** has greatly improved coastal protection against typhoons. Engineers estimate that an earthen sea dyke with rock facing (revetment) will last about 5 years before it requires repair due to wave damage; however the same sea dyke with a 100m wide protective belt of mangroves in front, will last up to 50 years!

Vietnam has also enacted a 500-1000 m wide green belt (Full Protection Zone) along the Mekong Delta coastline for storm and flood protection (see details Box 3C).

The **Philippines** has a forestry code specifying a 20 m wide mangrove buffer zone along all shorelines, and 50 m wide in typhoon-prone areas.

- 2.3 The precautionary approach should include risk assessment and wherever possible remedial action to reduce the threats to mangrove ecosystems from sea level rise, and catastrophic events including storms and oil spills (See Figure 2.3).
- 2.4 States should continuously adjust, refine and where possible enhance, the precautionary approach to mangrove management as knowledge and experience are gained.

Table 2.1: Conservation management priorities for critical mangrove forest areas in Southeast Asia, classified by habitat and community type

Category	Management Priorities
Mangrove forests which are primary/pristine	Regardless of location, pristine mangrove forest should be preserved or declared as forest reserves because such areas are important in maintaining ecological balance in the coastal ecosystem and for educational and research purposes and as genetic reservoirs.
Mangrove areas subjected to significant environmental hazards for example storms, erosion, floods, water withdrawal and seasonal drought	A minimum protective zone of mangrove forest should be left untouched. The following are examples of the minimum width for mangroves specified in some Southeast Asian countries: > 100 m on open coast > 25 m on river banks and lagoons > 10 m on inland banks, creeks and channels
Mangrove areas near or adjacent to known habitats important as fish, molluscan and crustacean nurseries and/or fishing grounds	Considering the importance of mangroves as nursery grounds for aquatic species, mangroves near or adjacent to known areas abundant for fish, molluscan and crustacean fry and/or fishing grounds should not be alienated or released for development.
Mangrove areas near populated areas/urban centres	Some mangrove areas in urban areas should be conserved exclusively for sustainable utilisation, coastal protection, tourism, education and recreation purposes by the local people who should be involved in any reforestation and maintenance efforts.
Mangroves on small islands	These mangroves serve as a major ecological component of the island ecosystem and should in no case be disturbed.
Mangroves in estuarine areas	To maintain the ecological balance of estuarine areas there should be protection zone areas of mangroves preserved on the banks of the mouth of the river fronting the sea.
Mangroves with abundant mature trees producing seeds and propagules (mother trees)	Mother trees are vital for restoration and rehabilitation as sources of seed and propagules for planting. They are also the means for mangroves to self sustain.

Modified from: National Mangrove Committee of the Philippines.

Box 2F: Reentrancias Maranhenses Protection Area A WHSRN Site Location and Ramsar site (Wetland of International Importance) Northwest coast of the state of Maranhao, Northern Brazil.

The Reentrancias Maranhenses Protection Area Between the mouth of the Gurupi River and the Bay of San Marcos, including Cajual Island, is a very geomorphologically diverse area, with bays and estuaries, mangroves, sandy beaches and coastal dunes. Tides are up to 8 meters. The area comprises 2,680,911 hectares. Reentrancias Maranhenses Protection Area is a Western Hemisphere Shorebird Reserve Network site and a Ramsar site (1,775,036 ha) composed of extensive low, seasonally flooded coastal lands characterized by fields, gallery forests, mangrove swamps, and lacustrine basins along the northeast coast of Brazil. The site qualifies under all of the representative/uniqueness criteria and most of the Ramsar biodiversity criteria, including those for waterfowl and fish. This site is among the eight largest Ramsar sites in the world. The coast of North-Central Brazil, between Belem and Sao Luis area stands out as one of the most spectacular areas in terms of importance for migratory shorebirds for the hemisphere.

Table 2.2: Management priorities for mangrove forest areas in South America, classified by physiographic type and indicator species

Category	Indicator Species	Management priorities (applying to all categories)
Overwash Forest	<i>Rhizophora, Anadara, Ucides, Crassostrea</i>	<p>Conservation of biodiversity specific for each physiographic type</p> <p>Protect a physiographic type of mangrove when the pressure for a resource in that area is high</p> <p>Protect areas where ecological processes/services e.g. energy flow are important for ecological functioning of the mangrove ecosystem and related systems</p> <p>Restrict activities which promote the deterioration of the environment e.g. the positioning of shrimp farms and agriculture activities in predominantly basin forests</p>
Fringe Forest	<i>Rhizophora, Avicennia, Ucides, Anadara, Iguana, Uca</i>	
Riverine Forest	<i>Laguncularia, Rhizophora, Cardisoma</i>	
Basin Forest	<i>Avicennia, Conocarpus, Melamphus, Cardisoma, Uca</i>	
Hammock Forest	<i>Rhizophora, Avicennia</i>	
Scrub Forest	<i>Rhizophora, Avicennia</i>	

The six physiographic types are modified from Lugo and Snedaker (1974) and Odum et al. (1982).

PRINCIPLE 3 POLICY AND LEGAL FRAMEWORKS

National and international policy and legal frameworks are required to provide overall guidance for the conservation and sustainable use of mangrove resources and to ensure protection for mangrove-associated biodiversity.

- 3.1 States should ensure that effective and coordinated policy and legal frameworks, supported by clear institutional and administrative responsibilities, are developed at the local, national and transboundary levels, as appropriate, to support mangrove management. To this effect, existing policies, laws and institutions dealing with mangroves should be reviewed and amended as needed.
- 3.1a One of the first steps for States in reviewing their legislation and policies should be to identify and eliminate economic and fiscal measures that are inconsistent with the conservation and wise use of mangrove ecosystems and other coastal wetlands.
- 3.1b Policy should be based on the following four principles: (1) No further loss of coastal wetlands, including mangroves and associated habitats; (2) No further wetland degradation; (3) Wise use of wetlands, and; (4) Wetland improvement and restoration. (See examples Box 3A).

Box 3A: Ramsar guidelines on Wetlands

The Ramsar Convention has officially adopted many guidance documents at the Conference of the Contracting Parties (see http://ramsar.org/key_guidelines_index.htm). Some key examples are:

- Guidelines for the implementation of the wise use concept, 1990 (http://ramsar.org/key_guide_wiseuse_e.htm). First adopted as an annex to Recommendation 4.10 of the 4th Meeting of the Conference of the Contracting Parties (Montreux, Switzerland, 1990).
- Guidelines for developing and implementing National Wetland Policies, 1999 (http://ramsar.org/key_guide_nwp_e.htm). 7th Meeting of the Conference of the Contracting Parties (COP) to the Convention on Wetlands (Ramsar, Iran, 1971), San José, Costa Rica, 10-18 May 1999.
- Guidelines for reviewing laws and institutions to promote the conservation and wise use of wetlands, 1999 (http://ramsar.org/key_guide_laws_e.htm). 7th Meeting of the COP San José, Costa Rica, 10-18 May 1999.
- Guidelines for establishing and strengthening local communities and indigenous people's participation in the management of wetlands, 1999 (http://ramsar.org/key_guide_indigenous.htm). 7th Meeting of the COP San José, Costa Rica, 10-18 May 1999.
- Principles and guidelines for wetland restoration, 2002 (http://ramsar.org/key_guide_restoration_e.htm). 8th Meeting of the COP Valencia, Spain, 18-26 November 2002.

- 3.1c The policy and legal framework for wetland ecosystems should give priority to protecting the resource security and open access of local and indigenous peoples, who have a traditional association with mangroves. (The term “indigenous peoples” describes social groups with a social and cultural identity distinct from the dominant society which makes them vulnerable to being disadvantaged in the development process (World Bank Operational Directive 1991; see Box 7C).
- 3.1d States should also recognise that all too often it is not lack of legislation but inadequate enforcement of applicable laws, regulations and rules that works against wetland conservation on the ground. Actions should be taken to eliminate the following common reasons for inadequate enforcement:
- Lack of surveillance and monitoring procedures

- Absence of legally-backed rights to information for local and indigenous communities
 - Lack of local participation in natural resources decision-making processes
 - Lack of political will and public awareness to uphold legislation
- 3.1e The policy and legal frameworks for mangroves are often complex and poorly understood at all levels. The relevant authorities should review the legal status of mangroves at national level, then consolidate and summarize the key points into a form that can be easily understood by stakeholders; e.g. as a pamphlet in the local language, with illustrations.
- 3.1f Clear agency responsibilities for mangrove management are needed which facilitate coordination between the various agencies most likely to be involved, these include departments and agencies for forestry, fisheries, water and navigation, environment, land use planning and tourism. Cooperation among these institutions should include harmonization of the legal frameworks relevant to wetland ecosystems that apply to each of these sectors.
- 3.1g It is desirable to have clear policies for mangrove conservation and rehabilitation. The overall goal should be to legally protect and sustainably manage all remaining mangrove ecosystems. It is especially important to avoid further fragmentation of mangrove habitats and interference with their supporting hydrological systems.

Box 3B: Examples of the policy and legal framework for mangroves

Policy

- **Thailand** currently (2002) has about 170,000 hectares of mangrove forest. The national policy is to increase this area to 200,000 ha by 2006. Institutional responsibility for mangrove conservation has recently been assigned to the Office of Mangrove Conservation under the Department of Marine and Coastal Resources, which is a department under the new Ministry of Natural Resources and Environment.

Regulations

- In **Brazil**, it has been illegal to cut mangroves since 1926 and the legislation was amended in 1965 to make it even more restrictive. Some exceptions are permitted, e.g. to allow for important public utilities, such as bridges and electricity lines. Environmental legislation was further strengthened by the law on environmental crime in 1998.

- 3.1h Physical zoning (land and water use restrictions), of mangroves can be a valuable, practical means to help implement conservation and other management objectives. Mangrove areas should be clearly zoned, with the function and conservation status of each zone identified and legally defined. Zoning of mangroves should be part of the overall coastal zone management plan, so that it is not viewed as an isolated activity. (See Box 3C for examples of zoning).

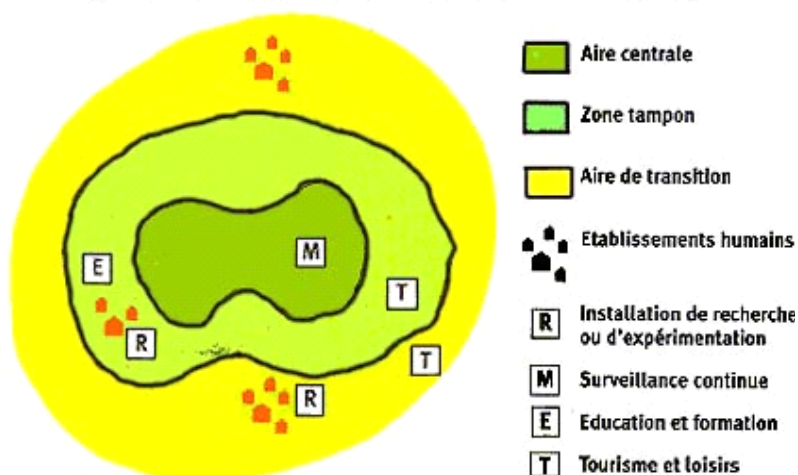
Box 3C: Examples of land use zoning involving mangroves

- **Vietnam** has enacted a zoning plan for the Lower Mekong Delta featuring a Full Protection Zone (FPZ) for coastal protection, a Buffer Zone for controlled economic activities (40% by area), but retaining 60% forest cover, and an Economic Zone where there are no forest conservation restrictions. The FPZ is to be demarcated with clear signs using both symbolic and written information.



- The National Mangrove Plan for **Ecuador** has strategies for zonation that were accepted in 1990. The zonation plans for each province (Esmeraldas, Manabi, Guayas and Guayaquil) are implemented depending on the user groups. Reserve mangrove areas and community areas are identified within the designated mangrove zone.
- Saloum Biosphere Reserve, **Senegal** has a zoning plan (with IUCN support) with core, buffer and transition zones. This work was carried out with the technical support of the Ecological Monitoring Centre to map all the areas of the BR using satellite data (Landsat and Spot). The central area is strictly protected and is a national park, it is clearly marked and understood to be a conservation zone by the local people and the government. However, the buffer zone for sustainable development and the transition zone for multiple use are not clearly marked and are not well understood both by either the local people or the government.

Zonage schématique d'une réserve de biosphère



- 3.1i States should be cognizant of their international treaty obligations. These include broad mutually agreed commitments that require development of site-specific measures based on national legal frameworks. The CBD expressly requires that national decision-making should include consideration of the conservation and sustainable use of biological resources (CBD Article 10).

- 3.1j States should note that Article 8 of the CBD obliges the parties to respect, preserve and maintain knowledge, innovations, and practices of indigenous and local peoples embodying traditional lifestyles relevant for the conservation and sustainable use of biological diversity and their wider application with the approval and involvement of the holders of such knowledge, innovations, and practices and encourage the equitable sharing of the benefits arising from the utilization of such knowledge, innovations and practices.
- 3.1k The legal framework should provide mechanisms to ensure that full and independent EIAs are conducted for development activities that could impact on wetland ecosystems, including mangroves. Physical infrastructures such as embankments, roads, dikes, ponds and canals may affect the normal tidal flow, surface run-off and sediment deposition dynamics along mangrove coastlines, even if they are not physically located within mangrove areas. Thus, EIAs should include assessment of the impact of infrastructure development projects on the hydrological regime both upstream and downstream of the proposed development site.
- 3.2 In view of the multiple uses of the coastal zone, States should ensure that representatives of all the different sectors/stakeholders are consulted in the decision-making process in development and management planning, and in environmental protection activities for mangroves.
- 3.2a The best multiple use systems for coastal areas involving mangroves need to be determined by careful assessment of the environmental and socio-economic conditions affecting local stakeholders and with all stakeholders participating in the assessment process.
- 3.2b Non-destructive uses of mangrove ecosystems and associated habitats should be encouraged over activities that involve conversion, destruction or degradation and/or altering their hydrological conditions.
- 3.2c All decisions on development activities should be formulated based on a wide base of knowledge, including landscape-level or regional resource capability assessments, research studies, traditional/local knowledge and ample, open consultation with local stakeholders and traditional users..
- 3.2d States should provide the financial and economic conditions for coastal cities to have adequate sewage and landfill treatment systems. Mangroves can be used to treat sewage discharge on a small scale, but not the quantities generated by large cities.

Box 3D: Examples of inter-agency consultations on mangrove management issues

Inter-agency stakeholder consultation and licensing practices have been established for the Matang Mangrove Forest Reserve in Peninsular **Malaysia**. The licensing of charcoal kilns and wood harvesting is done by the Forestry Department and fish cage licensing by the Fisheries Department. Preservation of a bird sanctuary and archaeological sites were also agreed after consultation with the wildlife department and national museum, respectively. In **Malaysia** it is standard practice to have State and District level committees dealing with all administrative and operational issues. The District level committee, chaired by the District Officer is where real on the ground issues can be discussed and resolved among the different agencies concerned. The District committee also includes community leaders such as the local member of parliament and or state legislative council members of the District concerned.

Songor Ramsar site, **Ghana** has a committee that works in consultation with government agencies. The **Ghana** Wildlife Division at the national level constituted the National Advisory and Oversight Committee with representations from the District Assembly, Wildlife Office, District Planning Office, Traditional Council, Traditional Authorities, Women's groups, Fisherfolks, Farmers, Canoe fishermen and farmers associations, Co-operative salt winners associations and the local media.

- 3.3 States and mangrove managers should ensure that the laws and regulations protecting mangrove ecosystems and associated habitats should provide effective penalties that are adequate in severity to deter violations. These can include penalties, fines, and suspension of user authorization or refusal of permits, in order to promote compliance. Planning and activity-based legislation must provide for mechanisms, whether in the form of administrative

orders, or judicial injunctions, to put a halt to illegal operations. Deposit performance bonds provide a useful mechanism to ensure compliance with permit conditions.

3.4 The following measures are recommended to promote compliance with the appropriate laws and regulations:

- Legalize the activities of legitimate mangrove users. A licensing or permit system could be considered as a mechanism (see Kenya example Box 3F). However, any licensing or permit system must be managed in an open and transparent manner by both government officials and local people.
- Designate areas of mangrove forest as “set aside” areas to help meet the subsistence fuelwood and timber needs of very poor mangrove dwellers.
- Penalties for violations should reflect the severity of the mal-practices concerned.
- Speedy disposition of cases involving violations of laws and regulations are strongly urged to protect mangrove resources, and as a deterrent to would-be violators.
- Education of all stakeholders in key aspects of mangrove legislation (see also Principle 3.1a)
- Develop actions and mechanisms to promote the organisation of local communities to help them understand and access the legal system to respect the law and protect their rights as mangrove users (See example Box 3E access to justice and Box 3F measures to promote compliance).

Box 3E: Access to justice

In **Brazil** one of the most important laws is Law No. 7.347 of 1985 that states that NGO's and public prosecutors can initiate “popular civil actions” for the enforcement of environmental and other “diffuse” “collective” rights. NGO's as well as the Public Prosecutor and other governmental entities are authorized to seek monetary damages and injunctions in the enforcement of consumer, environmental and cultural rights. (Source: Nogueira Souza Patu 2002).

In **Costa Rica**, the Organic Environmental Law provides for an Environmental Inspector and an Environmental Administrative Tribunal. The Inspector is obliged to report violations of the Environmental legislation and related laws to the Environmental Attorney's Office, the authority responsible for the public maritime domain as well as the Ministry of Public Affairs. The Tribunal is empowered to record and adjudicate charges brought against public or private entities for alleged violations of the legislation on environmental protection and natural resources. The Tribunal may impose administrative fines or penalties and its decision is final. (IUCN Law Paper 38).

3.5 In conformity with their national legislation, States should implement effective assessment, monitoring, surveillance and law enforcement measures to protect their mangroves.

3.5a Surveillance and law enforcement are most effective when supported by regulatory mechanisms adopted by the local communities themselves (i.e. community management systems for resource tenure and dispute resolution) (see example Box 3F).

Box 3F: Examples of measures to promote compliance with the legal framework for mangroves

Example of an appropriate level of enforcement - In Peam Krasop Wildlife Sanctuary (Koh Kong **Cambodia**), illegal charcoal kilns were destroyed from 1995 by the Department of Environment, as they were the cause of large-scale cutting of some of Cambodia's best mangroves. The DoE operated with the support of an inter-agency committee set up by the Provincial Authority against charcoal production activities. This action was also backed by existing legislation (Decree 33, dated 1987) prohibiting the cutting of mangrove wood for charcoal production, and a Royal Decree on Protected Areas Management in **Cambodia**. To further strengthen its fight against charcoal production, in 1999 the Provincial Authority (DoE) declared the buying or selling of mangrove charcoal to be illegal, thereby targeting the powerful middlemen in the charcoal trade for the first time, as well as the producers.

Strict penalties are applied in **Ecuador** to those destroying mangroves illegally, namely a fine of USD 7000/ha; in addition, violators have to replant the affected area.

In **Kenya**, to be allowed into the mangrove forest to harvest mangrove wood products, a cutting license (cheti cha ukataji) is required from the Forest Department. The cheti designates the cutting areas and number of mangrove poles permitted to be extracted from the forest. The cutting permit is revised annually at a cost of USD 135 for poles and USD 40 for firewood. After cutting the poles are all brought to a landing site and piled into their respective size classes. The royalty paid to the government depends on the quantity and utilisation class removed (e.g. twenty poles of diameter size 11.5 cm to 13.5 cm is charged a revenue of USD 1.5). There is no tax charged to cutters for harvesting poles for domestic use, but for purposes of building a home, a local school, cutting for boat building purposes, domestic firewood collection, and other domestic community uses, a fee is charged.

- 3.5b Monitoring/assessment of mangroves must be simple and inexpensive, but reliable. Two levels of assessment are desirable (a) routine, low level monitoring by local people; (b) more intensive, periodic monitoring by governmental agencies, NGO's and researchers. (See Principle 5 for recommended methodology).
- 3.5c States should encourage studies and research which supports the legal framework regulating the quantities of mangrove resources that may be extracted. It is particularly important to have accurate knowledge of the maximum sustainable extraction quantities for mangrove wood and aquatic species in order to determine quotas and similar regulatory mechanisms.

Box 3G: Examples of Community based management of mangrove resources

In **Ghana**, several coastal areas which are sacred to the local people and are therefore well protected exist. Due to the value of mangroves, and the lack of alternative forms of energy, coastal communities depend heavily on mangrove for domestic fuelwood. In the Lower Volta area, the eight main communities that supply the largest mangrove wood market in **Ghana** decided to institute a quota on their members when the impact of unregulated cutting was explained to them.

- 3.6 States should identify and adopt mechanisms by which mangrove conservation activities can be financed, so that much of the cost of conservation, management and supporting research and education can be recovered. Mangrove Forest Development Funds (MFDFs) or Environmental/Ecological Trust Funds are recommended as good potential mechanisms for financing mangrove conservation activities. A percentage of the royalty charged on mangrove products (e.g. timber, aquaculture products); is placed in the MFDF exclusively to finance mangrove conservation and rehabilitation activities (see Box 3H).

Box 3H: Examples of Forest or Trust Funds used to support mangrove conservation

- In **Malaysia**, the Forest Development Fund (FDF) is established by the State Forest Departments in accordance with Section 56 of the National Forestry Act (1984). The FDF is established through an existing financial procedure known as the financial instrument. This specifies the type of expenditure allowed, e.g. for enrichment planting, silvicultural treatments and rehabilitation, or forest inventory, which are directly related to forest development or forest rehabilitation. The FDF is administered by the Forest Department, which reports to the State committee chaired by the State Secretary, with the State Financial Officer and the Director of Forestry included as committee members. A yearly expenditure and income statement is submitted to the committee for approval, together with annual auditing by the government auditor-general. The FDF covers forest development in general for the whole state, including mangrove and freshwater swamp forests.
- In the **Philippines**, 25 year leases are provided to the local communities as Community Based Mangrove Forest Management Agreements (CBFMA); the proceeds from the harvest value of the mangrove wood are shared 75% to the community, 25% to the government; the government set aside 10% in a Department of Environment and Natural Resources trust fund to support mangrove replanting costs.

PRINCIPLE 4 IMPLEMENTATION AND INTEGRATION

There is a general weakness in the implementation of policy and legal frameworks for mangroves, lack of consultation between the management agencies and the various mangrove stakeholders, inadequate monitoring and evaluation of implementation performance and lack of integration of mangrove management with coastal zone and river basin area management.

- 4.1 Mangroves should be managed using the Ecosystem Approach (see definition Box 1A and *Terminology*), taking due account of activities and impacts both upstream of the mangrove ecosystem and in adjacent coastal areas (see Box 4A). The ecosystem approach considers mangrove management as an integral part of coastal zone and river basin area management. Thus states should recognise that strong coordination is required at all levels between the authorities concerned with mangroves and other coastal and riverine ecosystems and resources.

Box 4A: Examples of upstream activities affecting mangrove ecosystems

In **India**, water and sediments from the Ganges River have been diverted through a barrage (dam) at Farakka since 1974. This has adversely affected agriculture, navigation, irrigation, fisheries, forestry and industrial activities, and increased salinity intrusion of coastal rivers, groundwater, riverbed aggradations, sediment influx, coastal erosion and submergence in **Bangladesh**. Together with agricultural and industrial activities upstream polluting the remaining water, it has caused a number of negative impacts for the Sundarbans mangrove ecosystem. The stress of the system is thought to be one reason for the top-dying of the Sundari trees (*Heritiera fomes*) (Gorai River Restoration Project EIA, 2001).

In **Ghana**, the changes in hydrology of the Volta river (discharge and hydro period) that followed the construction of the Akosombo and Kpong dams (constructed in 1964 and 1983, respectively) have limited the extent of saline intrusion into the Volta estuary. This change in water chemistry, flooding and sedimentation has led to die off of mangroves near the coast.

In the Jaguaribe Estuary, **Brazil**, a dam constructed upriver of the mangrove ecosystem has reduced the deposition of alluvial sediments along the estuary, leading to die-off some of the mangrove forest near the estuary mouth (Lacerda, 2001).

Current rates of mangrove deforestation are likely to have serious consequences for the ecosystem function, fisheries productivity and resilience of reefs. Mumby et al. (2004) experiments showed that mangroves are very important as they serve as intermediate nursery habitat between seagrass beds and patch reefs, which increases the survivorship of young fish. Also mangroves enhance the biomass of several commercially important coral reef fish species. Mumby et al. (2004) suggest conservation efforts should protect connected corridors of mangroves, seagrass beds and coral reefs.

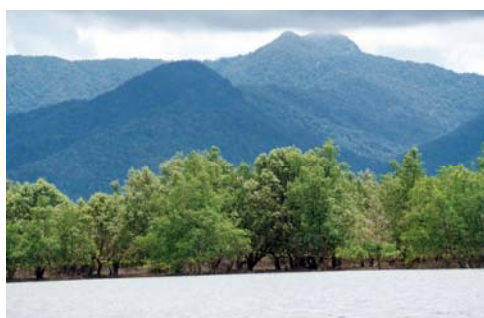


Figure 4.1: The mountainous watershed catchment area above, but interconnected with the coastal mangroves (in foreground) in Ranong Province, Southern **Thailand** (Photo by Donald J Macintosh, cenTER Aarhus).

- 4.2 States with neighbouring coastal areas and connected water sources should cooperate together at the sub-regional, regional and international levels to facilitate the sustainable use of their common resources and to conserve the environment. States should also seek wide support in order to improve integrated coastal area and river basin management, including drawing on the wide experience of regional and international initiatives (See Box 4B).

Box 4B: Regional and International Initiatives to facilitate cooperation in management of water resources

At the regional and river basin level there are over 200 agreements which provide a basis for cooperation in the management of shared water resources. For example:

- The Convention on Biological Diversity (CBD), which identifies the conservation of the biodiversity of inland waters as a particular priority.
- The Convention on the Law of the Non-Navigational Uses of International Watercourses (New York, 21 May 1997: not yet in force) which requires states to avoid, eliminate or mitigate significant harm to other watercourse states and establishes detailed rules with regard to the changes in use of any international watercourse. Issues covered include EIA, consultation, joint protection of watercourse ecosystems, pollution control, introduction of alien species, prevention of erosion, siltation, and salt-water intrusion; and
- The Global Programme of Action for the Protection of the Marine Environment from Land-based Activities (GPA).
- The sustainable use of freshwater has been identified as a critical component of Agenda 21 and as such has been the focus of a series of meetings under the auspices of the United Nation's Commission on Sustainable Development and other UN agencies.
- Creation of the Global Water Partnership to act as a framework to coordinate efforts to promote integrated water resource management, especially in developing countries.
- The development of the Vision for Water, Life and the Environment through the Global Water Commission under the auspices of the World Water Council.
- The establishment by the World Bank and IUCN-The World Conservation Union of the World Commission on Dams.
- The Ramsar Convention guidelines on river basin management, 1999 (http://ramsar.org/key_guide_basin_e.htm), international cooperation, 1999 (http://ramsar.org/key_guide_cooperate.htm), allocation and management of water for maintaining the ecological functions of wetlands, 2002 (http://ramsar.org/key_guide_allocation_e.htm) and the principles and guidelines for incorporating wetland issues into Integrated Coastal Zone Management (ICZM), 2002 (http://ramsar.org/key_guide_iczm_e.htm).

The African Ministerial Conference on the Environment (AMCEN) and the African Ministerial conference on Water (AMCOW) rationalise approaches on environment and water use. These committees can be used to raise mangrove issues at regional level within Africa.

- 4.3 Management objectives which encourage sustainable use of biological resources and support local peoples rights should be translated into specific actions by developing implementable management plans within the legal framework for mangroves. Based on the management plan, realistic operational plans should be developed that are suitable for implementation, involving simple, practical and transparent procedures.
- 4.4 The management of the mangrove ecosystem as a whole should also include clear management objectives for each of its individual resources. Management plans should be reviewed and adjusted periodically, to ensure that each resource is being managed sustainably.
- 4.5 States should identify implementing agencies for mangrove management at the national level and harmonise institutional arrangements for mangrove management to clearly define responsibilities and to minimize duplication of efforts and funding among the various agencies/departments concerned.
- 4.6 States should establish interministerial committees to promote cooperation and coordination among national authorities involved in the planning, development, conservation and management of coastal ecosystems and river basins (see Box 4C).

Box 4C: Example of interministerial committee for implementation of national policies affecting mangroves

In **Bangladesh** there is an interministerial Steering and Technical committee for integrated coastal zone management. The Program Development Office-Integrated Coastal Zone Management is in the Water Resources Planning Organization (WARPO) of the Ministry of Water Resources, Bangladesh but is composed of representatives from all relevant Ministries and Departments involved in coastal zone management.

- 4.7 States should also promote and coordinate cross-sectoral planning and implementation, which includes the private, scientific and NGO sectors and, in particular, takes account of the needs and rights of local people. For this purpose the establishment of a national coordinating body for mangrove management is recommended (e.g. a National Mangrove Committee or inter-ministerial body; see Box 4D).

Box 4D: Examples of national coordinating bodies for mangroves

National Mangrove Committees (NATMANCOMs) were set up in many Asian countries with assistance from the UNESCO/UNDP Regional Project RAS/79/002: Research and Training Pilot Programme on Mangrove Ecosystems. UNESCO requested each participating country to constitute a NATMANCOM, both to act as an advisory body on mangroves for the country concerned, and to participate at regional level in the project activities as a member of the Regional Task Force for mangroves. The NATMANCOMs operated well through the project period up to 1989 and continued to work effectively in several countries after the project.

The **Indian** National Committee on Mangroves and Coral Reefs in the Ministry of Environment and Forests includes members from the Coast Guard, Ministry of Defence; Department of Ocean Development; Central Marine Fisheries Research Institute; Botanical Survey of **India**; Zoological Survey of **India**; National Institute of Oceanography; Calcutta University and Annamalai University. The Committee was formed under the Government of **India** in 1978-9 and meets twice a year. For implementation the information discussed at the National Committee is disseminated to the State Level Steering Committees. Information also passes in the opposite direction. Implementation of Management Action Plans is through the State Forest Departments (one in each State of **India**). There are also Research Sub-committees on Conservation and Management of Mangroves and Coral Reefs. NGOs such as the Mangrove Society of India are encouraged to create awareness among the people and work on major mangrove projects associated with local communities.

- 4.8 States should ensure that the authority (or authorities) managing mangrove ecosystems in the coastal management process have the appropriate expertise and are provided with adequate financial resources and mandates to carry out their responsibilities. This is particularly important at the local level of decision making, which is usually the municipal/district level. Existing sources of financial, technical and human resources should be reviewed in order to make their full potential available for the conservation and sustainable management of mangroves.
- 4.9 Mangrove conservation should be strengthened by assigning protected area status to appropriate locations, especially those that also have important ecological, cultural or historical significance. Such areas should be legally protected through governmental legislation. Countries can also nominate a protected area for international recognition if it conforms to one of the existing international conventions or regional conservation frameworks (see Table 4.1).

Table 4.1: Examples of Protected Areas involving mangroves

IUCN Protected Area Category by purpose	Mangrove Site	National Status*	International Status*
<i>Ia: Strict Nature Reserve</i>	Majagual, Esmeraldas, Ecuador	Ecological Reserve	Ramsar Site
<i>Ib: Wilderness Area</i>	Sundarbans, India and Bangladesh	Wildlife Sanctuary, Reserved Forest, Sundarbans Tiger Reserve	World Heritage Site Biosphere Reserve Ramsar Site
<i>II: National Park</i>	Superagui National Park, Paraná, Brazil	National Park	World Heritage Site
<i>III: Natural Monument</i>	CanGio, Vietnam	Special use forest	Biosphere Reserve
<i>IV: Habitat/Species Management Area</i>	Xuan Thuy, Vietnam	Special use forest	Ramsar Site
<i>V: Protected Landscape/Seascape</i>	Peam Krasop Wildlife Sanctuary, Cambodia	Wildlife Sanctuary	Includes a Ramsar Site
<i>VI: Managed Resource Protection Area</i>	Somone Lagoon Community Protected Area, Senegal	Conservation forest	Biosphere Reserve

* It is possible for a mangrove conservation area to be granted both legal status nationally as a protected area and international recognition at a number of levels. Classifications include National Parks and Nature Reserves (terminology used varies, see Terminology for details of The World Conservation Union (IUCN) categories in Table above). Other designations can also recognise areas of special natural or cultural significance. For example, countries can nominate areas to be accepted as internationally important through different conventions – World Heritage Sites, Biosphere Reserves and Ramsar Wetlands.

- 4.10 States should develop strategic plans (preferably country wide and in line with ICZM framework) to provide for the conservation and sustainable use of mangroves and establish criteria and guidelines that must be addressed in preparing and considering predictive Environmental Impact Assessment.
- 4.11 States should develop Mangrove Management Plans within coastal zone management plans so as to provide coordinated, cross-sectoral actions to implement the National Mangrove Action Plan. The Mangrove Management Plan should involve the following:
- Stakeholder participation at all stages of planning and implementation.
 - Assessment of the status of mangroves and the success of management initiatives in the respective areas and progress reporting
 - Local academic and research institutions with appropriate expertise of implementation, monitoring and evaluation of mangrove ecosystems.
 - Performance criteria on the effectiveness of implementation repeated at least once every 3 to 5 years.
- 4.12 States should ensure that all proposed development projects that may directly or indirectly affect mangroves both upstream and in the coastal area should be evaluated before approval (and later monitored) as part of an established Environmental Impact Assessment process.
- 4.13 States should control/abstain from mangrove conversion for agriculture or salt production, housing, industries and mining, infrastructure (e.g. ports, roads, canals) or coastal aquaculture and ensure that coastal engineering and construction practices are environmentally sound/go through an EIA process.
- 4.14 States should recognise the importance of mangroves as a component of disaster preparedness to help mitigate natural and human induced disasters, especially catastrophic events such as cyclones, hurricanes, tidal and storm surges and oil pollution such as oil spills. (See Figure 2.3 and Box 4E for a practical example of the use of mangroves for storm and flood mitigation).

Box 4E: Use of mangroves for disaster mitigation

Since 1994 the Red Cross has planted 12,000 ha of mangrove forest in northern **Vietnam**. The mangroves protect 110 km of the 3,000 km sea dyke system. The planting of mangroves has cost USD 1.1 million, but has helped reduce maintenance costs by USD 7.3 million per year (World Disasters Report, 2002).

- 4.15 States should also view mangroves as an important component of national sea-level rise mitigation measures since the frequency and scale of storms and flooding are expected to increase under current sea-level rise scenarios. Sea-level rise presents a serious threat to the coastal zone, in particular to low lying deltaic regions. The expected impacts include loss of land, increased vulnerability to storms and flooding, accelerated coastal erosion and increased salinisation (Vietnam Environmental Monitor, 2003).



Figure 4.2: A mangrove rehabilitation site in Gazi Bay, **Kenya**, replanted after environmental damage caused by the El Niño event of 1997/8 under the El-Niño Rehabilitation Program (Photo courtesy of KMFRI, Kenya).

- 4.16 States should promote interdisciplinary research on mangroves in support of integrated coastal area management, in particular applied research studies which integrate environmental, economic, social, legal and institutional aspects of sustainable mangrove management (see also Principle 15).
- 4.17 Ultimately, sustainable management of mangrove ecosystems will depend on governmental bodies at all levels, working together with NGOs, donor agencies, local communities and other stakeholders towards a common goal. To achieve this, States should promote integration of the various approaches and tools for management provided in this document.

PRINCIPLE 5 MANGROVE ASSESSMENT

Mangrove survey, mapping, inventory and monitoring data are required to support the sustainable management of mangrove ecosystems.

- 5.1 There is a severe lack of current baseline information to support mangrove ecosystem management. As a first step, States should undertake a mangrove ecosystem assessment, this should be based on surveys, mapping and inventories of all mangrove areas using standard methodologies (see Box 5A for guidelines). The national inventories should include both protected and unprotected mangrove areas based on mangrove distribution data and land use classifications as a basis for management planning. The national targets for mangrove protected areas should be coordinated with regional and global targets (e.g. World Summit on Sustainable Development targets, see *Terminology* for more information).

Box 5A: Guidelines for mangrove ecosystem survey and inventory (this includes inventory of the mangrove forests, tidal flats, salt flats and other intertidal habitats and waterways associated with mangrove ecosystems)

Basic information required:

Biophysical features

- Location, Area and Demarcation (defined by maps, satellite imagery and GPS)
- Climate (major features e.g. rainfall and temperature)
- Tidal/Hydrological regime
- Dominant Soil Type (colour, organic matter content and texture)
- Water chemistry (salinity, pH, colour, transparency and nutrients)
- Type of forest (primary, secondary, degraded)
- Structure of the forest (density of forest, height of trees, dbh, basal area of trees, biomass, species composition and regeneration characteristics).
- Species inventories (flora and fauna and note special features including rare/endangered/migratory species)

Management features

- Existing or proposed land zoning system
- Land/water use and Ownership
- Local knowledge/Traditional uses e.g. medicinal plants
- Ecosystem products, functions and attributes
- Pressures and threats on the area
- Potential areas available for rehabilitation/restoration
- Related institutions or ongoing projects to promote collaboration and avoid duplication of work

Key References:

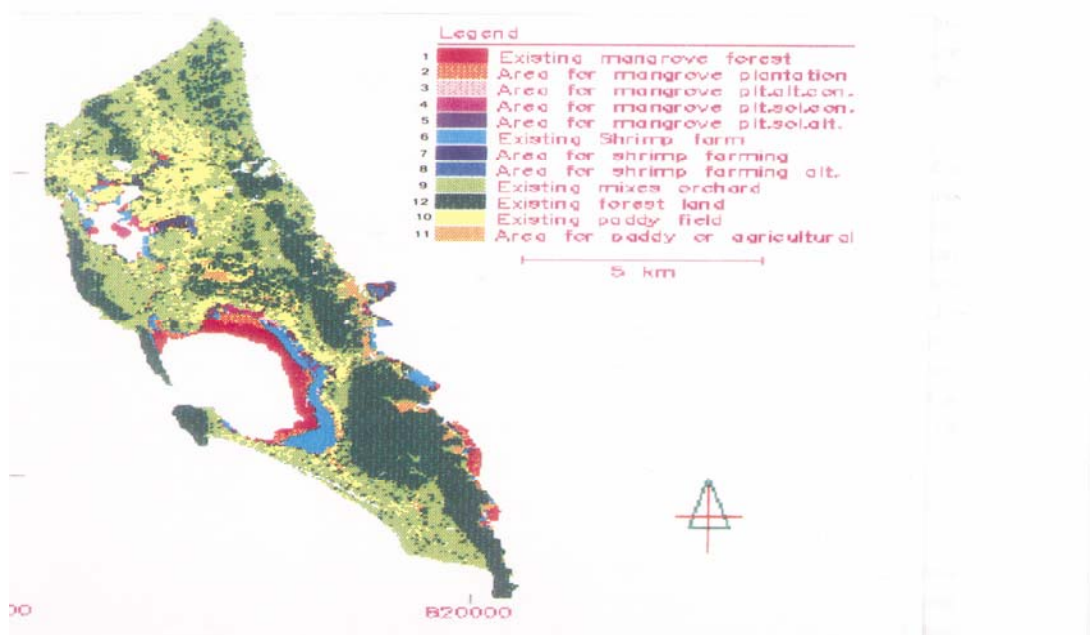
1. Ramsar Framework for Wetland Inventory (8th Meeting of the COP Spain, November 2002). The Framework provides guidance on a standard approach to designing a wetland inventory program from site based to provincial, national and regional levels. It includes information on determining appropriate remote sensing techniques to apply, existing standardised inventory methods, and recommends standards for core data field and data recording.
2. Conservation International methodology for rapid assessment of aquatic systems (AquaRAP) (see <http://www.biodiversityscience.org/xp/CABS/research/rap/method>). Small teams of expert biologists (international and national) conduct rapid assessments of the biological value of selected areas over a short time period (3-4 weeks) to aid in protecting areas.
3. Survey Manual of Tropical Marine Resources (English *et al.*, 1997). Provides detailed methods on mangrove surveys, including measuring forest structure and environmental parameters.
4. A Manual for an inventory of Asian Wetlands (Finlayson *et al.*, 2002). Provides a detailed protocol on the assessment, evaluation and monitoring of wetlands in Asia. Similar to Ramsar Framework for Wetland Inventory but with more detailed information on core data collection.
5. Marine Protected Areas (Gubbay, 1995). Provides principles and techniques for management (selection, legislation, making a management plan, techniques for zoning, enforcement, involving the community and education and interpretation).
6. Manual for Investigation of Hydrological Processes in Mangrove Ecosystems (Kjerfve, 1990).
7. The mangrove ecosystem: research methods (Snedaker and Snedaker, 1984).
8. World Mangrove Atlas (Spalding *et al.*, 1997). Provides maps and areas of mangrove cover for each country of the world.
9. Remote sensing handbook for tropical coastal management (Green *et al.*, 2000). It compares different mangrove mapping techniques in terms of process, cost and accuracy.
10. Remote sensing techniques for mangrove mapping (Green *et al.*, 1998). Resource for techniques used in mangrove inventory.
11. FAO Guidelines on mangrove forest management (FAO, 1994). Contains chapters on Information needs; The use of remote sensing in mangroves; Planning and implementation of forest surveys in mangroves; and Resource assessment and forest inventories of mangroves.

- 5.1.a States should integrate baseline data with remote sensing and GIS to directly address priority management issues (Box 5B).

Box 5B: Examples of remote sensing as a tool for mangrove management

In **Thailand** a mangrove forest database has been installed on the TYDAC-SPANS GIS of the Remote Sensing Center. A correlation analysis between physical factors (soil, geomorphology, tidal amplitude and latitude, water salinity) and mangrove forest properties was performed to determine the actual potential of this area for mangrove forest development. A “site potential map” was then produced. The site potential map was combined with a land cover map drawn through remotely sensed data, resulting in a land use coastal planning map.

Figure 5.1: Land use coastal planning map of Khungkraben, Thailand



In **Bangladesh**, hydro-dynamic model studies have been applied to predict impact on mangrove stand due to salinity level changes because of reduced fresh water flow.

- 5.1.b States should develop and adopt simple indicators as a tool to monitor environmental changes in mangrove ecosystems that can be understood by local managers and communities and used by them to record the impacts of management interventions. For example:

- Number of damaged trees (high = negative indicator)
- Viable fruiting on mangrove trees (high = positive indicator)
- Abundance and diversity of birds (high = positive indicator)
- Soil stability (high erosion rate = negative indicator)
- Crab or oyster abundance and diversity (high = positive indicator)

States should note that the most valuable ecological indicators are those that also have an economic or cultural value in the local communities. For example, in the Saloum delta in Senegal, the decrease in the quantity of oysters collected is locally perceived as a sign of mangrove degradation. The harvest of these oysters is one of the most important sources of income for women.

- 5.2 States should integrate all mangrove baseline data/inventory information into a national database and update this regularly as a tool for management decision-making and made available to all stakeholders. States should strengthen and develop existing institutions and

information systems and establish standardized regional databases and procedures for collection, collation, retrieval and dissemination of information related to mangroves (Box 5C).

- 5.3 States should take steps to make the information on mangroves more accessible and useful, particularly to managers and policy makers. The following actions are recommended: (1) Establish a Database Network and websites and organize regular meetings and workshops for database managers to update the information; (2) Establish programmes for interpretation and extension so that the results of research and technical reports are rapidly accessible to the community and decision makers; (3) Analyse the usefulness of the databases to managers and policy makers through regular feedback and make adjustments accordingly.
- 5.4 States should promote local, regional and international co-operation in mangrove information gathering and exchange, research collaboration and the sharing of management experiences. (See Principle 14 on mangrove research and information exchange for further details of research support for mangrove management). Mechanisms for cooperation between communities at local level are provided in Principle 8.

Box 5C: Examples of mangrove databases operating at different geographical scales

National

The **Kenya** mangrove database was set up by the Eastern Africa Coastal Resources Database and Atlas Project under the UNEP Regional Seas Program in 1994. The database is maintained by the **Kenya** Marine and Fisheries Research Institute (KMFRRI), and contains ArcInfo 3.4.2 coverage of all mangrove areas along the **Kenya** coast. Details of mangrove species composition, type classes, stem density as well as average volume in cubic meters per hectare are included in the database. The database is compatible with GIS ArcView software. The database is constantly consulted by the Government agencies interested in mangrove management such as the Forest Department, the Fisheries Department and the **Kenya** Wildlife Service.

Senegal started a database on its protected areas including mangroves in 2000. WAAME an NGO in **Senegal** in partnership with ADG (Belgium) and Department of National Parks are compiling a mangrove database funded by EU, 2003. The database is for scientists, NGOs, Universities at national and international levels working on mangroves in Senegal. The database will be held in WAAME's resource centre in Foundiougne.

Regional

The Centre for African Wetlands (CAW) was commissioned in 2001 at the University of **Ghana** to contribute to the preservation of the global, regional, national and local values of West African wetlands for the benefit of society as a whole. CAW has initially focused on twelve countries: **Benin, Burkina Faso, Cameroon, Cape Verde, Côte d'Ivoire, Ghana, Guinea-Bissau, Liberia, Mali, Mauritania, Nigeria** and **Senegal**, for the partnership development and the subsequent establishment of the CAW network and focal points. It serves therefore as a reference point for information on West African wetlands, including mangroves.

International

The Global Mangrove Database and Information System (GLOMIS) was started in 1996. It is a searchable database (<http://www.glomis.com>) of scientific literature relating to mangroves, institutions and scientists working on all aspects of mangroves, as well as regional projects and programmes related to mangroves. GLOMIS is based at the International Society of Mangrove Ecosystems (ISME) Secretariat in Okinawa, Japan, and is supported by four Regional Centres located in Brazil, Fiji, Ghana and India. The ISME Regional Centre for Central and South America (located in Fortaleza, Brazil) provides copies of mangrove references from the GLOMIS database on request and exchanges information with other libraries in South America.

FAO provides a number of databases related to mangroves. Some of these refer to FAO projects and publications on mangroves, others provide a short description of the mangrove vegetation in all the countries and areas in which mangroves occur, and the largest and most recent database contains more than 2800 datasets related to recent and past mangrove area estimates. See www.fao.org/forestry/mangroves for details.

PRINCIPLE 6 SOCIO-ECONOMIC CONSIDERATIONS

Mangroves provide important socio-economic benefits to indigenous peoples and local communities worldwide; it is essential therefore to manage mangrove ecosystems and their resources sustainably to maintain and improve their livelihoods.

- 6.1 When deciding on the use, conservation and management of mangrove resources, due recognition should be given, as appropriate, in accordance with national laws and regulations, to the traditional practices, needs and interests of indigenous peoples and local communities who are highly dependent on mangrove resources for their livelihood (see terminology for definition).
- 6.2 States should work closely with local and traditional resource users to broaden the knowledge base necessary for decision-making to ensure that the level of extraction of natural resources are kept within sustainable levels. States should adopt policy measures (e.g. education, licenses, enforcement) to ensure that the levels of extraction of natural resources (e.g. forest cutting, fish, crustacean and molluscan harvesting and aquaculture) are kept within permitted and sustainable levels. Such measures, supported by awareness raising activities, are necessary because local and traditional resource users do not necessarily know the best way to manage mangrove resources sustainably.
- 6.3 In mangrove ecosystems where traditional resource utilisation already exceeds sustainable levels states should introduce mitigation measures in consultation with the user groups. Clear mechanisms, which are supportable by resource users should be established to reduce exploitation to a sustainable level and to monitor and enforce this effectively (see Box 6A). Potential mechanisms include species/resource-level catch/harvest-quotas, zoning and graduated access and harvest schemes, and protection of refugia and other key habitat. Small grants given to local communities or councils will greatly support local protection of these resources.

Box 6A: Examples of protection systems used in mangrove ecosystems

In the mangroves in **Ecuador** there are user groups for crabs (involving both male and female collectors), mussels (female collectors only), charcoal production (men only) and other user groups e.g. tourist guides (both men and women). Each group nominates a representative for the "National Coordination for mangrove protection" committee which co-ordinates with the State. Many NGOs (e.g. Fundecol, Greenpeace, Ecological action and FEPP) support the committee with funds for reforestation, policing/protection of the resources and education in mangrove values. Photos and videos are available illustrating the workings of this committee for education and dissemination to other interested parties.

Mangrove planting for coastal protection against typhoons has been supported by Red Cross funded projects in nine provinces of the Red River Delta region of northern **Vietnam** (Fig. 2.4). Poor households selected by each commune were paid to plant *Kandelia candel*, propagules. *Rhizophora stylosa* propagules and *Sonneratia casseolaris* seedlings were also interplanted with *Kandelia* at some sites. The coastal communes involved with mangrove planting were also helped to establish a mangrove protection system, with guards (paid initially by the projects, then later by the communes themselves), guard posts and in some cases patrol boats. Each commune has also erected notice boards explaining the benefits of the mangroves, but also setting out community regulations regarding their unlawful exploitation, based on an agreed punishment and reward system. An example from Thai Thuy District in Thai Binh Province, **Vietnam** is shown in Table 6.1

Table 6.1: Community regulations for mangrove protection in Thai Binh Province, Vietnam

Regulations	Penalties and Rewards
1. All people have responsibility for protecting mangrove forests	For cutting trees or grazing animals – VND 50,000
2. Planters have to fulfill their contract duties	For cutting mangrove branches VND 20,000
3. Cutting, catching aquatic species and grazing by domestic animals is not allowed	For catching aquatic products in newly planted areas – VND 5,000
4. People using boats must use the designated corridors	A reward of 50% of the fine paid is given to the persons informing the guard team about violators of the regulations

Note: VND 15,000 = USD1.00 approximately.

6.4 The approval and development of other activities within mangrove areas should be based on national and regional plans that identify critical resources and conflicts with all other actual or potential resource uses. Such plans should include an assessment of direct and indirect impacts, cumulative effects, socio-economic effects and cultural impacts and benefits to local communities and include the protection of coastal habitats for sustaining traditional fisheries, supporting tourism, and maintaining the integrity of ecological functions.

Box 6B: Mechanisms to ensure sustainable development in mangrove ecosystems

All proposed development projects that may impact on mangroves both directly or indirectly should be subjected to a comprehensive and independent EIA which includes socio-economic valuations (e.g. cost-effectiveness and social impact) that reflect the true social, economic and cultural costs and benefits of the planned development. The findings of EIAs should be made available at a public hearing to debate the proposed development project.

There are various ways by which the legal system can support restoration of degraded wetlands. One is through the establishment of a system of environmental performance bonds. Legislation may also provide for the making of environmental restoration orders. This type of order may be issued where individual wetlands are damaged or destroyed by the actions of a legal person and the damage is detected and the responsible party is identified. Breach of these laws would constitute a criminal offence subject to financial or other penalties.

Incentives for local industries that implement pollution prevention measures.

Charging levies on those who pollute the mangrove ecosystem on a “polluter-pays” basis.

- 6.5 Sustainable livelihood options for local communities dependent on mangroves should be identified and encouraged within prescribed limits. Potential livelihood activities include small-scale artisanal fishing, crab catching, shellfish harvesting, hunting, eco-tourism, indigenous fish cage culture and mollusc culture, apiculture and agro-forestry plantations on the adjoining community lands. States should encourage local communities and NGOs with good experiences/practices of sustainable livelihood practices to document them.
- 6.6 States and NGOs should pay particular attention to helping communities whose existing activities result in unsustainable utilisation of mangroves and related ecosystems. Alternative livelihoods and income generating activities should include basic training programmes on environmental topics, sustainable resource use, household finance and community organisation.
- 6.7 States should encourage energy plantations in adjoining areas of mangroves so as to discourage their cutting for fuel wood consumption and encourage development of fodder depots so as to reduce pressure of livestock grazing in mangrove areas (See Box 6C).

Box 6C: Examples of the use of mangroves for fodder and/or fuelwood

Mangrove leaves are used extensively as natural fodder in some arid regions (e.g. **Pakistan, Egypt** and **Eritrea**). *Avicennia marina* is the preferred species, but *Rhizophora mucronata* also provides good fodder for camels, goats and cattle. Browsing can be very intensive, therefore mangrove plantations have also been established in some countries to provide the necessary fodder and reduce grazing pressure on natural mangrove areas.

In **India** for example there is a 50% centrally sponsored scheme Area Orientated Fuel wood and Fodder Plantation Project (AOFFP). This scheme aims at supplying fuel and fodder to the local population so that pressure caused by illicit felling of Government forests becomes reduced and, at the same time, the people benefit from employment. For example, 100,000 ha of *Acacia auriculiformis* a fast-growing timber tree, were planted outside the Sundarbans forestry area to reduce the pressure on the mangroves for fuelwood and fodder.

- 6.8 Pollution from human activities, including garbage, sewage, oil and industrial effluents, solid and toxic wastes are a major threat to mangrove ecosystems. Therefore, waste disposal from urban, industrial, agriculture or aquaculture sources should be carefully regulated. The inputs of organic matter, nitrogen and phosphorus compounds into estuaries coastal waters should be kept to an absolute minimum through the use of adequate treatment before discharge. This is particularly true in the more stagnant mangrove channels where eutrophication can lead to anoxic (oxygen depleted) conditions, and severe degradation of the aquatic system. This requires that appropriate practices to eliminate, minimize or mitigate the impacts of pollution should be enforced (Box 6D provides some examples of existing regulations to control pollution in coastal areas. It should be noted however, that existence of a particular regulation may not be adequate without effective enforcement).

Box 6D: Examples of regulations to control pollution in coastal areas

Specific environmental regulations for shrimp farming in **Thailand** have been formulated by the Department of Fisheries (the governmental department responsible for shrimp farming):

- a) Shrimp farms and hatcheries must be registered.
- b) The biological oxygen demand (BOD) of effluent water must be below 10mg/l; and the Secchi disc transparency measure greater than 60 cm.
- c) On farms larger than 50 rai (approx. 8 ha), effluent water must be treated in settlement ponds prior to being discharged into canals, etc.
- d) Release of salt water into freshwater bodies, and the discharge of silt and sediment into public bodies or onto public land, are forbidden.

(See Thailand country case study in "Country Case Study Report", or Smith (1999), for further details.)

In **Nigeria**, the Federal Environmental Protection Agency Act, 1988 determines the allowable levels of pollution and effluent discharge to water bodies and the Harmful Waste Act 1990 Cap165 prohibits dumping of toxic wastes.

In **Ghana**, the Environmental Protection Act 490 (1994) specifies waste management along the coast. Under schedule 5 of the Environmental Impact Regulations, 1999 (L.I. 1652) the areas that are listed to be very sensitive with respect to general construction and the service sector are the following mangrove areas:

- a) Areas with primary pristine dense growth,
- b) Areas adjourning the mouths of major river systems,
- c) Areas near or adjacent to traditional fishing grounds
- d) Areas that act as natural buffers against shore erosion, strong storms or storm surges.

The **Brazilian** Association of Shrimp Farmers has recently (2002) introduced a code of conduct for monitoring effluents, solid wastes and use of chemicals from aquaculture which its members must follow (ABCC, 2001).

In **Colombia** there are regulations to restrict/control pollutants from all activities that occur in the coastal zone (Resolution 1594/94).

- 6.9 States should ensure that mechanisms are enacted to restore or rehabilitate mangrove ecosystems adversely affected by human activities. Mangrove rehabilitation projects should seek to restore maximum benefits in terms of habitat recovery and ecological functioning at the minimum cost socially and economically. For example, where mangroves are being proposed for conversion to other uses, developers could be required to restore or rehabilitate a similar area of mangrove of at least the same area as that proposed for development.
- 6.10 The raising of funds is a key factor in determining the success of biodiversity conservation management, including mangrove rehabilitation. Income generation for the recognized/established management body and traditional resource users is essential to viability and sustainability. Identify and quantify appropriate charges that can be levied on interest groups, especially commercial entities, benefiting from facilities, amenities and natural resources based on mangroves. Income derived should be used for operational and mitigation costs in the protected area. The recommended options to promote socio-economic benefits based on sustainable use of mangrove ecosystems are provided in Box 6E.

Box 6E: Measures recommended to promote and diversify the socio-economic benefits from mangrove ecosystems

- Favourable loans for environmentally friendly projects.
- Grants for environmental commitments and protection of critical areas.
- Incentives for the private sector to support research on mangrove diversity management.
- Marketing mangrove products and their services on a fair market price basis.
- Supporting the involvement of local communities in mangrove protection, including training local people to become mangrove wardens.
- Developing alternative low intensive products as an incentive to conserve mangroves by local communities.
- Promoting opportunities for technology development transfer of more efficient technologies e.g. fuel efficient stoves and information exchange between local communities on sustainable resource management.

PRINCIPLE 7 CULTURAL AND COMMUNITY ISSUES

Mangrove ecosystems are associated with unique human traditions and knowledge, but they are also under severe pressure from some forms of exploitation, both traditional and non-traditional.

- 7.1 States should ensure that cultural/historical and other traditional associations with mangroves are respected (see Box 7A for examples). Such traditions should be protected by being fully integrated into the conservation and resource management plans for mangrove ecosystems.

Box 7A: Examples of important cultural/historical associations with mangroves

- Sea gypsies (Chao Le) are a traditional ethnic minority group who have lived in the Ranong mangrove system in **Thailand** for about 200 years. Their staple diet and income come from gathering mangrove oysters and from fishing.
- The Historical and Cultural Park in Can Gio Biosphere Reserve, **Vietnam** records the importance of the Can Gio mangrove forest historically (Fig 7.1). The Can Gio mangroves were destroyed by herbicides during the American War but were replanted by the Vietnamese people from 1978 onwards.
- Spirit houses used to protect mangroves are a common sight in Southeast Asia, especially in **Cambodia** (Fig. 7.2) and **Thailand**, while temples associated with mangroves can be found in India and Myanmar.
- Everyone entering the Sundarbans in both **Bangladesh** and **India** requests the permission and protection of the local deity, Bano Bibi for the Muslims and Vano Devi for the Hindus, before engaging in their work, whether wax and honey collecting, fishing or gathering fuelwood. Shrines are built to the deity at the entry points into the mangrove forest.
- The black slaves from Africa that escaped and lived in the mangroves of **Central** and **South America** have left a legacy over the past 500 years, which is kept alive today in poems and dances.



Figure 7.1: Part of a historical and cultural park in the Can Gio Biosphere Reserve, **Vietnam** showing the underground shelter in the mangroves where Vietnamese resistance fighters hid during the War with America (photo by Elizabeth Ashton, center Aarhus).



Figure 7.2: A spirit house in Peam Krasop Wildlife Sanctuary, Koh Kong, **Cambodia** placed there to protect a large *Lumnitzeria littorea* tree from being felled. (Photo by Elizabeth Ashton, center Aarhus).

- 7.1a States should officially recognize and promote sustainable mangrove management practices involving local communities.
- 7.1b The values and potential applications of traditional knowledge related to mangroves should be high-lighted, for example ecological knowledge about mangrove fisheries and the use of traditional medicinal plants (Box 7B). In support of this objective, local people should be encouraged to document their traditional knowledge and cultural associations with mangroves.

Box 7B: Examples of the value and potential uses of traditional knowledge about mangroves

Throughout its range of distribution, the mangrove species *Excoecaria agallocha* has been used traditionally to treat leprosy. Alkaloids in the latex of *Excoecaria* (Family Euphorbiaceae) may have been efficient in alleviating the pain of lepers bathing in water containing the latex (Vannucci, 1991, 1992).

Other traditional uses of mangroves for medicines (Bandaranayake, 1998) include: *Acanthus ilicifolius* (aphrodisiac, asthma, diabetes, skin diseases, snake bites, stomach ache); *Acrostichum aureum* (boils and wounds); *Avicennia marina* (rheumatism, small pox, ulcers); *Bruguiera gymnorhiza* (eye diseases); *Ceriops tagal* (stops haemorrhages); *Excoecaria agallocha* (leprosy and toothache); *Heretiera littoralis* (diarrhoea); *Rhizophora apiculata* (hepatitis, typhoid); *Xylocarpus granatum* (cholera, fever, malaria). Research into these and other medicinal mangrove plants is of high potential value in the medical field.

In **Nigeria**, fishing nets are dyed using tannins from the red mangrove *Rhizophora racemosa* to prevent crab attack. A similar method has also been recorded by indigenous people in other parts of Africa, Arabia and South America.

In **Ecuador**, the local people prepare an energising liquor from the pneumatophores of *Avicennia germinans*.

- 7.2 States should recognise that conversion of mangroves and other destructive uses of mangrove resources have occurred because the land use rights both official and unofficial of local communities and indigenous peoples have not been respected. The traditional land use and resource use rights of such groups should be carefully safeguarded. This should be done by promoting land tenure rights as a tool and acknowledging the role local people should play in managing mangrove resources. Valuable guidelines are provided in the World Bank Operational Directive on indigenous peoples (See Box 7C).

Box 7C: Guidelines on development planning towards indigenous peoples (World Bank Operational Directive, OD4.20 September 1991)

- 1) The key step in project design is the preparation of a culturally appropriate development plan based on full consideration of the options preferred by the indigenous people affected by the project.
- 2) Studies should make all effects to anticipate *adverse trends* likely to be induced by the project and develop the means to avoid or mitigate harm.
- 3) The institutions responsible for government interaction with indigenous people should possess the social, technical, and legal skills needed for carrying out the proposed development activities. Implementation arrangements should be kept simple. They should normally involve appropriate existing institutions, local organisations and non-governmental organisations (NGOs) with expertise in matters relating to indigenous peoples.
- 4) Local patterns of social organisation, religious beliefs, and resource use should be taken into account in the plan's design.
- 5) Development activities should support production systems that are well adapted to the needs and environment of indigenous peoples, and should help production systems under stress to attain sustainable levels.
- 6) The plan should avoid creating or aggravating the dependency of indigenous people on project entities. Planning should encourage early handover of project management to local people. As needed, the plan should include general education and training in management skills for indigenous people from the outset of the project.
- 7) Successful planning for indigenous peoples frequently requires long lead times, as well as arrangements for extended follow-up. Remote or neglected areas where little previous experience is available often requires additional research and pilot programmes to fine-tune development proposals.
- 8) Where effective programmes are already functioning, bank support can take the form of

incremental funding to strengthen them rather than the development of entirely new programmes.

Additionally the World Bank operational directive includes guidelines on land tenure as follows:

Where the traditional lands of indigenous peoples have been brought by law into the domain of the state and where it is inappropriate to convert traditional rights into those of legal ownership, alternative arrangements should be implemented to grant long-term renewable rights of custodianship and use to indigenous peoples.

- 7.3 States should minimize the negative impacts of population pressure on mangroves and associated coastal ecosystems. Migration/resettlement into already overexploited coastal areas should be avoided.



Figure 7.3: Poor families previously living in huts in the mangrove Full Protection Zone (left) have been moved to new houses built for them in the Buffer Zone (right) under a coastal resettlement programme in the Lower Mekong Delta, **Vietnam** (see details Box 7D) (Photo by Donald J Macintosh, center Aarhus).

Box 7D: Examples of improved livelihood opportunities for mangrove dwellers

The Coastal Wetlands Protection and Development Project in the Lower Mekong Delta, **Vietnam** is helping the Government of Vietnam to resettle people from the mangrove Full Protection Zone to the more landward Buffer Zone and prevent others from migrating into the protected zone. The resettled people act as local forest guards to protect the mangroves. In addition to receiving land and a new house, training is being given in engine mechanics, tailoring, aquaculture and agriculture to improve their livelihood prospects and make them less dependent on mangrove resources.

In Koh Kong Province, **Cambodia**, mangrove charcoal kilns were destroyed to protect the remaining mangrove forest (see Box 3F), so alternative livelihoods were supported by the Ministry of Environment and external donors; for example, animal husbandry and home gardens, mangrove plantations. A model village was also developed to relocate former charcoal producing families.

- 7.4 Recognise, promote and strengthen the contributions of women to the conservation, rehabilitation and sustainable management of mangroves. Figure 7.4 and Box 7E provide examples of the positive involvement of women in mangrove conservation and resource use.



Figure 7.4: In the Jaguaribe River estuary, Ceará, **Brazil**, about 30 women (wives of local fishermen) are engaged in a project to rear mangrove oysters (*Crassostrea rhizophorae*) using non-destructive methods. (Photo by: Prof. T.C.V. Gesteira, Universidade Federal do Ceará).

Instead of collecting wild oysters by cutting them off mangrove roots (the traditional practice), the women now use artificial oyster collectors made from plastic water bottles to obtain spat. The oysters are then transferred to rearing in trays suspended from a fixed frame made from pvc pipe and concrete. Oysters with a meat weight of 1-2g are reared in this way until they can be harvested and sold with a meat weight of 5-7g. The oyster project has been funded by Ceará State Science foundation (FUNCAP) and supported with applied research from the Federal University of Ceará. As well as receiving technical and financial assistance, the women's group has representation in the local municipal administration. Currently, the women can produce 100 dozen oysters weekly, which is sufficient to supplement their basic subsistence income by about 25%. In addition to plans to expand production, the group also needs help to market the oysters more profitably.

Box 7E: Examples of contributions by women to mangrove management

The women of each household in the Sundarbans, **India** automatically become joint members of Forest Protection Committees (FPCs) and Eco-Development Committees (EDCs). However, in some FPCs women are primary members. Some FPCs comprise of women members only or are controlled by womens groups (e.g. CARE-INDIA), and with the positive participation of women it has been observed that the FPCs function better. Self help groups have been formed among the members of FPCs to take up various vocational and income generation activities utilising funds from their own savings as well as bank loans where necessary and available. These activities (e.g. sewing, orchards) are particularly inspiring for women as they are able to earn or supplement the livelihood of their families (West Bengal State Forest Report 2001).

In **Ghana**, the Ada-Azizakpe Womens Group carried out mangrove rehabilitation within the swamps of their island settlement with the support of Heifer International, an international NGO that aims at serving poor people and caring for the earth to alleviate hunger and poverty. The NGO supported the women by sharing livestock among the group members, who in turn were encouraged to replant degraded mangrove areas around the settlement with *Rhizophora racemosa*.

The gathering of oysters provides supplementary income for the women of the islands of Sine-Saloum in **Senegal** and constitutes an appreciable contribution of protein to their diet. Therefore, it is necessary to safeguard the oyster stock by practices which respect the mangrove. This is the reason it was necessary to develop alternate solutions to the gathering of oysters such as the culture of the exploited species *Crassostrea gasar*. This motivated WAAME an NGO to choose three sites (Bassoul, Diogane and Ngadiore), villages among the islands of Saloum in order to test the raising of oysters. This study began in February 2001 and the monitoring is done by the women's groups they have formed.

- 7.5 States should increase community awareness at all levels regarding the cultural, social, economic and ecological importance of mangroves and their associated ecosystems. Tried and tested mechanisms to promote community awareness include seminars, workshops, field visits, youth camps and use of the media for information dissemination. Many NGOs are well equipped and experienced to support such activities (see detailed recommendations in Principle 8: Capacity Development).
- 7.6 States should promote the exchange of community experiences in mangrove rehabilitation and conservation. Participating together in workshops and site visits are good mechanisms to help different communities to achieve this (see examples in Box 7F).

Box 7F: Examples of inter-community cooperation to promote mangrove rehabilitation

In the Visayas, **Philippines**, there is good inter-community communication involving community leaders from neighbouring islands visiting a successful mangrove planting project (using *Nypa* and *Rhizophora* species) at Buswang, in Aklan Province, the Visayas. The Department of Environment and Natural Resources organises such visits to promote similar community projects elsewhere.

In **Senegal**, a programme promoted by the National Parks integrates scientists, NGOs, women, youth camps and technical services in the management and rehabilitation of mangroves so that they can exchange experiences. The NGO WAAME is presently working with 50 villages, women's groups and schools in reforesting mangroves. WAAME is also providing exchanges of experiences in fish smoking, oyster farming through community exchanges and local technical training (see WAAME website). Other examples of community operation activities in Senegal are provided at the UNESCO-CSI website (<http://www.csiwisepactices.org>) on wise practice.

In **Ecuador**, there is communication and links between the different communities and user groups for example between North and South Esmeraldas, and between other provinces, and with the National coordination committee for mangrove protection. This system has been operating since about 1992 with effective results in promoting sustainable mangrove management in Ecuador.

In 1999 the Mangrove Action Project (MAP), working closely with the Yadfon Association in **Thailand** and the Small Fishers Federation of **Sri Lanka**, helped launch the program "In The Hands Of The Fishers" (IHOF) which is a series of workshops bringing together grassroots NGOs and fisherfolk from two or three developing nations containing mangroves. These workshops offer an innovative format for information and skill sharing among local stakeholders, while also offering a toolkit of working alternatives to help enhance Community Based Coastal Resource Management. In addition to the workshops, follow-up projects are undertaken at the participating villages, and these then serve as sites or nodes for modelling sustainable, low-intensity development alternatives for example improved nipa palm sugar stoves.

PRINCIPLE 8 CAPACITY DEVELOPMENT

Capacity development for mangrove ecosystem management, and awareness raising about mangroves in general are needed at all levels from decision makers in government, to district and municipal officials, community leaders and educational institutions (teachers, students and school children).

- 8.1 To develop their capacity for mangrove ecosystem management, States should establish and strengthen coordination and networking among different institutions, government agencies, private sectors, local communities and other mangrove stakeholders.
- 8.2 States should develop curricula/teaching modules and supporting teaching materials on mangroves suitable for adoption into national environmental education programmes for (a) primary and secondary schools; (b) institutions of higher education and (c) academic extension units and distance learning programmes that can help transfer academic knowledge into practical applications for mangrove protection and resource use (See Box 8A and 8B).

Box 8A: Examples of existing educational programmes on mangroves

In **Thailand**, students of Bangtaboon School which is situated in the mangrove forest of Petchaburi Province, the students receive practical teaching in mangrove research, rehabilitation and protection, with the active support of the Ministry of Education.

In the Red River Delta, **Vietnam**, the teachers use a “Big book” developed by NGOs illustrating the role of mangroves for coastal protection (see Fig. 1.4). School children also participate in innovative learning activities, such as, theatre, puppets, dance, art, school, competitions, video and CD ROM to promote the conservation and sustainable use of mangroves and related ecosystems.

Khulna University in **Bangladesh** offers several courses directly related to mangroves, such as Mangrove Ecology and Coastal Afforestation, Mangrove Resource Utilisation and Management.

In 1996, **Ghana** introduced environmental studies into primary schools and ecological studies into secondary schools, including coverage of forestry and wetlands. The Centre for African Wetlands based at the University of Ghana supports studies on wetlands under the MPhil Environmental Science Programme.

In **Nigeria**, integrated science is taught in primary and secondary schools and at University level there are postgraduate studies on mangroves offered in the coastal Universities.

In **Ecuador**, ESPOL (Escuela Superior Politecnica Del Litoral “Polytechnic Superior School of the Littoral”) University degree courses are taught on coastal resource management, including mangroves.

The Mangrove Action Project (MAP is a non-profit organisation based in the **USA**, see *Terminology* for details) has released a Mangrove Educational Curricula which was developed at the Cayman Islands for school children from kindergarten to ninth grade and is taking it to other parts of the world, modifying it for local regions and translating it into local languages.

Box 8B: BIOMA - A successful experiment on capacity building for coastal wetlands conservation

Bioma is a unique concept, created out of an experiment on how young talent can be focused toward the promotion of the long-term conservation and wise use of mangroves and other fragile coastal wetlands. The Laboratory is a training unit within the University of Sao Paulo, **Brazil**. Its goal is to engage young undergraduate and graduate students in conservation issues of great importance to civil society and to the conservation of national heritage. As a result, numerous master-level thesis and PhD dissertations have been produced that were specifically designed to meet the needs of local resource managers, addressing important information gaps, and capable of directly supporting specific wetland conservation actions. The scope of Bioma has been broadened to offer free, high-quality technical services to local governments, conservation groups and local communities concerned about the management of their mangrove wetland resources. Bioma is self-supported by voluntary contributions by its members, and maintains its high level of social engagement without extra costs to its host institution. Its principal assets are the level of engagement that has been generated among the students that participate in its activities, and the high level of technical expertise available through its multidisciplinary approach. Although Bioma is hosted by the Oceanographic Institute, its members include students from several faculties such as: Economics, Biology, Oceanography, Law and Architecture. Bioma serves as a practical example on how to direct academic strengths to leverage conservation actions where they are most needed, and where financial resources may be limited.

- 8.3 States should support basic and applied research through small grants and scholarships to graduate level students working on their Master thesis or PhD dissertations. These grants may be provided through the academic institutions or National Research Councils.
- 8.4 States should seek assistance from academic institutions, NGOs and international organisations to develop and implement practical in country training courses and seminars to build capacity among government staff, community leaders and teachers, using local dialects and techniques to promote conservation and sustainable management of mangrove ecosystems. Without such assistance, wetland managers, community leaders, and local communities may not understand or fully appreciate the value of mangroves. Similarly, research findings should be interpreted and explained so that local stakeholders can understand them. They may also need guidance on how to restore mangroves, especially hydrological restoration measures, and on how to develop more sustainable livelihood activities.



Figure 8.1: Traditional leaders from mangrove areas in **Ghana** attending a training course on wetlands ecology and management for World Wetlands Day (February 2nd 2002) (Photo by Chris Gordon, University of Ghana).



Figure 8.2: Community awareness training course on mangrove forests for farmers in Ca Mau, Lower Mekong Delta, **Vietnam** (Photo by Donald J Macintosh, centER Aarhus).



Figure 8.3: A community workshop for the Eperara-Siapidara Amerindians, at Laguna Santa Bárbara, the **Colombian** Pacific coast (Photo by Hernando Bravo, Colombia).

- 8.5 States should collaborate to develop regional capacity for training of trainers in mangrove ecology and management by establishing appropriate training and resource centres, or by strengthening existing centres with regional capabilities (Box 8C).

Box 8C: Examples of Regional and International training opportunities on mangroves

The Aquaculture Department of the Southeast Asian Fisheries Development and Education Centre (SEAFDEC) offers regional training courses in Coastal Resources Management.

APEC (Asia Pacific Economic Cooperation) Programme is offering training programs on mangroves for teachers and students from 21 countries.

The Centre of Advanced Studies in Marine Biology, Annamalai University, Parangipettai, **India** conducts a United Nations University International Course on Biodiversity in Mangrove Ecosystems. This is a two week course offered annually to train trainers, young professionals from Asian country Universities or other institutions that can replicate the work in their own country on their return after training.

- 8.6 States and NGOs should provide information and technical training to assist people at the site management and community levels to monitor and assess mangrove resources, including rapid resources assessment using simple, standardized and operational protocols (see Box 8D; Principle 5: Mangrove Assessment).

Box 8D: Examples of community training in mangrove resource management

In **Vietnam**, training courses are conducted regularly for farmers in Ca Mau, Lower Mekong Delta by the Division of Forestry, Department of Agriculture and Rural Development (DARD). The farmers are from both the State managed Forest and Fishery Enterprises (FFE) and from private farms. The planting and maintenance techniques that they learn are put in to practice on their farms with good success (see Figure 8.2).

In **Thailand**, the community of Pled Nai Village in Trad Province have been trained in mangrove rehabilitation, maintenance and protection. These activities have been possible through the strong commitment of a local NGO, Yad Fon, which has helped to mobilise governmental and public support for this poor coastal community (Yad Fon Association).

In the central **Philippines**, the New Buswang, Kalibo, Mangrove Plantation is an example of a successful 70-ha reforestation project due, among other factors, to the people's association KASAMA (Kalibo Save the Mangroves Association), a community-based organization initially comprising 27 families and a local NGO called USWAG. KASAMA families planted a total 50 ha of *Rhizophora* species and *Nypa fruticans*, each family was assigned an average area of 1.7 ha. Aside from site preparation and planting, activities included regular maintenance (removal of debris, pruning of damaged branches and stands, replacement of dead plants), protection and record keeping for 3 years. The local community leaders were also trained in basic law and organization by the local NGO.

In **Senegal**, there are training programmes in the Saloum Biosphere Reserve on how to develop sustainable livelihoods, planting of mangroves, managing finances and organising women's groups. These programmes held by a local NGO WAAME focus on mangrove management and planting and oyster farming and fish smoking.

In **Nigeria**, the NGOs Nigeria Conservation Foundation and CCDI provide training on utilisation and management of mangrove resources, especially the *Nypa* palm which they are trying to help the local people to utilise (e.g. to make thatch for houses, straw hats, and to use the sap) so that the numbers of *Nypa* are controlled (this mangrove palm is regarded as a weed in Nigeria).

- 8.7 States and donor agencies should establish training programmes for wetland managers and researchers at all levels including exchange programmes, scholarships, fellowships and grants for on-the-job training in community development.
- 8.8 States and NGOs should promote awareness programmes on mangroves in a manner suitable for politicians, land use planners and developers, other decision-makers and members of the judiciary to understand the values of mangrove ecosystems.
- 8.9 States and NGOs should develop educational facilities, which include walkways and information centres at strategic mangrove sites to provide convenient access and knowledge for local communities, school children, tourists and other interested groups (Box 8E).
- 8.10 Information on mangroves should be provided appropriately for the different interested groups including translation into local languages and simplified versions for school children. Illustrated information boards, posters and brochures are excellent and inexpensive formats for visitor information. Video films, for example on methods to restore mangroves, are another excellent format suitable for training and awareness among all interest groups.



Figure 8.4: School children visiting the Ranong Biosphere Reserve, **Thailand**, which has a well-designed walkway through the mangroves and informative signboards for visitors on mangrove biology and ecology in Thai and English. (Photo by Donald J Macintosh, cenTER Aarhus).



Figure 8.5: The museum at Can Gio Biosphere Reserve, **Vietnam** with botanical and zoological specimens of different mangrove species. (Photo by Elizabeth Ashton, cenTER Aarhus).

Box 8E: Examples of information centres for mangroves

In **Senegal**, a museum in the Saloum Biosphere Reserve has a library of information on mangroves and a biological station through a National Park and IUCN project, which is due to completion in 2003/4. The NGO WAAME resources Centre in the Saloum BR has a mangrove interpretation centre for children, local communities and tourists to visit.

In **Brazil**, the Labomar institute (Arquivos de Ciencias do Mar) of the Federal University of Ceará (Universidade Federal do Ceará) in Fortaleza provides an interpretation centre on mangroves and other marine environments for school children. Labomar also houses the Central and South America regional centre for ISME/GLOMIS. The Federal University of Ceará co-manages a mangrove wetland park together with the municipality authority of Fortaleza City.

- 8.11 States should strengthen the capacity to interpret and understand policies and legislation on the conservation and sustainable management of mangroves, including community level laws/regulations (see Box 8F; Principle 3.1). Illustrated posters are strongly recommended for information dissemination, as these can be displayed prominently (e.g. in government offices, schools and village meeting places) to reach a wide audience.



Figure 8.6: A crab poster published by Ceará State, **Brazil** to emphasise the preservation of crabs by protecting berried females and young crabs. The poster teaches “If you know how to collect the Uçá crab there will be no scarcity” (Photo by Donald J Macintosh, cenTER Aarhus).

Box 8F: Examples of information dissemination on mangrove management policies to local stakeholders

In the Lower Mekong Delta of **Vietnam**, leaflets have been distributed explaining the allowable and non-allowable activities in the two coastal land zones involving mangroves (Full Protection Zone and Buffer Zone).

In **Ecuador**, the Ministry of Environment (MoE) receives information from local stakeholders and University research before deciding policies. The MoE and the action group within the government PMRC (Management Programme on Coastal Resources) provides posters and leaflets on coastal resources utilisation, including mangroves. There are visits made by PMRC to explain environmental policies to local stakeholders in more detail and to seek their agreement on local implementation.

PRINCIPLE 9 FOREST MANAGEMENT AND SILVICULTURE

Mangrove forestry/silviculture objectives may have an economic, environmental or aesthetic basis, or a combination of these. Wherever, possible, multiple-use management should be the ultimate goal of mangrove forest management.

- 9.1 States should follow the general guidelines that already exist for responsible forest management, for example the “Forest Principles” adopted at UNCED.
- 9.1a The guiding objective of the Forest Principles, is “to contribute to the management, conservation and sustainable development of forests and to provide for their multiple and complementary functions and uses.” The 15 principles (and subprinciples) all support this objective (Annex 1 and Box 9A).
- 9.1b The multiple and complementary functions and uses of mangrove forests include habitat conservation, timber and fuelwood production, non-timber forest products, shoreline and river channel stabilisation, waste water treatment, fisheries and wildlife support, storm and flood protection, ecological and biodiversity restoration and land-scaping.

Box 9A: Principles 4, 5, 9 and 12 from UNCED Forest Principles

4. The vital role of all types of forests in maintaining the ecological processes and balance at the local, national, regional and global levels through, inter alia, their role in protecting fragile ecosystems, watersheds and freshwater resources and as rich storehouses of biodiversity and biological resources and sources of genetic material for biotechnology products, as well as photosynthesis, should be recognized.

5. (a) National forest policies should recognize and duly support the identity, culture and the rights of indigenous people, their communities and other communities and forest dwellers. Appropriate conditions should be promoted for these groups to enable them to have an economic stake in forest use, perform economic activities, and achieve and maintain cultural identity and social organization, as well as adequate levels of livelihood and well-being, through, inter alia, those land tenure arrangements which serve as incentives for the sustainable management of forests.

(b) The full participation of women in all aspects of the management, conservation and sustainable development of forests should be actively promoted.

9. (a) The efforts of developing countries to strengthen the management, conservation and sustainable development of their forest resources should be supported by the international community, taking into account the importance of redressing external indebtedness, particularly where aggravated by the net transfer of resources to developed countries, as well as the problem of achieving at least the replacement value of forests through improved market access for forest products, especially processed products. In this respect, special attention should also be given to the countries undergoing the process of transition to market economies.

(b) The problems that hinder efforts to attain the conservation and sustainable use of forest resources and that stem from the lack of alternative options available to local communities, in particular the urban poor and poor rural populations who are economically and socially dependent on forests and forest resources, should be addressed by Governments and the international community.

(c) National policy formulation with respect to all types of forests should take account of the pressures and demands imposed on forest ecosystems and resources from influencing factors outside the forest sector, and intersectoral means of dealing with these pressures and demands should be sought.

12. (a) Scientific research, forest inventories and assessments carried out by national institutions which take into account, where relevant, biological, physical, social and economic variables, as well as technological development and its application in the field of sustainable forest management, conservation and development, should be strengthened through effective modalities, including international cooperation. In this context, attention should also be given to research and development of sustainably harvested non-wood products.

(b) National and, where appropriate, regional and international institutional capabilities in education, training, science, technology, economics, anthropology and social aspects of forests and forest management are essential to the conservation and sustainable development of forests and should be strengthened.

(c) International exchange of information on the results of forest and forest management research and development should be enhanced and broadened, as appropriate, making full use of education and training institutions, including those in the private sector.

(d) Appropriate indigenous capacity and local knowledge regarding the conservation and sustainable development of forests should, through institutional and financial support and in collaboration with the people in the local communities concerned, be recognized, respected, recorded, developed and, as appropriate, introduced in the implementation of programmes. Benefits arising from the utilization of indigenous knowledge should therefore be equitably shared with such people.

See Annex 1 for full document

or go to <http://www.un.org/documents/ga/conf151/aconf15126-3annex3.htm>

9.2 States should clearly define the specific objectives for mangrove forest management and provide a clear framework for forestry management activities, which may include silviculture, such as a working plan for wood production. Table 9.1 gives examples of sustainable mangrove forest management systems to meet specific objectives.

- 9.2a The management framework should be consistent with any existing integrated coastal area management frameworks and other existing legislation and be based on past experiences, research and other knowledge of the area. The history of a site and the activities that have led to the present forest conditions there should be taken into consideration for management planning.
- 9.2b Mangrove forest management practices and targets should be designed within the limits of sustained yield/ecosystem resilience.
- 9.2c There is a need for planning, monitoring, evaluation and revision to ensure that forestry operations stay within sustainable limits, including meeting the livelihood requirements of traditional users.
- 9.2d Local population should be involved in management planning and implementation.
- 9.2e There should be an equitable sharing of costs and benefits of mangrove forest management
- 9.3 The rational management of mangrove forests should be based on an indepth understanding of the forest and its environment that must be obtained through observations and measurements of composition, structure, and ecology. This information should then be used to assess the capability (aptitude) of the area for mangrove forest management and silvicultural utilisation (See Box 9B).

Box 9B: Use of mangroves for silviculture

Certain characteristics of mangroves make them well suited for silvicultural treatment; these include: rapid growth rates, high regenerative power, few species, tendency to form uniform (even aged) stands, and the diversity of valuable forest products mangroves provide.

Usually the information necessary for silviculture is collected through a forest survey that includes inspection and analysis of aerial photographs, ground-truthing, and actual on-the-ground measurements to assess the volume of forest products that is available for harvest. Also needed is the time it takes for the forest to reach maturity. Mangrove forests may be harvested at different ages (rotations) to yield various end products. The rotation time is the time for the trees to reach the desired size, or the stand to reach the desired volume. The rotation period depends on the growth rate of the trees. This in turn depends on the quality of the site. Local people may have information that can help determine the rotation time. High quality sites for silviculture are those where growth rates are highest. Managing or sustained yield is like utilizing the interest while protecting the capital. The coupe is the annual harvest allowable while providing a sustainable yield. In theory the coupe is $1/R_{th}$ of the total area suitable for management. Notice should be taken that in some areas, irrespective of size of the annual coupe or silvicultural system used for harvesting, regeneration fails to take place as expected, or is very poor. In these cases the harvesting protocol must be changed or regeneration speeded through plantings. It has been found that clearcuts of narrow strips at an angle to waterways work best to favour natural regeneration. However uncut fringes along coasts and waterways must be maintained to avoid bank erosion.

- 9.4 States should also recognise the importance of managing mangrove forests for the sustainable production of non-wood forest products (such as honey, medicines, thatching, fodder, handicraft materials and tannin, and sugar, vinegar and alcohol produced from the Nipa palm). Over-exploitation of any of these can be just as damaging to the ecosystem (but more difficult to detect before it is too late) than felling of trees.
- 9.5 States should give priority to protecting any stands of mature mangroves that are still reproductively viable, even in locations where pristine mangrove areas no longer exist. Even in disturbed areas, reproductively active trees and shrubs are valuable as “seed stands” because many mangrove species have good dispersal mechanisms (floating, saltwater tolerant fruits or propagules). This is an important prerequisite to support sustainable forest management and mangrove rehabilitation efforts.
- 9.6 States should determine the reasons why natural recovery (regeneration) of mangroves has not occurred before artificial restoration/rehabilitation is considered. Other measures, such as

restoring the natural hydrological regime, may be sufficient to enable mangroves to regenerate without the need for planting.

- 9.7 States should identify degraded or destroyed mangrove areas for restoration or rehabilitation (see *Terminology* for definitions). Allow natural regeneration wherever possible, but if this is inadequate assist with active interventions involving restoring the natural hydrological regime and mangrove planting. Five critical steps should be followed to achieve successful mangrove restoration or rehabilitation (Lewis and Marshall, 1998; Stevenson et al., 1999).
1. Understand the autecology (individual species ecology) of the mangrove species at each site (management area), in particular the patterns of reproduction, propagule distribution and successful seedling establishment with local mangrove forest communities.
 2. Understand the normal hydrological patterns and other stress factors that control the distribution and successful establishment and growth of targeted mangrove species
 3. Assess the modifications of the previous mangrove environment that occurred that currently prevents natural secondary succession, including hydrologic modifications and any additional stresses (i.e., cutting of timber, grazing, fires, disease, etc.)
 4. Design the restoration program to initially restore the appropriate hydrology and/or remove any additional stressors that might prevent natural secondary succession. Then attempt to utilize natural volunteer mangrove propagule recruitment for plant establishment
 5. Only utilize actual planting of propagules, collected seedlings or cultivated seedlings after determining through Steps 1-4 that natural recruitment will not provide the quantity of successfully established seedlings, rate of stabilization, or rate of growth of saplings established as goals for the restoration project.
- 9.8 A careful technical assessment should be made for all sites being considered for mangrove planting. Particular attention should be given to the factors that control mangrove establishment and development (See Box 9C). If mangrove planting is deemed necessary to rehabilitate a site, use local mangrove species as far as possible (see Annex 2 for planting guidelines from Asia and Table 9.2 for practical examples of mangrove rehabilitation).

Box 9C: Factors that limit mangrove establishment and development



- Isolation from natural seed/propagule sources
- Unsuitable planting elevation for desired species
- Excessive wave or current exposure
- Unsuitable substrata (wrong soil type or soil water characteristics)
- High salinity
- Excessive ground surface temperature
- Damage by flotsam, smothering by seaweed or green algae
- Disease, isopod or barnacle infestations and/or crab/monkey attack (herbivory)
- Grazing by livestock, human disturbance and vandalism

- 9.8a States should support the establishment of mangrove plant nurseries and conservation of forest areas for seed/propagule production to support mangrove restoration or rehabilitation efforts using local mangrove species. Wherever, possible local people should be employed in the seed/propagule collection and nursery management activities.
- 9.8b States should provide guidance on the management of mangrove plant nurseries to ensure that best practices for plant health and protection from pests are followed, including avoidance of use of pesticides and other chemicals to control insect and crustacean pests.

- 9.9 States should plant mangroves on open mudflats only if there were mangroves present previously, mangroves are likely to colonise naturally on newly accreted lands but require some assistance, or if coastal protection is a top priority e.g. due to storm risks. Mudflats provide important feeding grounds at low and high tide for e.g. waterbirds and fish but can also be used for planting mangroves if the intertidal level, currents and soil conditions are suitable.
- 9.10 **DO NOT** plant mangroves on sea grass beds or coral reefs as these are important ecosystems in their own right.
- 9.11 Mangrove planting on public or community lands should involve local people at all stages: site selection and design, seed and propagule collecting, nursery preparation of mangrove seedlings, planting out of rehabilitation sites, and the maintenance and protection of plantation forests.
- 9.11.1 Site selection and design of any mangrove rehabilitation or plantation schemes should allow for local access needs e.g. landing sites, boats and walking routes, collection sites for crustaceans
- 9.11.2 The knowledge of local communities of the importance of certain areas for birds and marine life should be taken into account.

Table 9.1: Practical examples of Mangrove Forest Management to meet specific objectives

Management Objective	Working example
Wood production The Matang Mangrove Forest Reserve in Peninsular Malaysia, has been managed sustainably for the production of charcoal for over 100 years. Forest management is based on a Silvicultural Operation and Working Plan.	<p>The silvicultural operation in Matang operates on a 30 year rotation with thinnings at 15 and 20 years. The forest is divided into blocks of a few hectares, which are allocated to charcoal companies. Each block is clear-felled, leaving a 3 metre strip on the shoreward side to prevent erosion of the bank and to provide mother trees for propagules.</p> <p>The timber is cut into logs of standard length, which are transported by boat to the charcoal kilns at a nearby village. Due to the way the blocks are allocated for clear-felling, they are always surrounded by a mature forest so repopulation with mangrove propagules occurs rapidly. The debris (branches and bark) resulting from the clearing takes about two years to decompose. After one year the site is inspected and, if less than 90% of the area is covered by natural regeneration, repopulation is assisted by artificial planting. Local villagers are contracted to rear suitable seedlings in small nurseries for this purpose. <i>Rhizophora apiculata</i> is the preferred species for charcoal and is planted at 1.2 m intervals. Any weeds, for example the mangrove fern <i>Acrostichum</i> spp., are destroyed by hand or using chemical weed-killers. After 15 years the young trees are thinned to a distance of 1.2 m (4 feet) to prevent overcrowding and the timber removed is used for fishing poles. After 20 years the stand is again thinned to a distance of 1.8 m (6 feet) and the resulting timber used for the construction of village houses. Finally, after 30 years the block is clear-felled for charcoal production, except for a 3 metre buffer zone along the bank.</p>

<p>Figure 9.1: Transporting logs for charcoal production in Matang Mangrove Forest Reserve, Peninsular Malaysia cut from 30 year old stands of <i>Rhizophora apiculata</i> (Photo by Elizabeth Ashton, cenTER Aarhus).</p>	
<p>Coastal protection</p>	<p>In India there is a total ban on cutting mangroves to protect villages and agricultural lands from storm surges.</p> <p>In northern Vietnam the mangroves are planted very close together (0.5 m x 0.5 m) as a coastal protection belt at least 100 m wide in front of the sea dyke.</p> <p>In Bangladesh accretion areas, hundreds of ha of mudflats have been planted with mangrove seedlings in prograding delta areas for coastal protection. The mudflats are, and can be consolidated into new islands by planting mangroves.</p>
<p>Research</p>	<p>In Bangladesh, Malaysia, Thailand, Vietnam and the Philippines trials have been conducted in nurseries to improve the cultivation of mangrove seedlings for transplanting. Seedling survival and growth has been compared under different conditions e.g. soil salinity and nutrient status, fertilization, pest control.</p>
<p>Figure 9.2: Royal Forest Department Mangrove Nursery, Phuket, Thailand (Photo by Donald J Macintosh, cenTER Aarhus). Trials have been conducted to improve the cultivation of mangrove seedlings for transplanting. Seedling survival and growth have been compared under different conditions e.g. soil salinity, nutrient status and pest control</p>	
<p>Biodiversity Conservation</p>	<p>In 1977 three sanctuaries covering over 125 sq miles were set aside in the Bangladesh Sundarbans to protect the Bengal tiger. This area was increased to 1,400 km² in 1996 and in UNESCO declared these three sanctuaries as World Heritage Sites. The tiger is the greatest indicator of health of the Sundarbans as it is the top carnivore in a complex food web. Protecting the tiger is equivalent to protecting the entire ecosystem, because the tigers' survival depends on maintaining of the ecological integrity of the ecosystem.</p>
<p>Restoration</p>	<p>A 500 ha mangrove restoration site at West Lake near Fort Lauderdale, Florida, USA was very successful using a combination of excavation of dredged material and hydrologic restoration (see Lewis 1990a, Lewis and Streever 2000). No planting of mangroves took place or was necessary. All three of the local Florida species of mangroves volunteered on their own. Another form of this hydrologic restoration is to reconnect impounded mangroves to normal tidal influence (Turner and Lewis 1997, Brockmeyer et al. 1997). Brockmeyer et al. (1997) was able to keep restoration costs</p>

	<p>to US\$250/ha with careful placement of culverted openings to impounded mangrove wetlands along the Indian River Lagoon, USA.</p> <p>Sanyal (1998) has recently reported that between 1989 and 1995 9,050 ha of mangroves were planted in West Bengal, India with only a 1.52% success rate.</p>
Rehabilitation of degraded mangroves	<p>During the 1997-98 El-Niño event in Kenya, 30% of 54,000ha of mangroves found in Kenya died as a result of siltation and water logging. Natural regeneration of the affected areas proved to be slow to restore the forest because of the lack of mother trees. In 2000, a project to rehabilitate degraded mangrove areas as a result of El Niño weather was initiated at Gazi bay, Kenya. Some 10,000 trees of mostly <i>Rhizophora mucronata</i> and <i>Ceriops tagal</i> were replanted in 2.0 ha plots. The survival rate two years later was 75%, the majority being <i>Rhizophora</i>.</p> <p>Mixed planting of two, three or four species has shown more positive results than planting only one species as a monoculture. Good examples described in the country case studies include <i>Kandelia candel</i> (main species) plus inter planting of <i>Sonneratia caseolaris</i> and <i>Rhizophora stylosa</i> in the Red River Delta, Vietnam; mixed planting of <i>Rhizophora mucronata</i>, <i>R. apiculata</i>, <i>Bruguiera cylindrica</i> and <i>Ceriops tagal</i> in Ranong, Thailand; mixed planting of <i>Nypa</i> or <i>Rhizophora</i>, <i>Heritiera</i> and <i>Xylocarpus</i> in India (see Fig 9.3).</p>

9.12 To summarise Principle 9, States should adopt the following principles for mangrove rehabilitation and afforestation:

- 9.12.1 Priority should in the first instance be given to the management of existing mangrove areas – including the rehabilitation of degraded sites where needed.
- 9.12.2 Rehabilitation should preferably be done through natural regeneration – or assisted natural regeneration (including restoring the hydrological regime), followed by enrichment planting and planting/afforestation of areas previously covered by mangroves.
- 9.12.3 Priority should be given to the use of local species and provenances (where the health and form of these are good)
- 9.12.4 Afforestation sites (for coastal protection or provision of wood) should be chosen with extreme care (include the need to avoid sea grass beds, coral reefs and mudflats important for waterbirds)
- 9.12.5 Introduction of new species should be avoided where possible (see Box 2D)

Figure 9.3: Restorative planting involving several mangrove species is being introduced successfully in various parts of the Sundarbans. For example, on embankments of ponds in Binodpur village, 24 Parganas South, **India** *Nypa* or *Rhizophora* are planted at the lower levels and *Xylocarpus granatum* higher up on the banks. Still higher, *Heritiera fomes* followed by coconut (*Cocos nucifera*) are planted (Photo by Elizabeth Ashton, cenTER Aarhus).



Table 9.2: Examples of mangrove rehabilitation at selected sites

Place	Objectives	Species planted	Comments
Bangladesh Ganges-Brahmaputra Delta	Planting newly formed mud islands for land consolidation and coastal protection	<i>Sonneratia apetala</i> , <i>S. caseolaris</i> <i>Avicennia</i> spp., <i>Excoecaria agallocha</i> , <i>Heritiera fomes</i> , <i>Xylocarpus</i> spp., <i>Bruguiera sexangula</i> , <i>Ceriops decandra</i> and <i>Nypa fruticans</i>	Forestry Department initiated afforestation programme in 1966. Seeds are directly planted or seedlings are raised in nurseries. 170,000 ha have been planted (Siddiqi, 2001).
Thailand Ranong Biosphere Reserve	Rehabilitate abandoned shrimp ponds and tin mining sites	<i>Rhizophora apiculata</i> , <i>R. mucronata</i> , <i>Ceriops tagal</i> , <i>Bruguiera parviflora</i>	Private sector and Local community groups did the planting under the supervision of the Royal Forest Department.
Benin Lake Nokoué, Porto Novo Lagoon, Ouémé Delta	Restore ecological function as fish nurseries	<i>Rhizophora racemosa</i> , <i>Avicennia africana</i>	Fishing in Lagoons Project started restoration programme 15 years ago with the cooperation of the local people.
Ghana Ada	Rehabilitate over-exploited areas to protect fish ponds	<i>Rhizophora racemosa</i>	Volta Basin Research Project for Aquaculture Development
Senegal Saloum Biosphere Reserve	Restore degraded areas ecological function as wildlife habitat	<i>Rhizophora racemosa</i> , <i>R. harrisonii</i> , <i>R. mangle</i>	Local NGO, local community and University participated in planting

PRINCIPLE 10 FISHERIES

Mangrove associated fisheries have worldwide importance in providing subsistence food and income, as well as commercial benefits, for a wide range of stakeholders, including indigenous peoples and local fisher communities. However, lack of enforcement of existing fishery regulations, including lack of protection of mangrove nursery sites and habitat degradation are among the major reasons for the widespread decline in mangrove fisheries.

- 10.1 States should be aware that many millions of people depend on traditional fishing activities in mangrove ecosystems for food and income generation. Great care should be taken to support the livelihoods of mangrove fishers, to promote awareness of the fisheries importance of mangrove ecosystems, and to help local communities to adopt more sustainable fishing and/or aquaculture practices. (see Box 10A).

Box 10A: Examples of how better management can lead to more sustainable fishing and fish trading practices in mangrove ecosystems

The 'acadja' or brush park system of **West Africa** is a traditional method of fishing, which involves setting up artificial habitats in the middle of lagoons using tree branches. Many tree branches are pushed into the bottom of the lagoon to form a sanctuary for fish. The *acadjas* are fished about six months after the branches are put in position. There are examples of both sustainable (**Benin**) and unsustainable (**Nigeria**) uses of mangroves to construct *acadjas*. The *amatong*, a variation of the brush park system using rocks as well as branches is practised in Negros and other islands in the Philippines and if used sustainably is a good additional source of income.

In **Senegal**, the project "Rehabilitation and integrated management of the resources of wetland communities in the Ramsar site of Saloum Delta" financed by the Dutch Committee for IUCN was a test initiative for equitable shrimp trade. It consisted in supporting the small-scale fishermen from eight villages with equipment adapted to sustainable fishing concerning the renewal of stocks and the safety and security of the small-scale fishermen. Nets (with the lawful mesh size), life jackets, ropes etc. were provided with the objective to improve and upgrade the utilisation of techniques and machines for sustainable fishing to safeguard the resource. A private company, which is partner to this initiative, buys the production and sets up the means of collecting and transporting the production to its manufacturing unit based at Mbour. It pays the factory price to the producer, which is different to the prices that the intermediaries practice. However, standards of quality are required, as a rigorous selectivity is in force. So the fishermen group together and each village grouping can measure its performance on the environmental level which is cheap. In summer, a working capital is released for each village grouping in order to reinforce the capacities of the small shrimp producers and to prepare direct access to the market avoiding the middlemen. The marketing of the village productions inspires of the system of equitable trade (fair trade) worldwide and tends to improve the pay back chain to the profit of the small producers. The income generated after elimination of the middlemen (intermediaries) returns to the villages in the form of community cash, which contributes to financing some small development projects at the end of the fishing season. This monetary income will also contribute to the regeneration of the mangrove ecosystem, as the buying of improved ovens will reduce the consumption of mangrove wood for smoking fish. The first trends of this initiative test of equitable trade are still favourable on two essential points: (1) the fishermen understood that the mature shrimp are more expensive than the juveniles and consequently the question related to the selectivity of the fishing gears is selected and regulated; (2) community organisation pays them more money, which enables them to choose periods of rest for them and the resources also.

- 10.2 States should be cognizant of the general guidelines that exist to promote responsible fisheries and they should ensure that these guidelines are adopted widely to protect mangrove associated fisheries. These include: the FAO Code of Conduct for Responsible Fisheries (1995), the FAO Technical Guidelines series for Responsible Fisheries (1996-2003), the SEAFDEC Regional guidelines for Responsible Fisheries in Southeast Asia (2001), and the Ramsar Resolution VIII.32 (2002) on conservation, integrated management and sustainable use of mangrove ecosystems and their resources. The following Principles relate specifically to mangrove fisheries including subsistence collecting of aquatic resources by hand.

- 10.3 States should protect mangrove nurseries and breeding habitats of fish, crustacean and molluscan species important to subsistence and/or commercial fisheries (See Table 2.1 and 2.2 and Box 10B). States should consider the following measures for habitat protection (a) prohibiting fishing within clearly defined areas; and (b) giving local communities management responsibilities for specific fishery sites under a stewardship arrangement, or similar community-based agreement, which includes appropriate fishery conservation measures.

Box 10B: Examples of mangrove habitat protection to conserve fishery stocks

In **Brazil**, the legal framework making it illegal to destroy any mangroves was established to protect their fisheries support functions.

In **Vietnam**, there is a large totally protected area of shallow coastal waters ("Bai Boi") to conserve the breeding habitat of fish, shrimp and mud crabs. The mangrove Full Protection Zone of the lower intertidal belt also features strict rules, which limit fishing to hand collecting (use of boats, nets and other fishing gear is not permitted).

- 10.4 States should also recognise that mangrove fisheries include wide spread subsistence collecting of minor aquatic resources by hand chiefly within the mangrove intertidal zone. In partnership with local communities states should clearly demarcate intertidal common-use areas where community regulated access for non-destructive fishing activities are permitted for local communities. The great importance of open access areas for subsistence hand collecting of mangrove fish, crustaceans and molluscs by poor fishers should be recognised by all stakeholders.
- 10.5 In line with the FAO Fish Code, States should prohibit dynamiting, poisoning and other comparable highly destructive fishing practices. Other fishing activities harmful to mangrove ecosystems (e.g. using fine nets that remove almost the total recruitment of fish and crustacean larvae/juveniles) and over fishing should be carefully regulated in consultation with and the voluntary agreement and full participation of the local fisher communities (see Box 10C). Steps should also be taken to provide alternative income generations so that the harmful fishing activities can be phased out and eventually stopped.

Box 10C: Examples of destructive fishing methods in mangrove ecosystems

Mangrove associated penaeid shrimp species (e.g. *Penaeus monodon*, *P. merguensis*) are collected heavily for broodstock and seed (postlarvae and juveniles), especially in **Bangladesh** (see Fig 10.1). There is a high mortality of other shrimp/fish species as by-catch from the shrimp seed fisheries. Catching seed (for grow out ponds) need not be banned, but should be regulated, and the use of captive broodstock from hatcheries should be promoted as an alternative source of seed production.

In **Benin**, the vegetation behind mangroves is burned in order to capture land crabs (*Cardisoma* species), but the mangroves also sometimes catch fire.



Figure 10.1: Women and children collecting shrimp larvae in the Sundarbans mangrove ecosystem, **Bangladesh**, using very fine nets. This fishery is now banned in the mangroves, but still continues in the river system. It is not feasible to ban this activity completely until alternative livelihoods for these local families can be developed (Photo by Dipak Kamal, Khulna University, Bangladesh).



Figure 10.2: Floating Fish cage culture in Matang mangrove Forest Reserve, **Malaysia**, which also serves as a tourist attraction (Photo by Donald J Macintosh, cenTER Aarhus).



Figure 10.3: The Tar jal fishermen fish in creeks in the Eastern Sundarbans, **Bangladesh** with the aid of pet otters. This traditional fishing method is very effective compared to other types of fishing and is not harmful to the environment. However, the method is slowly dying out as new fishing techniques are introduced. This unique, interesting and traditional method should be supported for future generations and as a tourist attraction (Photo by Dipak Kamal, Khulna University, Bangladesh).

PRINCIPLE 11 AQUACULTURE

Mangrove associated aquaculture has worldwide importance in providing subsistence-level food and income, as well as commercial benefits, for a wide range of stakeholders. Unfortunately, some aquaculture development has also resulted in severe environmental degradation and socioeconomic problems, due in part to poor management practices and/or lack of enforcement of environmental regulations. The importance of sound management in relation to mangrove aquaculture development in mangrove ecosystems cannot be overestimated.

- 11.1 States should be aware that there are many forms of subsistence aquaculture that provide vital economic support to mangrove communities worldwide. Great care should be taken to support the livelihoods of mangrove fishers, to promote awareness of the fisheries importance of mangrove ecosystems, and to help local communities to adopt more sustainable fishing and/or aquaculture practices.
- 11.2 States should be aware that general guidelines already exist for responsible aquaculture. These include: the FAO Code of Conduct for Responsible Fisheries (1995); the Environment Code of Practice for Australian Prawn Farmers (1999); Thai Code of Conduct for Responsible Shrimp Aquaculture (1999); the SEAFDEC Regional guidelines for Responsible Fisheries in Southeast Asia-Responsible Aquaculture (2001); the Global Aquaculture Alliance (GAA) Guidelines for Sustainable Shrimp Farming (2001); the Ramsar Resolution VIII.32 (2002) on conservation, integrated management and sustainable use of mangrove ecosystems and their resources; the WB/NACA/WWF/FAO consortium on Shrimp Farming and the Environment (2002); Code of Conduct for Responsible Aquaculture Development in the U.S. Exclusive Economic Zone (NMFS 2002); and the Naturland Standards for Organic Aquaculture (2002). However, some of these guidelines contain contradictory advice regarding mangroves and should be interpreted cautiously. Overall, there is a need to adopt better management practices for aquaculture that are also compatible with mangrove ecosystem management objectives. For example, locating shrimp farms in areas that make efficient use of land and water and also conserves ecologically sensitive habitats and ecosystem functions. The following Principles relate more specifically to aquaculture in and adjacent to mangrove ecosystems.
- 11.3 In principle, States should not sanction further conversion of mangrove forest, salt marshes and associated tidal flats for commercial aquaculture (see Box 11A Ramsar Resolution VII.21) and should take measures to restore abandoned aquaculture sites in these habitats. Guidance on the critical steps considered necessary for successful mangrove restoration in general, and pond restoration in particular, are provided by Lewis and Marshall (1998) and Stevenson et al (1999), see Principle 9.7 for details.

Box 11A: Ramsar Resolution VII.21

The Ramsar Resolution VII.21 San José, Costa Rica, 10-18 May 1999, recognizes the critical economic, social and environmental values of intertidal wetlands, including tidal flats, salt marsh, mangrove and seagrass beds for fisheries, biodiversity, coastal protection, recreation, education, and water quality. It recognizes that the livelihood of substantial numbers of people around the world depend on the productivity of intertidal wetlands and that a large proportion of these are being lost to reclamation, unsustainable aquaculture, and pollution, and that, in some regions, the scale of reclamation is increasing. It noted the growing scientific evidence of, and awareness by, local communities of the productivity of intertidal wetlands, in particular of tidal flats, and that the expertise in dealing with the conservation and wise use of intertidal wetlands at local and national levels is rapidly increasing but that there are no adequate mechanisms at the global level to share and benefit from these experiences and expertise. It reminds the Contracting Parties that recommendation 6.4, urges countries to work together in the area of information exchange to contribute to the long-term conservation of migratory waterbirds and their habitats; and noted that many such migratory waterbird populations are dependent upon intertidal wetlands are globally threatened. It reminds the parties that Recommendation 6.7 urges the designation of coral reefs and associated ecosystems, including mangrove forests and seagrass beds, to the List of Wetlands of International Importance; and called the Contracting Parties to document the extent of loss of intertidal wetlands that has occurred and to inventory remaining intertidal wetlands, and their conservation status. It asks the Parties, in collaboration with the Ramsar Bureau, International Organization Partners, and relevant groups, to develop initiatives to disseminate information on the extent of loss of these wetlands and its impacts, and on alternative development strategies for the remaining intertidal areas. It urges the review and modification of policies that adversely affect intertidal wetlands, and urges introduction of measures for their long-term conservation. It urges all Contracting Parties to suspend the promotion, creation of new facilities, and expansion of unsustainable aquaculture activities harmful to coastal wetlands until such time as assessments of the environmental and social impact of such activities, together with appropriate studies, identify measures aimed at establishing a sustainable system of aquaculture that is in harmony both with the environment and with local communities.

- 11.4 States should recognise that mangrove ecosystems are not the most suitable sites for aquaculture pond construction and that responsible aquaculture development in mangrove ecosystems should not destroy mangroves any further.
- 11.4a States should be aware that aquaculture in ponds converted from mangroves is generally unsustainable due to the potential acid sulphate soil conditions prevalent in most mangrove areas, or because it causes the irreplaceable loss of important coastal habitats, including tidal flats and salt flats. These areas provide important coastal transitional environments and habitats critical for sustainable coastal productivity and the persistence of fragile ecological processes including long-distance bird migrations.
- 11.4b Specifically, States should stop further expansion of shrimp farming into mangrove areas because it has already caused severe socioeconomic problems, such as dislocation of poor coastal communities, closed access to traditional common-use areas, and degraded coastal habitats (see Box 11D).
- 11.5 States should promote the development and adoption of integrated mangrove aquaculture systems, which are both environmentally sustainable and suitable (socio-economically viable) to support the livelihoods of poor fisher and farmer communities. Small-scale aquaculture activities in mangrove ecosystems should still be supported in order to benefit local communities who are making a transition from fishing to aquaculture to support their livelihoods. There are many good examples of non-destructive small-scale aquaculture systems operating sustainably in mangrove waterways. Examples of successful systems are:
 - Mudcrab fattening or growout in mangrove pens and cages (Malaysia, Kenya) (see Fig. 11.1).
 - Fish cage/bivalve and seaweed culture in mangrove waterways (Thailand)
 - Mixed shrimp-mangrove-crab-cockle systems (Vietnam)

- Oyster rearing (Brazil) (see Fig. 7.4).
- Integrated mangrove fish or shrimp farms, silvofisheries or tambaks (Indonesia; see Box 11B).

Within the mangrove ecosystem in Kenya, one of the crustacean species most exploited by the local communities is the mud crab, *Scylla*. Most of the captured crabs are sold to tourist hotels, and the rest consumed locally. Local fishermen indiscriminately catch the crabs irrespective of size, or whether it is a breeding population; and this has a great bearing on the future stocks of the species. It is therefore imperative that the community is educated on alternative methods of exploiting crabs without interfering with the adult population and the future stocks of the species. One of the ways of doing this is by introducing crab cultures in mangrove areas, where gravid females are collected from the wild, induced to spawn, and introduced to culture pens after a certain stage of their growth. Crab farming has net benefits to the local community through direct employment, as well as a source of income through the sale of the adults.



Figure 11.1: Crab pen culture in the mangroves of Mtwapa, Kenya (Photo courtesy of KMFRI, Kenya)

Box 11B: Examples of sustainable integrated mangrove aquaculture systems

Integrated mangrove-aquaculture systems, or silvo-fisheries, have a long tradition dating back many centuries to mangrove fishponds known as “tambaks” in Indonesia. Different forms of silvo-fisheries continue to operate on a large scale today in many countries, especially in Indonesia, **Philippines** and **Vietnam**. Some of the culture systems in operation are still based on traditional methods, others feature significant advances in design and operation. A well known, traditional example is the Empang Parit model from **Indonesia** (Fitzgerald, 1997). This model features a pond with a raised central platform planted with mangroves, surrounded by a deeper canal usually 3-5m wide that provides the permanent culture area for fish, shrimp and crabs. The central platform is flooded intermittently as the pond water level changes with the tidal cycle, giving the mangroves trees alternative periods of inundation and exposure to air. When inundated, the mangrove platform also provides valuable additional habitat for the cultured stock; mangrove crabs in particular like to use the platform in this manner. Performance of the model can be varied to meet local conditions and production needs by varying the ratio of mangrove forest to pond area, or by adjusting the density of trees (which in turn affects many processes in the pond e.g. light penetration and algal productivity, litter production and water circulation).

- 11.6 All commercial aquaculture developments involving mangrove ecosystems should be preceded by a full and independent EIA, which includes assessment of (a) the impact of the planned development on the mangrove ecosystem; (b) potential negative impacts on the livelihoods of local communities (e.g. by causing pollution/degradation of fishing areas, or preventing access to them, reducing or contaminating freshwater supplies); (c) recurrent environmental monitoring efforts, after the establishment of aquaculture operations.
- 11.7 States should recognise that, by retaining or promoting significant areas of mangrove habitat, the ecological conditions for sustainable aquaculture can be safeguarded. In practice, mangrove buffer zones in front of aquaculture development areas can help to support the vital ecological functions that mangroves provide.



Figure 11.2: A large, well managed shrimp farm in Ceará, **Brazil** on the site of a former salt works. Naturally colonising mangrove forest can be seen along the water canal on the right. A code of practice is followed by shrimp producers in Ceará, see Box 11C (Photo by Elizabeth Ashton, cenTER Aarhus).

- 11.8 In line with the precautionary approach (see Principle 2), **States should ban or strictly regulate exotic/alien species introductions for aquaculture**. Mangrove ecosystems are open systems with high levels of water exchange and animal movements between adjacent freshwater and marine habitats. Consequently, exotic/alien species, which escape from coastal aquaculture facilities, are likely to disperse very rapidly into and through mangrove waterways, with unpredictable consequences (see Box 2D).
- 11.9 States should encourage the development of local Codes of Conduct for coastal aquaculture, which will allow local shrimp farmer associations to adapt their own standards to local circumstances based on international environmental management principles (See Box 11C).

Box 11C: Local Codes of Conduct for aquaculture

In **Brazil** the government does not allow the use of two antibiotics (Nitrofurantoin and Chloramphenicol) in aquaculture and their sale is also prohibited. The association of shrimp producers of Ceará State recommends no use of antibiotics at all in its Code of Practice for Shrimp Farming.

The **Philippine** Code of Practice for Sustainable Shrimp Farming (2000) supports the protection of mangroves from adverse aquaculture impacts and mandates the development of wastewater discharge systems not detrimental to mangroves.

- 11.10 Abandoned or under-utilised shrimp/fish ponds should be rehabilitated back to mangroves by restoring the natural hydrology to promote mangrove recolonisation and/or by planting mangroves. Funds for such rehabilitation and other environmental mitigation measures should be identified, for example by increasing land use fees charged to aquaculture farms licensed in mangrove areas. Incentives for restoration/rehabilitation may be necessary where private land ownership is involved.
- 11.11 Wherever possible, States should mitigate against potential harmful impacts on mangrove biodiversity from aquaculture. In summary, these are:
- Mangrove habitat loss
 - Mangrove-associated species destroyed as by-catch in shrimp seed fisheries
 - Mangrove-associated species caught for use as fish feed in aquaculture
 - Escape of farmed aquatic animals, including in some cases exotic/alien species, into mangrove ecosystems
 - Disease organisms transferred from farmed aquatic animals to wild species populations
 - Pollution
 - Hydrological alteration

Box 11D: Examples of impacts from aquaculture development in mangrove areas

Negative impact from aquaculture development in **India** – in the mid 1990s local fishermen were adversely affected by shrimp farms in Nellore, because aquaculture development had restricted their access to traditional fishing areas and increased pollution in coastal waters (Patil and Krishnan, 1998).

Positive impact from aquaculture development in **Malaysia** – the cockle farming industry at Kuala Selangor (a mangrove fringed estuary with extensive intertidal and subtidal mudflats) has helped to promote awareness of the need for sound environmental management along the Selangor coast, as the quality of the cockles, e.g. their growth rate, condition factor and level of *E. coli* contamination, are very sensitive indicators of environmental change.

PRINCIPLE 12 AGRICULTURE, SALT PRODUCTION AND MINING

The conversion of mangroves to other forms of land use, including agriculture and salt pans has been a major cause of wetland habitat loss in many countries. Mining has also caused significant localized damage to mangrove ecosystems, especially in Africa and parts of Asia.

- 12.1 In principle, States should not sanction further conversion of mangroves, salt flats, salt marshes and associated wetlands for agriculture or mining (see Box 11A). Agriculture is generally unsustainable due to the potential acid sulphate soil conditions prevalent in mangrove areas. Sand mining and oil drilling have caused high rates of subsidence in specific coastal areas, including Ghana and Nigeria, respectively (see Box 12A).
- 12.2 Salt pans should be sited behind the mangrove forest zone and where possible integrated into existing landforms. *Artemia* brine shrimp culture with salt production in the same ponds should be encouraged within existing salt pond areas to help improve the livelihood of salt producers.
- 12.3 Coastal agriculture, salt production or mining should only proceed after individual and cumulative impacts have been assessed and positioning is based on landscape-level suitability assessments and integrated coastal development plans that insure appropriate siting to avoid critical habitats (such as coastal wetlands including mangroves, salt flats and marshes) and to promote multiple use and to avoid crowding of facilities of effluent discharges into stagnant waters. full and independent EIAs have been prepared, including their expected impacts on mangroves and other wetlands downstream of the proposed activities.
- 12.4 States should implement the principle of zero pollution from agricultural and salt production areas and mining sites (including effluent discharge). As a guiding principle, all developments of this type should be designed to (a) minimise changes of the hydrological conditions in surrounding wetlands; and (b) have built-in safeguards against pollution, such as adequate waste treatment and disposal systems, and monitoring of effluent quality and quantity.
- 12.5 To control the impact from commercial scale agriculture, salt production or mining activities, the “polluter pays” principle should be adopted through performance bonds (to restore abandoned facilities), or effluent taxes can be used to provide incentives for using appropriate technologies.

Box 12A: Examples of mining damage to mangrove ecosystems

In **Africa** the main impacts on mangroves from mining involve sand mining, titanium mining (in sites adjacent to mangroves) and oil drilling. The negative impacts from mining include increased turbidity and siltation in mangrove waterways, direct smothering of mangroves by mined sediments and indirect impacts from pollution (e.g. from oil exploration). The effects of oil pollution can last for many years.



Figure 12.1: An abandoned dredge at a former tin mining site in Ranong, **Thailand** in 1995. The site was subsequently restored through a combination of natural regeneration and artificial planting of mangroves (Photo by Donald J Macintosh, cenTER Aarhus).



Figure 12.2: Coastal erosion due to sand mining at the mouth of the Volta River Delta, **Ghana** has had serious consequences for the villages around Keta and is threatening the mangroves in the Keta Lagoon. (Photo by Donald J Macintosh, cenTER Aarhus).

PRINCIPLE 13 TOURISM, RECREATION AND EDUCATION

Tourism is one of the largest and fastest growing sectors of the global economy. Mangrove ecosystems can provide ecotourists with unique habitats and biodiversity opportunities, with many potential activities, including recreational fishing, bird watching, viewing wildlife and scenic boat trips.

- 13.1 States should recognise the potential value of sustainable tourism involving mangroves and other coastal wetland ecosystems (see definition Box 13A), but also be aware of the dangers of allowing tourism to develop in an unplanned/unregulated manner.

Box 13A: Definition of sustainable tourism

“All forms of tourism development, management and activity, which maintain the environmental, social and economic integrity and well being of natural, built and cultural resources in perpetuity” (Federation of Nature and National Parks of Europe, 1993).

- 13.2 It is important that mangrove tourism development is linked to conservation so that both can be sustainable. States should ensure that some of the revenue from tourism is used to pay for conservation efforts in mangrove ecosystems (see Box 13B).
- 13.3 States should develop guidelines and legislation for the sustainable management of mangrove tourism, taking account of the environmental carrying capacity of mangrove ecosystems (see definition in *Terminology*) and involve the local communities from the very beginning in tourism development, management and associated activities (see Box 13B). To minimise potential negative environmental impacts from tourism on mangroves, tourists should be restricted to clearly marked paths/board walks and approved boat transportation.

Box 13B: Examples of management issues affecting tourism sites involving mangroves

Kuala Selangor Nature Park in Peninsular **Malaysia** includes 300 hectares of mangrove forest. The objectives of the Park are conservation, education, scientific research, tourism and park management in relation to the local community. The carrying capacity for day visitors and chalet occupants was set at a very modest level to protect the natural environment. Conservation projects have included construction of a lake system as additional habitat for birds and fish, nesting platforms for birds, breeding programs and other research on endangered species (e.g. milky stork and mangrove-associated fireflies). School children and teachers can visit the park for nature study and university staff and students can apply to undertake their own research projects.

Kampong Kuantan, Peninsular **Malaysia** is another well-known mangrove ecotourism site near Kuala Selangor; featuring fireflies, which inhabit the mangroves along part of the Selangor River estuary. This mangrove attraction generates a turnover of MYR 11 million a year (almost USD 3 million). However, none of the tourist income is used to protect the *Sonneratia* mangrove trees, which support the fireflies and this ecotourism site. The number of trees supporting fireflies has decreased drastically in the past 10 years as river pollution and riverbank disturbance have increased.

Wasini Island in **Kenya** features a mangrove and fossilised coral garden site with a traditional fishing community. The Women's Group organise tourism (mainly foreign tourists) and act as guides; a boardwalk is maintained and the mangroves are well protected because of the local communities involvement in this tourist activity.

- 13.4 To support ecotourism, and as part of capacity development and education, mangrove reserves and recreational areas should provide visitor centres with well prepared displays (e.g. maps, photos, species descriptions) that teach visitors about the natural, cultural and historical features of the area (see Figures 13.1 to 13.4 and 8.4 and 8.5).
- 13.5 The management of tourist activities associated with mangroves should be developed jointly with the stakeholder groups and must never exclude the local community.

- 13.6 States should create opportunities for local communities to benefit directly from tourism activities associated with mangroves. Local people should be selected and trained as tourist guides by giving them basic training in mangrove ecology and conservation practices.
- 13.7 Mangrove tourism should be promoted in tourist hotels, newspapers and other forms of media to promote awareness. Key attractions with high selling points e.g. the State of Esmeraldas in Ecuador features the largest mangrove trees in the world (see Figure 13.1).

Figure 13.1: The Majagual mangroves in Esmeraldas, **Ecuador** can reach 65m tall and are 100-150 years old. Twelve local tourist guides have been trained and they can take 10 people at a time through the mangroves on the walkway. About 2000-3000 tourists visit this site annually (mainly nationals). Esmeraldas students have to visit the mangroves as an educational requirement (Photo by Alejandro Boderó, Majagual, Ecuador).



Figure 13.2: The entrance ticket to Can Gio museum and nature park, **Vietnam** (Photo by Donald J Macintosh, cenTER Aarhus).



Figure 13.3: Visitor information boards at Ranong Biosphere Reserve visitor center, **Thailand** (Photo by Donald J Macintosh, cenTER Aarhus).



Figure 13.4: An otter watches tourists setting out on a boat trip in the Ranong mangrove ecosystem, **Thailand** (Photo by Donald J Macintosh, cenTER Aarhus).

PRINCIPLE 14 MANGROVE PRODUCTS AND RESPONSIBLE TRADE

Sustainably produced mangrove products should be promoted by "green labelling" and they should be marketed following the principles of fair-trading and benefit sharing.

- 14.1 The Convention on Biological Diversity and the Convention on International Trade in Endangered Species should be followed as guiding principles for the trade in mangrove products. Other relevant conventions dealing with benefit sharing in respect of genetic resources should also be complied with, including the International Treaty on Plant Genetic Resources for Food and Agriculture (see Box 14A, 14C and also Ramsar Convention on fair trade of wetland products).
- 14.1a Traditional and sustainably produced mangrove goods should be promoted under fair-trading practices. Conversely, states should carefully regulate the sale of other mangrove products to ensure their sustainability and to help prevent illegal product trading activities, in line with the relevant articles of the CBD (Box 14A).
- 14.1b States and trade organisations should ensure that the trade in mangrove-associated products (timber, non-timber and fishery/aquaculture products) does not compromise the sustainable development and responsible utilisation of mangrove resources.
- 14.2 States and trade organisations should also promote "green" labelling of mangrove products, based on sustainable production methods. States should ensure that the increased financial benefits from green label products are passed back to the local producers, with safeguards to ensure the poorer stakeholders are also included.
- 14.3 States should promote research and development into new, improved or value added products and production techniques from mangroves that can be produced on a sustainable basis (see Box 14B and Fig 14.1). Research should link up with farmers living in the mangrove areas. Model centres with well thought out marketing strategies should be established and supported by government structures.

Box 14A: Key articles of the CBD on fair trade and benefit-sharing

CBD Article 15.7

Take legislative, administrative or policy measures, as appropriate... with the aim of sharing in a fair and equitable way the results of research and development and the benefits arising from the commercial and other utilization of genetic resources with the Contracting Party providing such resources. Such sharing is to be on mutually agreed terms.

CBD Article 8(j)

Promote the wider application of the knowledge, innovations and practices of indigenous peoples and local communities with their approval and involvement and encourage the equitable sharing of the benefits arising from the utilization of the knowledge, innovations and practices of indigenous and local communities.

Box 14B: Examples of research on the sustainable use of mangrove products

In **Vietnam**, mud crabs and mudskippers have been collected traditionally for food. Mud crab and mudskipper farming in mangrove ponds is now developing rapidly, particularly among poor farmers. Research leading to the breeding of mudcrab and mudskipper in hatcheries and nurseries is now underway. Successful production of mudcrab and mudskipper fry would greatly enhance the potential to culture these mangrove-associated species.

See also Fig 7.4 sustainable oyster rearing in Ceará, **Brazil**.

Box 14C: Examples of the potential to promote “green labelling” of mangrove products

Mangrove charcoal from the Matang Mangrove Forest Reserve, Peninsular **Malaysia** is marketed in **Japan** as a product from “sustainably managed forests”.

“Kapi” is a type of shrimp paste produced by poor villagers in Ranong, **Thailand** from *Acetes* shrimp caught in mangrove waterways, which are then dried and salted. This is a sustainably produced, traditional product, which the producers used to sell very cheaply to local middlemen. With assistance from the management of the Ranong Biosphere Reserve where the villagers live, this mangrove product is now being better packaged to enable direct selling by the producers to local hotels, shops and other retail outlets. It has also been recommended that traditionally produced kapi should be promoted with a green label.



Figure 14.1: A range of mangrove products being sold at a local market in Ranong, **Thailand** (Photo by Elizabeth Ashton, cenTER Aarhus).

PRINCIPLE 15 MANGROVE RESEARCH AND INFORMATION DISSEMINATION

Inadequate understanding of the functions and values of mangrove ecosystems is one of the main constraints to conserving and managing mangrove resources sustainably. However, there are already considerable skills, information and opportunities available worldwide to use research knowledge more effectively to improve mangrove management.

- 15.1 States should promote further development of applied scientific knowledge on mangrove ecology and the economic, social and cultural values of mangrove ecosystems. Scientific knowledge should also be utilized more effectively to assist decision-making on the wise management and use of mangrove resources.

Box 15A: Examples of multidisciplinary research on mangrove ecosystems

The Centre for African Wetlands (CAW) at the University of **Ghana** has made an inventory of the research needs for West African wetlands, including mangroves. CAW promotes the development of knowledge on wetlands by providing capacity for research, training and networking.

“Projet de Formulation de la Reserve du Saloum” - a multidisciplinary 3 year project to formulate the Saloum Biosphere Reserve in **Senegal**, is strongly local community orientated, involving the National Parks and supported by the Netherlands through IUCN and UNESCO (see Box 3C).

The values of **Philippine** Coastal Resources: Why Protection and Management are Critical. White and Cruz-Trinidad, 1998. Coastal Resource Management Project, Cebu City, Philippines, 96 pp.

UNDP/UNESCO The Integrated Multidisciplinary Study of the Ranong Mangrove Ecosystem, **Thailand** (Macintosh *et al.*, 1991).

- 15.2 Opportunities should be provided for greater interaction between local communities, scientists, managers and policy makers to foster an exchange of views and experience on the management of mangrove ecosystems. Such interaction can be achieved in many ways, e.g. by field visits, consultations, workshops, symposia, newsletters and use of the Internet (see Box 15B). Selected mangrove web sites are provided at the end of the reference section.

Box 15B: Examples of current mechanisms available to exchange information on mangroves

Mangrove Database:

GLOMIS (Global Mangrove database Information System) has a directory of mangrove experts and references on mangroves to help exchange knowledge between different countries of the world (see <http://www.glomis.com>).

Email Discussion Groups:

Mangrove e-mail discussion lists provide a global forum for the exchange of information for those interested in mangroves. For example, (<http://possum.murdoch.edu.au/~mangrove/submang.htm>). To subscribe to this list send an e-mail message to majordomo@essun1.murdoch.edu.au with the subject and message body reading “subscribe mangrove”.

The Mangrove Action Project is dedicated to reversing the degradation of mangrove forest ecosystems worldwide and promoting the rights of local coastal peoples, including fishers and farmers, in the sustainable management of coastal environments. It has a quarterly newsletter, bi-weekly news bulletins, action alerts, and published articles, as well as planned public forums and presentations (see <http://www.earthisland.org/map/index.htm>).

- 15.3 States should register those research institutions and researchers engaged in studies on mangrove ecosystems, in order to encourage the exchange of information and prevent the unnecessary duplication of research work.

- 15.4 Research is most needed on the following topics related to mangroves: ecological functions and productivity of mangrove ecosystems; links and interactions between mangroves and other ecosystems; taxonomy and genetics of mangrove species; social research involving mangrove stakeholders, traditional knowledge, alternative livelihoods and appropriate technologies for sustainable management, economic valuation of mangrove ecosystems; policy issues and mangrove rehabilitation techniques.
- 15.4a Process and function orientated research is much needed in the field of mangrove ecology (see Box 15C).

Box 15C: Examples of research needs in mangrove ecology

The critical size of mangrove habitats that must be retained to maintain their ecological functions.
Understanding the aquatic nursery functions of mangroves and other mangrove-fisheries interactions.
Fate/pathways for nutrients/particulates in the mangrove ecosystem, including nutrients generated from mangrove-friendly aquaculture.
The importance of mangroves as habitat for biodiversity/wildlife.
The value of mangroves as an important feature of coastal protection.
The role of mangroves as carbon sinks.
Productivity studies on mangroves.
The impacts on mangrove ecosystems from global climate change and sea level rise.
Comprehensive research on the economic benefits of mangrove ecosystems including marine fisheries benefits.

- 15.4b Intensify taxonomic research on mangrove organisms. Increase the number and capacity of taxonomists and assistance and coordination with experts. Record local knowledge of species identification and species habits (behaviour and ecology).

Box 15D: Examples of recent taxonomic research on mangrove species

Research, even on common mangrove groups, e.g., sesamid crabs continues to generate descriptions of new species and taxonomic revisions (Tan and Ng, 1994).

The mangrove mudcrab, genus *Scylla* is another such example. Only a single species, *Scylla serrata*, was recognised until recently. Keenan *et al.* (1998) revised the genus, identifying four closely related species, *Scylla olivacea*, *Scylla paramamosain* and *Scylla tranquebarica*. The distribution and biology of the three additional species described is still poorly known, but new studies on these species are now underway.



Figure 15.1: A poster produced by Clive Keenan and David Mann, Bribie Island Aquaculture Research Centre, **Australia**, illustrating and describing the four mudcrab species now recognized by Keenan *et al.* (1998) - *Scylla serrata*, *Scylla olivacea*, *Scylla paramamosain* and *Scylla tranquebarica*.

- 15.4c There is limited information on mangrove genetic diversity and hence there is an urgent need for genetic studies with modern molecular tools like DNA profiles. This can be supported by

establishing regional and in some cases national level mangrove genetic resource centres (MGRC) with reference plant and animal specimens housed in herbaria and zoological museums, respectively (Box 15E).

Box 15E: Example of a mangrove genetic resource centre

In **India** there are national and state level centres where specimens of mangrove plants have been preserved. The Botanical Survey of **India** is the leading Government Organisation for this purpose. A number of mangrove genetic programmes have been initiated in some national laboratories. The National Mangrove Committee of India identified one island Kalibhanj-Dia of Bhitarkanika Sanctuary, in the delta of the Mahandi River in Orissa, to be protected as a National Mangrove Genetic Resource Centre (NMGR) because within the 2,000 ha area of this estuarine island there are about 64 mangrove plant species. The NMGR was established in 2000-2001.

- 15.4d Research on the direct and indirect use values of mangroves (benefits derived from their ecological and cultural functions) is crucial to fully incorporate the environmental costs associated with management actions (Table 15.1 and 15.2).

Table 15.1: The application of economic valuation to mangrove ecosystems

		Location of Goods and Services	
		On-site	Off-site
Valuation of Goods and Services	Marketed	Usually included in economic analysis, e.g., poles, charcoal, woodchips, and crabs.	May be included in economic analysis, e.g. fish, crustaceans and molluscs caught in adjacent waters.
	Non-marketed	Seldom included in economic analysis, e.g., local subsistence collecting of mangrove crustaceans and molluscs for food, medicinal uses, bioturbation activities by mangrove animals e.g. crabs, fish nursery areas, feeding grounds for estuarine fish, crustaceans and molluscs, wildlife sanctuaries, biodiversity attributes, educational and research uses.	Usually ignored, e.g., nutrients flow down estuaries, buffer against storm damage, erosion control.

Modified from Hamilton and Snedaker (1984) and Dixon (1991).

Table 15.2: Summary of mangrove ecosystem values to society estimated from around the world (Costanza et al., 1997).

Benefits of ecosystem services	Value (USD/ha/year)
Disturbance regulation	1839
Waste treatment	6696
Habitat/refugia	169
Food production	466
Raw materials	162
Recreation	658
Total benefits	3294

Note: These are average values and may not apply to individual mangrove sites.

- 15.4e Research on traditional knowledge of mangroves is needed but such research should proceed with due respect for, and acknowledgement of, the rights and ownership of indigenous/local

people. Local people should be encouraged to document their knowledge for future generations. See Box 15F for specific recommendations.

Box 15F: Mangrove traditional knowledge: priority research needs

To investigate ownership and right of use of mangrove traditional knowledge.

To research the social and economic aspects of mangrove resource use.

To document and evaluate traditional management systems for mangroves

- 15.4f States should promote research on appropriate technologies (e.g. GIS, See Principle 5.1a), based on forestry experiences, for natural regeneration and plantation mangroves, selection of species, tree density, identification of suitable mangrove areas and criteria for healthy growth of mangroves. Investigate restoration, rehabilitation and mitigation of degraded habitats such as abandoned shrimp ponds, salt pans, areas heavily cleared for firewood and oil spills.
- 15.4g Promote research on the sustainable use of mangrove resources, such as oysters, cockles, clams, snails, crabs and shrimps. These products are often a very important resource for local communities, but are commonly overlooked in fisheries statistics. Moreover mangrove crustacean and molluscan products are easily depleted by over collecting (see Box 7E).
- 15.5 States should coordinate research and development programmes to avoid duplication of effort and to promote more effective use of the information already available from previous research on mangroves.
- 15.6 States should seek assistance from leading national and international agencies (e.g. ISME) to help fill gaps in their knowledge base for mangroves and to help standardise methods of research.
- 15.7 Each country should develop a comprehensive mangrove information database to help monitor the status of mangrove biological diversity and provide convenient access to information useful for management. Such a database should include mangrove characterization (covering geomorphology, hydrology and climate) and biodiversity (genetic and species resources, biological community structure, ecosystem processes and functions, and social and economic values). The data collected will assist states to better understand their natural resources and help them to develop policies to integrate economic development with sound environmental management. The database should be updated regularly (see Principle 5 for guidelines on mangrove resource assessment and Box 5C for examples of existing mangrove databases).

TERMINOLOGY

Afforestation

The conversion of bare or cultivated land into forest. The establishment of a forest, stand or tree crop on an area not previously forested, or on land from which forest cover has very long been absent (IUFRO Silva term database: <http://iufro.boku.ac.at/>)

Agenda 21

A comprehensive set of programmes of action to promote sustainable development into the 21st century. Adopted, Rio, June, 1992.

Alien species

A species occurring in an area outside of its historically known natural range as a result of intentional or accidental dispersal by human activities (also known as exotic or introduced species) (UNEP-WCMC glossary).

Assessment

The identification of the status of, and threats to, wetlands/mangroves as a basis for the collection of more specific information through monitoring activities (Ramsar definition).

Biodiversity

Biodiversity is a condensed form of biological diversity. "Biological diversity" means the variability among living organisms from all sources including, *inter alia*, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems (CBD Article 2).

Biosphere Reserve

Biosphere Reserves (BRs) were established under UNESCO's Man in the Biosphere (MAB) Program in 1970. Biosphere Reserves are areas of terrestrial and coastal/marine ecosystems or a combination thereof and are a series of protected areas linked through a global network. Each reserve is through appropriate zoning patterns and management mechanisms intended to fulfil three complementary functions:

- A conservation function (to preserve genetic resources, species, ecosystems and landscapes);
- A development function (to foster sustainable economic and human development); and
- A logistic function (to support demonstration projects, environmental education and training, and research and monitoring related to local, national and global issues of conservation and sustainable development.

To carry out the complementary activities of nature conservation and use of natural resources, Biosphere Reserves are organized into three interrelated zones:

- A core area that should be legally established and sufficiently large to meet the conservation objectives.
- A buffer zone which is clearly delineated and which surrounds the core area. Activities do not hinder core area conservation but help to protect it for example through research.
- A transition zone is the area of co-operation that extends outwards, and which may contain a variety of agricultural activities, human settlements and other uses.

Benefit sharing

Refers to the sharing of results of bioprospecting activity and benefits arising from the utilization or commercialisation of the biological or genetic resources fairly and equitably with the indigenous cultural community/local community/protected area/private landowner concerned and the national government by the Principal/Collector. Among the results and benefits that may be shared are payment for access to specimens, royalties, data, technology, capacity building, training, joint research.

Bioprospecting

Refers to the research, collection and utilization of biological and genetic resources, for purposes of applying the knowledge derived therefrom for scientific and/or commercial purposes.

Buffer zones

Areas on the edge of protected areas that have land use controls and allow only activities compatible with protection of the core area, such as research, environmental education, recreation and tourism (UNEP-WCMC).

Capacity Building

Improving and building the technical and managerial skills and resources within an organization (World

Bank. Glossary of Municipal Solid Waste Management Terms)

Carrying capacity

It is the maximum number of individuals of a defined species that a given environment can support over the long term, or it is the ability of an environment to sustain the resource demands of a species or a community without losing its ability to regenerate the resource. The carrying capacity of a given area for a certain type of use can be defined as the capacity to provide space, resources and environmental conditions in a sustainable manner. IUCN, UNEP and WWF define it as the “capacity of an ecosystem to support healthy organisms while maintaining its productivity, adaptability, and capability of renewal”.

Co-management

The sharing of authority, responsibility, and benefits between government and local communities in the management of natural resources (UNEP-WCMC glossary).

Conservation

Protection from change, loss or damage or protection of valued resources through the protection, management and care of natural and cultural resources (Encarta, 1999).

Convention on Biological Diversity (CBD)

Adopted in Rio de Janeiro, Brazil, June 1992 and came into force December 1993. Signed by over 150 countries. Legally binding agreement with the three key objectives:

- Biodiversity Conservation
- Sustainable use of biodiversity
- Fair and equitable sharing of the resulting benefits

This Convention is the first global, comprehensive binding agreement to address all aspects of biological diversity: genetic resources, species and ecosystems. It requires countries to develop and implement strategies for sustainable use and protection of biodiversity and provides a forum for continuing dialogue on biodiversity related issues through the annual Conference Of the Parties (COP).

Convention on International Trade in Endangered Species of wild flora and fauna (CITES)

Adopted in Washington D.C. March 1973 and came into force July 1975 in response to the growing concern over large scale exploitation of wildlife for international trade which was threatening species with extinction. Aims to regulate international trade of wildlife (animals and plants dead or alive or any recognizable parts or derivatives of) threatened or endangered in the wild through a system of permits and controls.

Direct use value

The productive or consumptive values derived from direct use or interaction with a biological resource which may be marketed or non-marketed.

Ecosystem

A dynamic complex of plant, animal and micro-organism communities and their non-living environment interacting as a functional unit (Article 2 on the Convention of Biological Diversity).

Ecosystem Approach

It is a strategy for the integrated management of land, water and living resources that promotes conservation and sustainable use in an equitable way. It is based on the application of appropriate scientific methodologies focused on levels of biological organisation, which encompasses the essential processes, functions and interactions among organisms and their environment. It recognizes that humans, with their cultural diversity, are an integral component of ecosystems.

Adopted by the Conference of the Parties of the CBD, at its Fifth Meeting in Nairobi, 2000, as the primary framework for action under the Convention (V/6). Recommended the application of 12 principles on the Ecosystem Approach.

Principle 1: The objectives of management of land, water and living resources are a matter of societal choices.

Principle 2: Management should be decentralized to the lowest appropriate level.

Principle 3: Ecosystem managers should consider the effects (actual or potential) of their activities on adjacent and other ecosystems.

Principle 4: Recognising 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) Internalise costs and benefits in the given ecosystem to the extent feasible

Principle 5: Conservation of ecosystem structure and functioning, in order to maintain ecosystem services, should be a priority target of the ecosystem approach.

Principle 6: Ecosystem must be managed within the limits of their functioning

Principle 7: The ecosystem approach should be undertaken at the appropriate spatial and temporal scales.

Principle 8: Recognising the varying temporal scales and lag-effects that characterize ecosystem processes, objectives for ecosystem management should be set for the long term.

Principle 9: Management must recognize that change is inevitable.

Principle 10: The ecosystem approach should seek the appropriate balance between, and integration of, conservation and use of biological diversity.

Principle 11: The ecosystem approach should consider all forms of relevant information, including scientific and indigenous and local knowledge, innovations and practices.

Principle 12: The ecosystem approach should involve all relevant sectors of society and scientific disciplines.

Ecosystem Diversity

The variety of habitats, biotic communities and ecological processes in terrestrial, marine and other aquatic environments in a particular area, together with the processes and interactions that take place within and between these systems.

Ecosystem functions

The processes of production and dynamics of resources (organic matter, nutrients, biomass, elements) and energy through systems. A set of ecological processes responsible for providing an environmental good or service (Gilbert and Janssen, 1998).

Ecosystem resilience or resistance

Determines the persistence of relationships within a system, and is a measure of the ability of these systems to absorb changes in species composition and abundance and still persist without drastically changing the ecosystem performance.

Economic value

The value of a good or service placed by an individual or society through his willingness to pay using market price or other indicators.

Economic valuation

Measuring the preferences of people or society for a good or service or against economic activity.

Endangered species

A technical definition used for classification in the United States referring to a species that is in danger of extinction throughout all or a significant portion of its range. IUCN The World Conservation Union (1994) definition, defines species as endangered if the factors causing their vulnerability or decline continue to operate (UNEP-WCMC glossary).

Endemic

Restricted to a specified region or locality (UNEP-WCMC glossary).

Environmental Impact Assessment

A method of analysis which attempts to predict the likely repercussions of a proposed major development (usually industrial) upon the social and physical environment of the surrounding area (UNEP-WCMC glossary).

Existence value

The benefit an individual or society receives from merely knowing that a good or service exists. Society's willingness to pay towards the conservation of biological resources for their own sake regardless of their current or optional uses.

Food and Agricultural Organization (FAO) Code of Conduct for Responsible Fisheries

This code is voluntary but is based entirely on international law (especially UNCLOS). The Compliance Agreement is binding (Agreement to Promote Compliance with International Conservation and Management Measures by Fishing Vessels on the High Seas). The Code has been endorsed by COFI (FAO Committee on Fisheries) and adopted by the twenty-eighth session of the FAO conference on 31 October 1995 (<http://www.fao.org/fi/agreem/codecond/codecon.asp>).

The Code is global in scope and is directed towards members and non-members of FAO, fishing entities, sub regional, regional and global organizations, whether governmental or non-governmental, and all persons concerned with the conservation of fishery resources and management and development of fisheries, such as fishers, those engaged in processing and marketing of fish and fishery products and other users of the aquatic environment in relation to fisheries.

The Code “sets out principles and international standards of behaviour for responsible practices with a view to ensuring the effective conservation, management and development of living aquatic resources, with due respect for the ecosystem and biodiversity”. The Code also recognizes the nutritional, economic, social, environmental and cultural importance of fisheries and the interest of those concerned with the fishery sector.

Genetic Diversity

The variation within and between populations of species (i.e. individual plants, animals and micro-organisms), measured in terms of the variations between genes or DNA or amino acid sequences, as well as numbers of breeds, strains and distinct populations.

Genetic Resources

The genetic material of plants, animals and micro-organisms of value as a resource for future social, economic, environmental purposes. "Genetic resources" means genetic material of actual or potential value. (Article 2 CBD).

Goods

Articles for sale or use, often produced for later consumption as opposed to services

Hotspot

An area on earth with an unusual concentration of species, many of which are often endemic to the area.

Indigenous cultural communities or Indigenous people

Refer to a homogenous society identified by self-ascription and ascription by others, who have continuously lived as community on communally bounded and defined territory, sharing common bonds of language, customs, traditions and other distinctive cultural traits, and who, through resistance to the political, social and cultural inroads of colonization, became historically differentiated from the majority of other people.

Indirect use value

The value of an environment's ecological functions which support or protect the life forms dependent on that environment, or an economic activity.

Integrated Coastal Zone/Area Management (ICZM/ICAM)

Used to describe a continuous and dynamic process that unites government and the community, science and management, sectoral and public interests in preparing and implementing an integrated plan for the protection and development of coastal systems and resources (GESAMP, 1996).

Inventory

The collection and/or collation of core information for management, including the provision of an information base for specific assessment and monitoring activities. (Ramsar definition)

ISME

The International Society for Mangrove Ecosystems was established in August 1990. ISME is recognised as an international non-governmental organisation dedicated to the study and conservation of mangrove ecosystems. A secretariat for ISME was established on the island of Okinawa in Japan through the support of the Government of Japan, the prefecture of Okinawa and the University of Ryukyus. There are four sub-regional centres located in Fiji (Oceania and Australia), Ghana (Africa), Brazil (Americas) and India (South and Southeast Asia). There are about 1000 members worldwide.

(<http://www.mangrove.or.jp/index.html>)

IUCN (World Conservation Union) Protected Area Categories (IUCN, 1994)

Category Ia: Strict Nature Reserve – Area of land and/or sea possessing some outstanding or representative ecosystems, geological or physiological features and/or species, available primarily for scientific research and/or environmental monitoring

Category Ib: Wilderness Area – Large area of unmodified or slightly modified land and/or sea, retaining its natural character and influence, without permanent or significant habitation, which is protected and managed to preserve its natural condition

Category II: National Park – Natural area of land and/or sea, designated to a) protect the ecological

integrity of one or more ecosystems for present and future generations, b) exclude exploitation or occupation harmful to the purposes of designation of the area, and c) provide a foundation for spiritual, scientific, educational, recreational and visitor opportunities, all of which must be environmentally and culturally compatible.

Category III: Natural Monument – Area containing one, or more, specific natural or natural/cultural features which are of outstanding or unique value because of their inherent rarity, representative or aesthetic qualities or cultural significance.

Category IV: Habitat/Species Management Area – Area of land and/or sea subject to active intervention for management purposes so as to ensure the maintenance of habitats and/or to meet the requirements of specific species.

Category V: Protected Landscape/Seascape – Area of land, with coast and sea as appropriate, where the interaction of people and nature over time has produced an area of distinct character with significant aesthetic, ecological and/or cultural value, and often with high biological diversity. Safeguarding the integrity of this traditional interaction is vital to the protection, maintenance and evolution of such an area.

Category VI: Managed Resource Protection Area – Area containing predominantly unmodified natural systems, managed to ensure long-term protection and maintenance of biological diversity, while providing at the same time a sustainable flow of natural products and services to meet community needs.

IUCN Red List of Threatened Species

Provides taxonomic, conservation status and distribution information on taxa that have been evaluated using the IUCN Red List Categories and Criteria. This system is designed to determine the relative risk of extinction, and the main purpose is to catalogue and highlight those taxa that are facing a higher risk of global extinction (i.e. those listed as Critically Endangered, Endangered and Vulnerable). The IUCN Red List also includes information on taxa that are categorized as Extinct or Extinct in the Wild; on taxa that cannot be evaluated because of insufficient information (i.e. are Data Deficient); and on taxa that are either close to meeting the threatened thresholds or that would be threatened were it not for on-going taxon-specific conservation programmes (i.e. Near Threatened).

Jakarta Mandate on Marine and Coastal Biological Diversity

This program was adopted in 1995 at the Second meeting of the Conference of the Parties (COP) of the Convention on Biological Diversity (CBD) in Jakarta, Indonesia. Five key thematic issues were identified and are shown below together with their operational objectives for the work programme:

1. Integrated marine and coastal area management (IMCAM)

- 1.1 Reviewing existing instruments related to IMCAM
- 1.2 Promoting the development and implementation of IMCAM at the local, national and regional level
- 1.3 Developing guidelines for ecosystem evaluation and assessment (including indicators)

2. Marine and coastal living resources

- 2.1 Promoting ecosystem approaches to the sustainable use of marine and coastal living resources
- 2.2 Making available to Parties information on marine and coastal gene resources, including bioprospecting

3. Marine and coastal protected areas

- 3.1 Facilitating research and monitoring activities on the value and effect of marine and coastal protected areas or similarly restricted areas on sustainable use of marine and coastal living resources
- 3.2 Developing criteria for the establishment and management of marine and coastal protected areas

4. Mariculture

- 4.1 Assessing the consequences of mariculture for marine and coastal biological diversity and promoting techniques to minimize adverse impacts

5. Alien species and genotypes

- 5.1 Achieving better understanding of the causes and impacts of introductions of alien species and genotypes
- 5.2 Identifying gaps in existing or proposed legal instruments, guidelines and procedures and collecting information on national and international actions
- 5.3 Establishing an “incidental list” of introductions

Livelihood

The word livelihood can be used in many different ways but in this context we have used the UK Department for International Development (DFID) definition: “A livelihood comprises the capabilities,

assets (including both material and social resources) and activities required for a means of living. A livelihood is sustainable when it can cope with and recover from stresses and shocks and maintain or enhance its capabilities and assets both now and in the future, while not undermining the natural resource base” Carney (1998). (<http://www.livelihoods.org>)

Management

The act or practice of handling, administering, supervising or controlling, entities, resources and activities.

Mangrove Action Project (MAP)

A non-profit organisation based in USA, which is dedicated to reversing the degradation of mangrove forest ecosystems worldwide. Its central tenet is to promote the rights of local coastal peoples, including fishers and farmers, in the sustainable management of coastal environments. MAP provides four essential services to grassroots associations and other proponents of mangrove conservation:

- 1) It coordinates a unique international NGO network and information clearinghouse on mangrove forests;
- 2) It promotes public awareness of mangrove forest issues;
- 3) It develops technical and financial support for NGO projects; and
- 4) MAP helps publicize within the developed nations the basic needs and struggles of Third World coastal fishing and farming communities affected by the consumer demands of the wealthy nations. (This we do through our quarterly newsletter, bi-weekly news bulletins, action alerts, and published articles, as well as planned public forums and presentations.)

Mangrove ecosystems

Important wetland systems that fringe the intertidal zone along sheltered coastal, estuarine and riverine areas in tropical and subtropical latitudes.

They support many types of plants and animals. The majority of plants are evergreen trees, although deciduous trees, perennial and evergreen shrubs, epiphytes, parasites and climbers, grasses, palms and perennial ferns are also common constituents (Tomlinson, 1986), together with algae, fungi and microflora. Micro and macroscopic, terrestrial and aquatic (marine and freshwater), temporary and residential wildlife are all supported by mangroves (Hutchings & Recher, 1982; Hutchings & Saenger, 1987) forming a heterogeneous habitat.

The mangrove physical environment includes waterways (estuaries, deltas, rivers, creeks, canals, lagoons and backwaters), mudflats, salt pans and islands (Kjerfve, 1990), and is often highly saline, frequently inundated, soft bottomed anaerobic mud.

Mariculture

Saltwater seafood farming

(http://environment.jbpub.com/mckinney/interactive_glossary_showterm.cfm?term=mariculture%20)

Marine agriculture, i.e., farming the seas to grow algae or to raise finfish and shellfish

(http://www.jbpub.com/oceanlink/interactive_glossary_showterm.cfm?term=Mariculture).

Marine protected Areas (MPA)

In 1986, the IUCN Commission on National Parks and Protected Areas (CNPPA) began promoting the establishment and management of a global representative systems of marine protected areas. IUCN defines MPA as “any area of intertidal, subtidal terrain, together with its overlying water and associated flora and fauna, historical and cultural features, which has been reserved by law or other effective means to protect part or all of the enclosed environment” (Gubbay, 1995).

Monitoring

The collection of specific information for management purposes in response to hypotheses derived from assessment activities, and the use of these monitoring results for implementing management. The collection of time-series information that is not hypothesis-driven from wetland/mangrove assessment is here termed surveillance rather than monitoring (Ramsar definition).

Non-Governmental Organisation (NGO)

A non-profit group or association organized outside of institutionalised political structures to realize particular social objectives (such as environmental protection) or serve particular constituencies (such as indigenous peoples or other local communities). NGO activities range from research, information distribution, training, local organization and community service to legal advocacy, lobbying for legislative change, and civil disobedience. NGOs range in size from small groups within a particular community to huge membership groups with a national or international scope (UNEP-WCMC glossary).

Option value

The potential value of a resource for future (direct and indirect) use by protecting or preserving it today.

Precautionary Approach

A decision to take action, based on the possibility of significant environmental damage, even before there is conclusive, scientific evidence, that the damage will occur (European Commission, 1999. Integrating environmental concerns into development and economic cooperation. Brussels).

Principle 15 of the Rio Declaration on Environment and development states that:

“In order to protect the environment, the precautionary approach shall be widely applied by the States according to their capabilities. Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation.”

Ramsar Convention on Wetlands of International Importance especially as waterfowl habitat

Adopted in Ramsar, Iran February 1971 and came into force December 1975. Legally binding agreement now signed by over 110 countries with the following objectives:

- To promote the wise use and conservation of wetlands
- To make environmental assessments before transforming wetlands
- To establish nature reserves on wetlands
- To increase waterfowl populations in appropriate wetlands through management

Reforestation

Planting of forests on lands that have previously contained forests but that have been converted to some other use (IPCC, 2001). The reestablishment of forest cover either naturally (by natural seeding, coppice, or root suckers) or artificially (by direct seeding or planting) (IUFRO Silva term database <http://iufro.boku.ac.at/>)

Rehabilitation

The recovery of specific ecosystem services in a degraded ecosystem or habitat (UNEP-WCMC glossary). Establishment of mangroves in degraded/destroyed mangrove areas through activities by man namely hydrology and planting restoration. A functioning system reinstated by man but not necessarily what was there before.

Restoration

The return of an ecosystem or habitat to its original community structure, natural complement of species, and natural functions (UNEP-WCMC glossary). Returning a former mangrove forest area to forest cover through hydrological restoration and either followed by planting of seeds, seedlings or saplings or allowed to naturally recolonise.

Species diversity

The variation of species and subspecies among living organisms on Earth.

Stability

The ability of a system to return to the initial equilibrium state following a temporary disturbance.

Stakeholder

An institution, organisation, or group that has some interest in a particular sector or system (WHO. http://www.who.int/terminology/ter/Health_futures.html).

People who use, affect or otherwise have an interest in the mangrove ecosystem.

Sustainable development

“Development that meets the needs of the present without compromising the ability of future generations to meet their own needs” (Brundtland, 1987) or “the management and conservation of the natural resource base and the orientation of technological change in such a manner as to ensure the attainment and continued satisfaction of human needs for present and future generations. Such sustainable development (in the agriculture, forestry and fisheries sectors) conserves land, water, plant and animal genetic resources, is environmentally non-degrading, technically appropriate, economically viable and socially acceptable” (FAO, 1988).

See also “WSSD”

Sustainable Tourism

All forms of tourism development, management and activity, which maintain the environmental, social and economic integrity and well being of natural, built and cultural resources in perpetuity (Federation of

Nature and National Parks of Europe, 1993, p. 5).

Sustainable Use

The CBD definition of sustainable use: "Sustainable use entails the introduction and application of methods and processes for the utilization of biodiversity to prevent its long term decline, thereby maintaining its potential to meet current and future human needs and aspirations."

Article 10 of the Convention sets the sustainable use agenda as follows:

- integrate consideration of the conservation and sustainable use of biological resources into national decision-making;
- adopt measures relating to the use of biological resources to avoid or minimize adverse impacts on biological diversity;
- protect and encourage customary use of biological resources in accordance with traditional cultural practices that are compatible with conservation or sustainable use requirements;
- support local populations to develop and implement remedial action in degraded areas where biological diversity has been reduced; and
- encourage cooperation between its governmental authorities and its private sector in developing methods for sustainable use of biological resources.

Taxon

A grouping of species: taxonomic group at any level, e.g. Kingdom, Phylum or Division, Class, Order, Family, Genus, Species, Sub-species
(http://212.187.155.84/wnv/Subdirectories_for_Search/Glossary&References_Contents/KeywordsContents/t/Taxon.htm)

Total Economic Value (TEV)

Comprises direct use value, indirect use value, option value and existence value.

Valuation

The process of placing monetary value on goods and services that do not have accepted market prices (such as biodiversity).

WSSD (World Summit on Sustainable Development)

The Summit took place in Johannesburg, South Africa from 26 August to 4 September 2002 and brought together tens of thousands of participants, including heads of State and Government, national delegates and leaders from non-governmental organizations (NGOs), businesses and other major groups to focus the world's attention and direct action toward meeting difficult challenges, including improving people's lives and conserving our natural resources in a world that is growing in population, with ever-increasing demands for food, water, shelter, sanitation, energy, health services and economic security.

The WSSD Targets

(http://www.rio10.dk/index.php?a=show&doc_id=1118&PHPSESSID=8c825ac41bf13bc58600b7f1e7f1fe7) are:

- Poverty eradication
- Changing unsustainable patterns of consumption and production
- Protection/managing of natural resource base of socio-economic development
- Health and sustainable development
- Sustainable development of small island developing states
- Sustainable development for Africa

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MANGROVE WEB SITES (JULY 2004)

Australian Institute of Marine Science

<http://www.aims.gov.au/index.html>

Centre for Tropical Ecosystems Research

<http://www.biology.au.dk/cenTER/index.html>

East African Mangroves, Kenya

<http://www.specola.unifi.it/mangroves/Index.htm>

Food and Agriculture Organisation of the United Nations

<http://www.fao.org/forestry/mangroves>

GLobal Mangrove database and Information System

<http://www.glomis.com>

Guide to the Mangrove of Singapore handbooks

<http://mangrove.nus.edu.sg/guidebooks/>

International Society for Mangrove Ecosystems, Japan

<http://www.mangrove.or.jp/index.html>

Lewis Environmental Services

<http://www.lewisenv.com>

Mangrove Action Project, USA

<http://www.earthisland.org/map/index.htm>

Mangrove Environmental Protection Group, Mexico

<http://www.elmanglar.com/>

Mangrove Replenishment Initiative, Florida, USA

<http://www.mangrove.org/>

Mangrove Restoration website

<http://www.mangroverestoration.com>

Mangrove Web Home Page, Murdoch University, Western Australia

<http://www.science.murdoch.edu.au/centres/others/mangrove/>

Ramsar Convention on Wetlands

<http://www.ramsar.org>

Wetlands Ecology and Management journal

<http://www.kluweronline.com/issn/0923-4861>

Wetlands International

<http://www.wetlands.org/>

World Conservation Monitoring Centre, Cambridge, UK

http://www.wcmc.org.uk/marine/data/coral_mangrove/mangrove.main.html

Will be updated on a regular basis

ANNEX 1: UNCED FOREST PRINCIPLES

1. (a) States have, in accordance with the Charter of the United Nations and the principles of international law, the sovereign right to exploit their own resources pursuant to their own environmental policies and have the responsibility to ensure that activities within their jurisdiction or control do not cause damage to the environment of other States or of areas beyond the limits of national jurisdiction.

(b) The agreed full incremental cost of achieving benefits associated with forest conservation and sustainable development requires increased international cooperation and should be equitably shared by the international community.

2. (a) States have the sovereign and inalienable right to utilize, manage and develop their forests in accordance with their development needs and level of socio-economic development and on the basis of national policies consistent with sustainable development and legislation, including the conversion of such areas for other uses within the overall socio-economic development plan and based on rational land-use policies.

(b) Forest resources and forest lands should be sustainably managed to meet the social, economic, ecological, cultural and spiritual needs of present and future generations. These needs are for forest products and services, such as wood and wood products, water, food, fodder, medicine, fuel, shelter, employment, recreation, habitats for wildlife, landscape diversity, carbon sinks and reservoirs, and for other forest products. Appropriate measures should be taken to protect forests against harmful effects of pollution, including air-borne pollution, fires, pests and diseases, in order to maintain their full multiple value.

(c) The provision of timely, reliable and accurate information on forests and forest ecosystems is essential for public understanding and informed decision-making and should be ensured.

(d) Governments should promote and provide opportunities for the participation of interested parties, including local communities and indigenous people, industries, labour, non-governmental organizations and individuals, forest dwellers and women, in the development, implementation and planning of national forest policies.

3. (a) National policies and strategies should provide a framework for increased efforts, including the development and strengthening of institutions and programmes for the management, conservation and sustainable development of forests and forest lands.

(b) International institutional arrangements, building on those organizations and mechanisms already in existence, as appropriate, should facilitate international cooperation in the field of forests.

(c) All aspects of environmental protection and social and economic development as they relate to forests and forest lands should be integrated and comprehensive.

4. The vital role of all types of forests in maintaining the ecological processes and balance at the local, national, regional and global levels through, *inter alia*, their role in protecting fragile ecosystems, watersheds and freshwater resources and as rich storehouses of biodiversity and biological resources and sources of genetic material for biotechnology products, as well as photosynthesis, should be recognized.

5. (a) National forest policies should recognize and duly support the identity, culture and the rights of indigenous people, their communities and other communities and forest dwellers. Appropriate conditions should be promoted for these groups to enable them to have an economic stake in forest use, perform economic activities, and achieve and maintain cultural identity and social organization, as well as adequate levels of livelihood and well-being, through, *inter alia*, those land tenure arrangements which serve as incentives for the sustainable management of forests.

(b) The full participation of women in all aspects of the management, conservation and sustainable development of forests should be actively promoted.

6. (a) All types of forests play an important role in meeting energy requirements through the provision of a renewable source of bio-energy, particularly in developing countries, and the demands for

fuelwood for household and industrial needs should be met through sustainable forest management, afforestation and reforestation. To this end, the potential contribution of plantations of both indigenous and introduced species for the provision of both fuel and industrial wood should be recognized.

(b) National policies and programmes should take into account the relationship, where it exists, between the conservation, management and sustainable development of forests and all aspects related to the production, consumption, recycling and/or final disposal of forest products.

(c) Decisions taken on the management, conservation and sustainable development of forest resources should benefit, to the extent practicable, from a comprehensive assessment of economic and non-economic values of forest goods and services and of the environmental costs and benefits. The development and improvement of methodologies for such evaluations should be promoted.

(d) The role of planted forests and permanent agricultural crops as sustainable and environmentally sound sources of renewable energy and industrial raw material should be recognized, enhanced and promoted. Their contribution to the maintenance of ecological processes, to offsetting pressure on primary/old-growth forest and to providing regional employment and development with the adequate involvement of local inhabitants should be recognized and enhanced.

(e) Natural forests also constitute a source of goods and services, and their conservation, sustainable management and use should be promoted.

7. (a) Efforts should be made to promote a supportive international economic climate conducive to sustained and environmentally sound development of forests in all countries, which include, inter alia, the promotion of sustainable patterns of production and consumption, the eradication of poverty and the promotion of food security.

(b) Specific financial resources should be provided to developing countries with significant forest areas which establish programmes for the conservation of forests including protected natural forest areas. These resources should be directed notably to economic sectors which would stimulate economic and social substitution activities.

8. (a) Efforts should be undertaken towards the greening of the world. All countries, notably developed countries, should take positive and transparent action towards reforestation, afforestation and forest conservation, as appropriate.

(b) Efforts to maintain and increase forest cover and forest productivity should be undertaken in ecologically, economically and socially sound ways through the rehabilitation, reforestation and re-establishment of trees and forests on unproductive, degraded and deforested lands, as well as through the management of existing forest resources.

(c) The implementation of national policies and programmes aimed at forest management, conservation and sustainable development, particularly in developing countries, should be supported by international financial and technical cooperation, including through the private sector, where appropriate.

(d) Sustainable forest management and use should be carried out in accordance with national development policies and priorities and on the basis of environmentally sound national guidelines. In the formulation of such guidelines, account should be taken, as appropriate and if applicable, of relevant internationally agreed methodologies and criteria.

(e) Forest management should be integrated with management of adjacent areas so as to maintain ecological balance and sustainable productivity.

(f) National policies and/or legislation aimed at management, conservation and sustainable development of forests should include the protection of ecologically viable representative or unique examples of forests, including primary/old-growth forests, cultural, spiritual, historical, religious and other unique and valued forests of national importance.

(g) Access to biological resources, including genetic material, shall be with due regard to the sovereign rights of the countries where the forests are located and to the sharing on mutually agreed term of technology and profits from biotechnology products that are derived from these resources.

(h) National policies should ensure that environmental impact assessments should be carried out where actions are likely to have significant adverse impacts on important forest resources, and where such actions are subject to a decision of a competent national authority.

9. (a) The efforts of developing countries to strengthen the management, conservation and sustainable development of their forest resources should be supported by the international community, taking into account the importance of redressing external indebtedness, particularly where aggravated by the net transfer of resources to developed countries, as well as the problem of achieving at least the replacement value of forests through improved market access for forest products, especially processed products. In this respect, special attention should also be given to the countries undergoing the process of transition to market economies.

(b) The problems that hinder efforts to attain the conservation and sustainable use of forest resources and that stem from the lack of alternative options available to local communities, in particular the urban poor and poor rural populations who are economically and socially dependent on forests and forest resources, should be addressed by Governments and the international community.

(c) National policy formulation with respect to all types of forests should take account of the pressures and demands imposed on forest ecosystems and resources from influencing factors outside the forest sector, and intersectoral means of dealing with these pressures and demands should be sought.

10. New and additional financial resources should be provided to developing countries to enable them to sustainably manage, conserve and develop their forest resources, including through afforestation, reforestation and combating deforestation and forest and land degradation.

11. In order to enable, in particular, developing countries to enhance their endogenous capacity and to better manage, conserve and develop their forest resources, the access to and transfer of environmentally sound technologies and corresponding know-how on favourable terms, including on concessional and preferential terms, as mutually agreed, in accordance with the relevant provisions of Agenda 21, should be promoted, facilitated and financed, as appropriate.

12. (a) Scientific research, forest inventories and assessments carried out by national institutions which take into account, where relevant, biological, physical, social and economic variables, as well as technological development and its application in the field of sustainable forest management, conservation and development, should be strengthened through effective modalities, including international cooperation. In this context, attention should also be given to research and development of sustainably harvested non-wood products.

(b) National and, where appropriate, regional and international institutional capabilities in education, training, science, technology, economics, anthropology and social aspects of forests and forest management are essential to the conservation and sustainable development of forests and should be strengthened.

(c) International exchange of information on the results of forest and forest management research and development should be enhanced and broadened, as appropriate, making full use of education and training institutions, including those in the private sector.

(d) Appropriate indigenous capacity and local knowledge regarding the conservation and sustainable development of forests should, through institutional and financial support and in collaboration with the people in the local communities concerned, be recognized, respected, recorded, developed and, as appropriate, introduced in the implementation of programmes. Benefits arising from the utilization of indigenous knowledge should therefore be equitably shared with such people.

13. (a) Trade in forest products should be based on non-discriminatory and multilaterally agreed rules and procedures consistent with international trade law and practices. In this context, open and free international trade in forest products should be facilitated.

(b) Reduction or removal of tariff barriers and impediments to the provision of better market access and better prices for higher value-added forest products and their local processing should be

encouraged to enable producer countries to better conserve and manage their renewable forest resources.

(c) Incorporation of environmental costs and benefits into market forces and mechanisms, in order to achieve forest conservation and sustainable development, should be encouraged both domestically and internationally.

(d) Forest conservation and sustainable development policies should be integrated with economic, trade and other relevant policies.

(e) Fiscal, trade, industrial, transportation and other policies and practices that may lead to forest degradation should be avoided. Adequate policies, aimed at management, conservation and sustainable development of forests, including, where appropriate, incentives, should be encouraged.

14. Unilateral measures, incompatible with international obligations or agreements, to restrict and/or ban international trade in timber or other forest products should be removed or avoided, in order to attain long-term sustainable forest management.

15. Pollutants, particularly air-borne pollutants, including those responsible for acidic deposition, that are harmful to the health of forest ecosystems at the local, national, regional and global levels should be controlled.

ANNEX 2: GUIDELINES FOR PLANTING MANGROVES FROM THE PHILIPPINES

Seed and propagule collection <ul style="list-style-type: none"> Collect local seeds to ensure survival and adaptation of young plants to planting site and reduce the incidence of seed damage because of handling and transport Collect only mature seeds (immature seeds often don't survive) Tree collection of seeds is easiest at high tide from a boat. Seeds collected from the ground have a higher incidence of insect attack and are to be used as little as possible Prepare a seedling collection and planting timetable as production varies from place to place and tree species
Seed and propagule quality <ul style="list-style-type: none"> Discard abnormal and injured seeds. Eliminate seeds with holes (even pin sized) because these are usually infested by a beetle <i>Poecellips fallax</i>. Infested seeds can easily contaminate the other seeds
Seed and propagule Handling and Transport <ul style="list-style-type: none"> Retain pericarp (brown cap structure in <i>Rhizophora</i>) to provide protection to the shoot Keep seeds under a shed and cover with green banana leaves or thatch to prevent excessive loss of seed moisture Bundle seeds in 50s or 100s to facilitate counting and handling Keep seeds horizontal and covered with moist sacks to properly protect from heat when transporting
Seed and propagule storage <ul style="list-style-type: none"> Clean and treat the seeds (avoid using fungicides and insecticides as much as possible) Air dry seeds for one day Place seeds in plastic bags, seal and keep at room temperature (can keep like this for 1 to 4 months and still have 60-90% germination depending on the species) <i>Rhizophora</i> propagules can be kept in a shed under room temperature for two weeks without adversely affecting viability, as long as they don't get wet
Seedling production <ul style="list-style-type: none"> <i>Rhizophora</i> can be directly seeded by placing the hypocotyl end vertically in mud and removing pericarp <i>Ceriops</i> and <i>Bruguiera</i> although having shorter propagules can be planted directly in less inundated areas <i>Sonneratia</i> and other small seed mangrove species should be raised in a nursery. Best <i>Sonneratia</i> germination obtained if fruits are soaked in tap water for 7 days, mashed and seeds sown on flooded seedbeds using waterlogged mangrove soil. In nurseries use mangrove forest top soil in polyethylene plastic bags, directly sow seeds, place under partial shade and irrigate daily with brackishwater or freshwater. <i>Avicennia</i> and other small seed mangrove species wildlings (wild seedlings) can be transplanted to planting site successfully. Best size range for <i>Avicennia</i> is 60 to 90 cm tall. Can be planted earthballed or bareroot. Bareroot collected wildlings must be placed in plastic bags to prevent roots drying
Selection of Planting Sites and Species <ul style="list-style-type: none"> Mangrove zonation results from the combined affects of tidal inundation, exposure to wind, waves and water currents, soil properties, morphology of species, salinity, light and species association. Environmental factors and natural mangrove zonation should be taken into account in determining what species are particularly suited to the planting site. Seaward zone - daily inundated. Soil ranges from sandy to sandy loam, mudflat or coralline type. Usually inhabited with <i>Avicennia</i>, <i>Sonneratia</i>, <i>Aegiceras</i> and <i>Rhizophora mucronata</i>. Middle zone - daily inundated except during neap tides. Soil clayey, silty to silty clay. Usually inhabited with <i>Avicennia</i>, <i>Aegiceras</i>, <i>Bruguiera</i>, <i>Ceriops</i>, <i>Excoecaria agallocha</i>, <i>Lumnitzera</i>

<p><i>racemosa</i>, <i>Scyphiphora hydrophyllacea</i> and <i>Nypa</i></p> <ul style="list-style-type: none"> Landward zone – unaffected by tidal inundation over long periods of time except during high Spring tides. Soil clayey to silt clay. Vegetation highly diverse because of the presence of mangrove associates, vines and epiphytes. Mangrove species similar to middle zone but can also include <i>Acanthus</i>, <i>Heritiera littoralis</i>, <i>Barringtonia racemosa</i>, <i>Hibiscus tilaceus</i> and <i>Thespesia populnea</i> Riverine fringes at mouths of rivers commonly have <i>Avicennia</i>, <i>Aegiceras</i> and <i>Rhizophora</i> species and in interior riverbanks these species and <i>Bruguiera</i> and <i>Xylocapus granatum</i> can be found
<p>Preparation of Planting Site</p> <ul style="list-style-type: none"> Compartmentalize plantation area into manageable sizes for each planter/family/community to allow planting, maintenance and monitoring activities easier. Leave 3–5 m between compartments for pathways or in extensive areas a 10 m waterway for passage of boats, which should be determined by the users. Establish fence or stakes around the perimeter to protect young plants from trespassers while providing them a guide on the way to take especially at high tide. Clear planting sites from debris because these injure young plants as tide rises
<p>Planting</p> <ul style="list-style-type: none"> Use species that match the intertidal zonation and soil characteristics Direct seeding is recommended as entails less labour costs and has high survival rate. On soft ground push seeds one third to one half of the total length of the hypocotyls. On hard grounds firstly dig hole and plant one quarter to one third total length of hypocotyls. Best spacing 1 m x 1 m (Gan, 1995). Wildlings should be directly planted on the same day they are collected. Hole dug to freely accommodate earth and roots, ideal spacing 2 m x 2 m. Proper timing is critical for success. Should coincide with season of available mature seeds, calm weather and long days of low tide during the day
<p>Protection</p> <ul style="list-style-type: none"> Beetles (Coleoptera: Scolytidae) bore into seedlings and can cause mortality. Air drying of seedlings for 7-14 days before planting protects seedling from infestation during critical first 3 months Scale insects (Homoptera:Diaspididae) attack leaves of <i>Rhizophora</i> causing premature leaf fall. Severe infestation can lead to complete defoliation and seedling mortality. Infected seedlings should be buried in the mud to prevent destructive population build up. Spraying of insecticides is not practical it will only contaminate area and affect other life forms. Barnacles (Crustacea: Cirripidae) can attach to seedlings in high numbers and adversely affect respiration and photosynthesis. Infestation can be minimised by planting fully hardened seedlings, planting the right species at the right site, planting in shallowly inundated sites during high tides, or areas that are fully exposed for at least 3-4 hours a day at low tide. Barnacles can be scraped off every two months if done carefully but tedious and impractical. Sesarmid crabs (Crustacea: Grapsidae) inflict damage on young seedlings by eating bark and young leaves. When crab damage and also attack by monkeys is severe, shielding with bamboo tubes can protect the seedlings, although this is expensive. Drying seedlings for two weeks prior to planting makes seedlings less prone to damage. Diseases. Cuts can serve as entry for microorganisms. To prevent infection coat with coal tar or paint. Weeds. <i>Acrostichum</i> fern forms dense, tall thickets under open canopy. Natural colonization is difficult and survival of seedling reduced. Fern can be manually uprooted.

Sources: PCARRD, 1991.

ANNEX 3: THE TEXT OF THE PRINCIPLES

Principle 1: Objectives of Mangrove Ecosystem Management

The fundamental objective of mangrove ecosystem management is to promote conservation, and where necessary restoration or rehabilitation and sustainable use of mangrove ecosystems and their associated habitats to benefit local to global populations.

Principle 2: Precautionary Approach to Management

The overall approach to mangrove management should be a precautionary one, but a lack of scientific information should not be used as an argument for postponing, or failing to conserve mangroves or to manage them sustainably.

Principle 3: Policy and Legal Frameworks

National and international policy and legal frameworks are required to provide overall guidance for the conservation and sustainable use of mangrove resources and to ensure protection for mangrove-associated biodiversity.

Principle 4: Implementation and Integration

There is a general weakness in the implementation of policy and legal frameworks for mangroves, lack of consultation between the management agencies and the various mangrove stakeholders, inadequate monitoring and evaluation of implementation performance and lack of integration of mangrove management with coastal zone and river basin area management.

Principle 5: Mangrove Assessment

Mangrove survey, mapping, inventory and monitoring data are required to support the sustainable management of mangrove ecosystems.

Principle 6: Socio-Economic Considerations

Mangroves provide important socio-economic benefits to indigenous peoples and local communities worldwide; it is essential therefore to manage mangrove ecosystems and their resources sustainably to maintain and improve their livelihoods.

Principle 7: Cultural and Community Issues

Mangrove ecosystems are associated with unique human traditions and knowledge, but they are also under severe pressure from some forms of exploitation, both traditional and non-traditional.

Principle 8: Capacity Development

Capacity development for mangrove ecosystem management, and awareness raising about mangroves in general are needed at all levels from decision makers in government, to district and municipal officials, community leaders and educational institutions (teachers, students and school children).

Principle 9: Forest Management and Silviculture

Mangrove forestry/silviculture objectives may have an economic, environmental or aesthetic basis, or a combination of these. Wherever, possible, multiple-

use management should be the ultimate goal of mangrove forest management.

Principle 10: Fisheries

Mangrove associated fisheries have worldwide importance in providing subsistence food and income, as well as commercial benefits, for a wide range of stakeholders, including indigenous peoples and local fisher communities. However, lack of enforcement of existing fishery regulations, including lack of protection of mangrove nursery sites and habitat degradation are among the major reasons for the widespread decline in mangrove fisheries.

Principle 11: Aquaculture

Mangrove associated aquaculture has worldwide importance in providing subsistence-level food and income, as well as commercial benefits, for a wide range of stakeholders. Unfortunately, some aquaculture development has also resulted in severe environmental degradation and socioeconomic problems, due in part, to poor management practices and/or lack of enforcement of environmental regulations. The importance of sound management in relation to mangrove aquaculture development in mangrove ecosystems cannot be overestimated.

Principle 12: Agriculture, Salt Production and Mining

The conversion of mangroves to other forms of land use, including agriculture and salt pans has been a major cause of wetland habitat loss in many countries. Mining has also caused significant localized damage to mangrove ecosystems, especially in Africa and parts of Asia.

Principle 13: Tourism, Recreation and Education

Tourism is one of the largest and fastest growing sectors of the global economy. Mangrove ecosystems can provide ecotourists with unique habitats and biodiversity opportunities, with many potential activities, including recreational fishing, bird watching, viewing wildlife and scenic boat trips.

Principle 14: Mangrove Products and Responsible Trade

Sustainably produced mangrove products should be promoted by "green labelling" and they should be marketed following the principles of fair-trading and benefit sharing.

Principle 15: Mangrove Research and Information Dissemination

Inadequate understanding of the functions and values of mangrove ecosystems is one of the main constraints to conserving and managing mangrove resources sustainably. However, there are already considerable skills, information and opportunities available worldwide to use research knowledge more effectively to improve mangrove management.

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ACRONYMS

ABCC	Associação Brasileira de Criadores de Camarão
CBD	Convention on Biological Diversity
CCD	Convention to Combat Desertification
cenTER	Centre for Tropical Ecosystems Research, Aarhus University, Denmark
CITES	Convention on the international Trade in Endangered Species (UN)
CMS	Convention on Migratory Species
Danida	Danish International Development Assistance
EIA	Environmental Impact Assessment
ESCAP	Economic and Social Commission for Asia and the Pacific (UN)
FAO	Food and Agriculture Organisation (UN)
GATT	Global Agreement on Tariffs and Trade
GDP	Gross Domestic Product
GEF	Global Environment Facility
GESAMP	Group of Experts on Environmental Aspects of Marine Environmental Protection
GIS	Geographical Information Systems
GLOMIS	Global Mangrove Database and Information System
GOGLME	Gulf of Guinea Large Marine Ecosystem project
ICZM	Integrated Coastal Zone Management
IPRs	Intellectual Property Rights
ISME	International Society for Mangrove Ecosystems
ITTO	International Tropical Timber Organisation
IUCN	World Conservation Union
KMFRI	Kenya Marine and Fisheries Research Institute
NePAD	New Partnership for Africa's Development
NGO	Non-Governmental Organisation
PCARRDs	Philippine Council for Agriculture, Forestry and Natural Resources Research and Development
UNCED	United Nations Conference on Environment and Development
UNCLOS	United Nations Convention on the Law of the Seas
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNESCO	United Nations Education, Scientific and Cultural Organisation
UNFCCC	United Nations Framework Convention on Climate Change
WB	World Bank
WHC	World Heritage Convention
WRI	World Resources Institute