TECHNICAL ASSESSMENT AND SUPPORT FOR MANGROVE AND LITTORAL FOREST MANAGEMENT, PLANNING AND TRAINING FOR SMALL ISLANDS IN THE SOUTH PACIFIC

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by

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FOREWORD

Mangroves occurring on the many islands in the South Pacific are only a small component when compared to the worldwide inventory of mangroves. Although the mangroves found on the smaller islands may not seem as important on the global scale, they are extremely important to the small individual countries. Some of their benefits include shoreline protection, biodiversity, fisheries and a source for traditional products like building material, fuelwood and various cultural uses. These benefits are even more important to small island countries with limited resources and contributed to the survival of the indigenous people in earlier times.

Realizing the importance of the mangrove resource the Forest & Trees Support Programme of SPC and the Heads of Forestry in the Pacific in cooperation with the USDA Forest Service conducted several missions during the last 10 years to assist the smaller island countries with preserving, protecting and managing their mangroves

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The USDA Forest Service's Institute of Pacific Islands Forestry based in Hawaii has been providing assistance to the Federated States of Micronesia and other islands with close ties to the United States for several years. Research conducted by this group has contributed greatly to the information base needed to manage mangroves throughout the South Pacific.

This report is not all-inclusive but it is hoped that it will contain sufficient information to assist small islands in developing a management strategy for their individual countries. The second part of this report is a summary of the materials covered in the Workshop. Due to the short notice given to some of the presenters at the Workshop some of the presentations were not available to be included in the proceedings.

Due to funding constraints only three countries were visited with one workshop conducted in Kiribati. Several countries were invited to the workshops that were not visited by the consultant during this mission.

PREFACE

This report summarizes the observations and recommendations of a mission to evaluate the status of mangrove forest management in the island countries of Tuvulu, Kiribati and Pohnepei of the Federated States of Micronesia. It also includes copies of handout materials and presentations made at a workshop on mangrove forest management held in Kiribati for these island countries in addition to Tonga and Palau. Unfortunately, several of the presenters at the Workshop did not provide copies of their presentations for the proceedings of this report. Part II which is the material covered in the Workshop includes the handouts and presentations given to the participants at the Workshop. Much valuable information can be found in the references and web sites provided at the end of the report.

ACKNOWLEDGMENTS

The author sincerely thanks the many people who supported and participated in this mission. Thanks are due to Mr. Sairusi Bula head of the Pacific Islands Forest & Trees Support Programme and to the Heads of Forestry and their representatives in the islands participating in the mission. Without their support this mission could not have been accomplished.

A special thanks is due to Mr. Menate, Head of Forestry in Kiribati for hosting the Workshop and providing the excellent facilities and services enjoyed by all the participants. I would also like to thank the participants of the Mangrove Workshop, many who traveled long distances to attend the workshop. Their participation in the discussions and activities contributed greatly to a successful workshop.

I would also like to thank the USDA Forest Service's Institute of Pacific Islands Forestry for providing the background information from research that contributed to previous and current missions.

TABLE OF CONTENTS

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1.0 INTRODUCTION

In the smaller atoll island countries of the Pacific, the mangrove resource exhibits a great economic and ecological influence when related to shoreline protection and stabilization, primary productivity and energy flow, nutrient buffering and release, sediment screens and filters, marine and fisheries habitat, salt spray deflection and storm energy dissipation,

In addition to the ecological benefits, Pacific Islanders have used mangroves for traditional subsistence needs for hundreds of years. Mangroves are used for fuel, building materials, seaweed cultivation, fish traps, stakes, dyes for preserving and colouring canoe sails and clothing, leaves and flowers for garlands, coconut oil scent and many others. Currently, commercial exploitation of the timber resources on these islands is minimal or non-existent.

After several decades of neglect and destruction around the world, mangrove forests are beginning to be recognized by international agencies and governments as a priceless resource that is worth protecting. With more than half of the world's mangrove forests already destroyed through development and overexploitation, the damage to the resource is expected to continue unless precautions are taken. Lugo (1990) states that there is a struggle between those who want to maximize economic benefits through intensive use of the resource and those who advocate complete preservation of the ecosystem. It is important that a proper balance be reached through careful management of the resource.

In the face of severe population pressures in these islands, mangroves and other littoral forests are being cleared to make way for residential and industrial development, and agricultural activities. Other threats to the mangrove ecosystem include oil spills, dumping of hazardous waste, excessive sedimentation from higher ground and rubbish dumping (SPREP Environment Newsletter, 2003).

Since the Pacific Islanders are not as dependent on the traditional uses of mangroves as they once were, many do not recognize the need of protecting the mangroves especially when the mangroves are perceived to impede development or they could derive some quick income from the mangroves. There is an urgent need to develop an appreciation in the South Pacific of the many benefits provided by mangroves; especially the ecological benefits.

Although these benefits and threats are well known in the scientific community there is still a lack of awareness by politicians, government officials and the general public. This is one of the primary reasons legislation and funding to conserve and protect the mangroves has been difficult to obtain. If more people were aware they would demand that the governments take action.

2.0 TERMS OF REFERENCE

A consultant on mangroves, able to undertake review of management plans, recommend policy and operational changes and train national staff in mangrove management will be engaged to undertake the following specific activities:

Part 1
The expert will be visiting Pohnpei (FSM), Kiribati and Tuvalu to undertake the following duties:

- Review and assess the progress of on-going mangrove and littoral forest management at both the national and community levels;

- Identify and suggest policy and operational strategies/options for improving the mangrove and littoral forest management plan and identify areas that need to be considered by the Head of Forestry and the Ministry;

- Identify national training needs that relate to the overall management protection and rehabilitation of mangrove and littoral forests, including mapping, monitoring, recording, forest health surveillance and other related but relevant activities. The training needs identified will be the basis for a 4-5 day regional training workshop to be conducted immediately after the completion of the consultant's review and assessment visit to the three countries.

Part 2

- A 4-5 day regional training workshop will be conducted in Tarawa, Kiribati by the consultant immediately after the review/assessment visits to Pohnpei, Tuvalu and Kiribati. The regional workshop will include participants from FSM, Tuvalu, Kiribati, Palau and Marshall Islands. The participants should principally be representatives of forestry agencies in these countries, but if more than one participant can be accommodated then these can be the representatives of relevant communities, NGOs and other government agencies. The SPC Forestry Advisor, in

consultation with the national Heads of Forestry, will determine the workshop participants.

- Based on the training needs assessment undertaken at the national level and in consultation with the Heads of Forestry during the visits, the expert shall develop a training programme for the regional workshop and forward this to the SPC Forestry Adviser for endorsement.

The training sessions shall include both classroom and field activities/demonstrations including but not limited to:

1. Biology of Mangroves
2. Multiple use of mangroves including eco-tourism
3. Preparation of management plans including mapping
4. Impact of global warming on mangroves
5. Use of GPS, GIS, Remote Sensing and other tools for managing the mangrove resource
6. Starting a mangrove nursery
7. Best approaches to minimize or integrate human activities within the mangrove and littoral forest areas;
8. Preventative and rehabilitation measures and options for damaged forests and forest clearing
9. Monitoring and recording including health surveillance
10. Develop strategies for post-workshop community education, awareness and participation programme to be conducted by the workshop participants when they return to their countries and information on developing training and awareness materials
11. How to secure resources to manage the mangrove resource

3.0 BACKGROUND ON MANGROVE MANAGEMENT RELATED TO THIS MISSION

Several earlier missions and projects to small island countries in the South Pacific have been sponsored by the Pacific Forests & Trees Support Programme and the USDA Forest Service and other organizations. These previous missions have all expressed concern regarding the continued existence of mangroves in small island countries such as Kiribati, Tuvalu and Palau and in the Federated States of Micronesia (Pohnpei and Kosrae). The results of the missions revealed that mangroves were being destroyed at an alarming rate on some of the islands. It was also noted that government agencies were not assuming the responsibility for the mangrove resources and that legislation and funding for management of the mangroves were minimal.

A consultant, Mr William Metz of the USDA Forest Service, developed comprehensive mangrove management plans for several small island countries between 1994 and 1996. Numerous problems prevented any of these plans from being implemented.

In 1997 a consultant was sent by the Pacific Forest & Trees Support Programme to Kiribati to assist in the implementation of the mangrove management plan prepared by the previous consultant. Several activities outlined in the plan were initated but were not continued after the departure of the consultant. Awareness materials were prepared, an article was written for the newspaper, discussions were held with agencies and organizations and a National Mangrove Management Committee was formed. During the first committee meeting much interest in the conservation of mangroves in Kiribati was shown by the participants. The most limiting factor to the management of mangroves cited by government officials was the lack of resources to carry out the plan. Also, at that time the government had not assigned an agency to provide leadership in implementing activities to conserve the mangroves.

The current mission is the first mission of the Pacific Forests & Trees Support Programme to Pohnpei for mangroves. Previous missions to Pohnpei and other states in FSM have been sponsored by the Institute of Pacific Islands Forestry, USDA Forest Service. In 1996 Mr. William Metz of the USDA Forest Service completed a comprehensive mangrove management plan for the island state of Pohnpei. Although this plan is an excellent guide for the management of mangroves, it was never approved by the state government of Pohnpei.

The Federated States of Micronesia and Palau have benefited greatly by the research activities conducted in the mangroves by the Pacific Institute of Forestry of the USDA Forest Service in Hawaii. This group, located in Hawaii, has provided valuable information necessary to conserve and manage the mangrove resources in the South Pacific.

Several issues and concerns have been previously identified in the South Pacific Region. Some of them include:

1. The level of public and government knowledge of the importance of the mangrove ecosystem and the consequences of poor management is generally not good.
2. There has been a general lack of formal legislation requiring protection and management of mangroves.
3. It is not always apparent which agency within the national government in each country has the responsibility and authority for managing the mangroves.
4. Coordination of all the government and NGO groups involved in mangrove management issues in the South Pacific is lacking.
5. There has been a general lack of awareness of local people of the benefits of mangroves. Pacific island countries should develop programmes targeted towards both school children and the general public.
6. In most island countries, there is an almost complete absence of reference materials on the conservation and management of mangroves.
7. In Kiribati, Pohnpei and Palau comprehensive management plans for the mangroves were developed but never implemented or approved by higher authorities.
8. There has been a lack of training opportunities for people working in mangroves. Study tours, traveling workshops, audiovisual training materials and conservation guides have not been readily available for the South Pacific island countries.

4.0 SUMMARY OF THE CURRENT MISSIONS

4.1 Mission to Pohnpei, Federated States of Micronesia

Background

Pohnpei is a high volcanic island and is the third largest of the four island states of FSM. It covers an area of 35,488 hectares and is about 23 kilometers across. Mangroves are found encircling the island and comprise about 5,525 hectares. The main island is rugged and mountainous with mangroves extending as far as two kilometers from the mainland. Although some tree cutting has occurred in almost every area, the mangrove forests of Pohnpei are relatively intact. The six species of mangroves occurring in Pohnpei include Rhizophora apiculata, Rhizpphora mucronata, Sonneratia alba, Lumnitzera littorea, Bruguiera gymnorhiza, Terminalia, catappa, Heritiera littoralis and Xylocarpus granatum.

Mangroves have been utilized for traditional uses for hundreds of years on Pohnpei for products like poles, boat building materials, fuelwood, etc. According to Metz (Mangrove Management Plan unpublished 1996) there has been an increase in the subsistence use and commercial use of the mangroves on the island in recent years. With continuing population pressures this trend could continue. To date the greatest loss of mangroves has resulted from conversion and unregulated timber harvesting. Previous reports have also documented siltation from on-shore soil erosion due to building of roads, earthmoving and agricultural activities and dumping of household garbage and solid waste (SOPAC, 1994).

In 1987 the state government passed the Watershed Protection and Mangrove Management Act giving the Office of Agriculture and Forestry the authority to manage mangrove areas. Thus far few activities have been implemented as a result of the legislation.

Observations

The visit to Pohnpei began with discussions with senior officials representing the state and national forestry agencies. The consultant was given a tour around the island with numerous stops to observe the condition of the mangroves and talk with many of the local people. Several areas were visited where mangroves had been converted to other uses like landfills and dredging. Destruction to mangroves was observed from the clearing and infilling to create new house sites along the road that encircles the island. Numerous sites where garbage had been dumped were observed.

A visit was made to the local craft market where woodcarvers were observed carving many beautiful items from wood harvested from the mangroves. The preferred wood is Xylocarpus granatum (Figure 1).

Figure 1. Carvings from wood obtained from the mangroves of Pohnpei

In the discussions held with both state and national officials concerning the status of mangroves and their management on the island their concern for the resource was obvious. In 1996 a Mangrove Management Plan was prepared with the assistance of the USDA Forest Service. The Plan was very comprehensive for the management of mangroves on Pohnpei. The Plan outlined in great detail the direction and guidelines for the management of the forest for the next five to ten year period. The Plan was supported by a considerable amount of research conducted by the Institute of Pacific Islands Forestry of the USDA Forest Service as well as forest inventory data also provided by the same agency. The only possible shortfall of the Plan was a need to provide more emphasis on community input and to involve the communities in the decision-making process.

The plan included the principles of the Pohnpei's Forest Management Act of 1979, the Watershed Forest Reserve and Mangrove Protection Act of 1987, and the Pohnpei Environmental Protection Act of 1992. The Plan addressed mangrove land use and classification including the proposed designation of eleven Mangrove Preserves. These proposed Preserves represented about 41% of the total mangrove resource.

The government never approved the plan. However, it has served as guidance for activities in the mangroves since it was prepared. The reason the plan was never approved was not clear. Normally when such a plan is not approved suggested changes are made and the document would be resubmitted for approval.

On July 10th the consultant met with Mr. Torres, local director of the US Peace Corps. Mr. Torres stated that "awareness" of the need to conserve the mangroves was needed to improve the status of the mangrove ecosystem in Pohnpei. This was confirmed in discussions with many private citizens concerning the mangroves. Many people were aware of the mangroves but did not adequately understand their many benefits they provided or that they were

threatened. None of the general public interviewed were aware of the ecological benefits of the mangroves.

The USDA Forest Service is developing an Environmental Education module on the Mangrove Forests of Micronesia. When completed and implemented in the local school system this excellent reference will contribute immensely to creating awareness in younger people. This module with some modification could also be useful on other small islands in the South Pacific.

A US Peace Corps volunteer in cooperation with the USDA Forest Service has been working with the Office of Agriculture and Forestry for a couple of years. Unfortunately the individual was preparing to return to the US since he had completed his tour of duty in Pohnpei. He had worked with the Office of Agriculture and Forestry on GIS, community participation and awareness materials.

Discussions with NGO's and various agencies in Pohnpei indicated two of their greatest concerns regarding the mangroves were the threat of conversion and the need to create awareness in the general population on the benefits provided by the mangroves. They were also frustrated because no government agency was taking leadership to conserve and manage the mangrove resource. The Conservation Society of Pohnpei is promoting awareness on conservation to the school children using a traveling vehicle and specially designed awareness materials which include mangroves (Figure 2)

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Figure 2. Vehicle used by Conservation Society of Pohnpei to promote Conservation

Currently there is no formal management of mangroves in Pohnpei. However, several activities are underway such as efforts to create more awareness and a program to encourage several villages to set aside part of their adjoining mangroves as a reserve. One municipality

has agreed to establish the Senpehn/Lehdau Mangrove Reserve to be part of the program. A management plan with budget has been prepared with the assistance of the Office of Agriculture and Forestry. This approach may be more effective for the long run since the participation of the local people is necessary for the conservation of the mangrove ecosystem. This Programme hopes to eventually include the entire original eleven reserves proposed in the Mangrove Management Plan. These areas were also recommended as reserves by Devoe (1991) to protect unique wetlands over the long term.

Only one person on a staff of ten is working on the conservation of mangroves. Currently the emphasis of the Office of Agriculture and Forestry is to strengthen the watershed management program. This should indirectly benefit the mangroves since there should be less erosion with resultant siltation of the mangrove ecosystem. The mangroves depend on sediments from upland areas but if deposition is excessive the results could be detrimental. Hopefully, the next focus of the Office of Agriculture and Forestry will be on conservation and management of the mangroves.

Recommendations

Based on observations the following recommendations are made for Pohnpei:

1. The Office of Agriculture and Forestry should provide the leadership for implementing conservation and management of mangroves in Pohnpei.

2. Every level of government should be made aware of the need to approve and implement a plan to manage the mangroves of Pohnpei.

3. The current proposed Mangrove Management Plan needs to be revised and strengthened with regard to community participation and awareness. By involving the communities and their traditional leaders there will be more cooperation with the people in the local communities as well as more support at other levels in the state government.

4. The management of mangroves in Pohnpei should be a programme that combines local communities and traditional institutions with municipal and state government agencies.

5. Requests for adopting a Mangrove Management Plan may be more successful if the request comes from the bottom and goes up to the politicians and policy makers.

6. Shorten the current Mangrove Management Plan and develop an implementation plan with an annual program of work outlining activities to accomplish for each area of mangroves.

7. The government should devise a way to give communities some type of incentive for participating in the management of mangroves.

8. All communities may not want to participate initially in the conservation program. Awareness activities should give credit or recognition to the communities for their participation and accomplishments to encourage additional communities to participate in the program.

9. The higher the level that the Mangrove Management Plan must be approved the less likely it is to be approved and the more time it will take to be approved. The higher up the decision must be made the more political the decision becomes. It would be beneficial if the state forester would approve some type of plan or develop a document that would show the commitment of the agency to conserve and manage the mangroves.

10. Provide training in all areas of mangrove management to local foresters and people responsible for mangrove management. (Each municipality will have five people trained to assist in the new conservation program).

11. With participation of other agencies and NGOs the Office of Agriculture and Forestry should develop and implement a community awareness and participation program for maintaining healthy mangroves.

12. As recommended in the proposed mangrove management plan a National Mangrove Management Committee should be established. The committee would be responsible for promoting and advancing national mangrove policy, legislation and regulation development. The Committee should be chaired by the Office of Agriculture and Forestry.

4.2 Mission to Tuvulu

Background

Tuvalu is one of the smallest and most remote island countries in the world. It is comprised of nine low-lying coralline islands with a maximum elevation of four meters. Mangroves are found to some extent on eight of the islands. The total area covered by mangroves is not known but it is more than 40 hectares. Species that occur include Rizophora stylosa, R mucronata, Bruguiera gynmorrhiza and Lumnitzera littorea and a shrub species Perphis acidula (Woodroffe, 1987 and Seluka, et.al.1998).

Mangroves have been utilized for traditional uses for possibly thousands of years. Currently they are used for dyes (handicrafts) and minor fuelwood and as a source of crabs and fish.

Observations

Although the current mission revealed no management activities by the government in the mangroves, they are considered a threatened species in Tuvalu (Dahl, 1986). A large part of the mangroves on Funifuti were converted to build an airport runway during World War II. The remaining mangroves on the island are essentially trash dumps and a place to drain the

waste from the piggeries (Figure 3). At the time of this survey representatives from the World Health Organization were evaluating the health risks of the contamination due to the piggeries.

Figure 3. Piggeries draining into mangrove pond in Tuvalu

Although it was not possible during this mission to visit any of the other islands with mangroves, there are a reported 28.5 ha. of Rhizophora on the island of Namumanga. On the island of Vaitupu there are about 6 ha of mangroves found along the fringe of two lagoons where some of the trees reach 6 meters in height. Mangroves are found scattered as individual trees or small groups of trees on many of the other islands.

Discussions with several NGOs and government agencies expressed a strong desire to protect the remaining mangroves and to restore some of the areas where the ecosystem has been damaged. Mangroves are quite valuable as a source of dye used in the handicrafts industry sponsored by NGOs. The Agriculture Department (Head of Forestry) is very interested in conserving and managing the mangroves in Tuvalu. They would like to begin by developing awareness materials make the communities of the situation and what can be done to improve the status of mangroves.

Recommendations

Based on observations of the current mission the following recommendations should be implemented conserve the mangroves

1. Develop a plan with the communities and NGOs to conserve and manage the mangroves of Tuvalu. (a draft plan was prepared by the two participants at the workshop in Kiribati)

2. Develop awareness materials for the schools and general public on mangroves

3. Require an environmental analysis before any additional development can impact the mangroves

4. Clean up and relocate the piggeries that are polluting the mangroves

5. The government should work with the local NGOs to conserve the remaining mangroves

6. The government should also work with the local NGOs to restore some of the areas near the airport back to mangrove forests

7. A National Mangrove Committee should be established to assist in the decision-making process regarding the conservation of the mangroves of Tuvalu.

8. The Head of Forestry should designate a person to be in charge of coordinating and planning activities for conservation of the mangroves

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4.3 Mission to Kiribati

Background

The Republic or Kiribati consists of 33 islands in three main groups-the Gilbert Islands, the Phoenix Islands and the Ellice Islands. All of these are atoll islands with some of the most infertile soil in the world. Information on mangroves is only available from the Gilbert Islands. On the islands of Tarawa, Aranuka, Butaritari and Maiana there are a total of 258 hectares of mangrove forests. There are four species which include Rhizophora stylosa, Bruguiera gymnorhiza, Sonneratia alba and Lumnitzera littorea. Butaritari has the most with 166 hectares including all four species. On the other islands R. stylosa is the only species represented. No data are available at this time for the mangrove resources on the atoll islands of Little Makin, Abemama, Nonouti, Beru and Onotoa.

Traditionally the people of Kiribati have used the mangroves for subsistence purposes for thousands of years. The mangroves supply both wood and non-wood products as well as fuelwood, timber for construction and general structural needs, garden and fish trap stakes, dyes for preserving and coloring canoe sails and clothing and leaves for flowers for garlands and leis. The mangroves also provide habitat for a variety of marine, fish and wildlife. In addition they also protect the shoreline against erosion and reduce the salt spray on land vegetation.

Due to the limited amount of mangroves and the need to conserve it is doubtful that utilization will expand beyond traditional uses. Limited commercial harvesting is possible.

Observations

Although a draft mangrove management plan and an implementation plan were prepared for Kiribati several years ago there is currently no plan in effect. Reasons given are a lack of funds and no clear mandate from the government on which agency should prepare and

implement such a plan. However, recent consolidation of the Fisheries Department and the Environmental Unit and Agriculture into the Ministry of Environment will allow a much closer relationship among the units. Currently the Environment has assumed the leadership role to implement management of the mangroves in Kiribati. The Division of Agriculture has approximately 31 foresters (mostly agricultural officers) scattered throughout the islands that could assist in the implementation of a mangrove management strategy.

Currently there is no management of mangroves occurring in Kiribati. The original mangrove management plan was prepared in 1995 by a USDA Forest Service consultant funded by the Pacific Forests & Trees Support Programme (SPC). This Plan was never approved or updated. During this consultancy a copy of the original proposed Mangrove Management Plan could not be located in Kiribati. There were very little reference materials on mangroves in the Division of Agriculture library.

The Ministry of Environment has directed the Environmental Department to prepare a mangrove management plan in cooperation with the Agriculture Department and other relevant agencies.

Recommendations

1. Revive the Mangrove Management Committee and seek input from the communities and other agencies and organizations on developing a management strategy for the mangroves of Kiribati.
2. Develop a mangrove management plan using where appropriate the information already available in the earlier Kiribati Mangrove Management Plan.
3. Begin developing awareness materials to inform the communities, schools and other agencies on the plans for conserving the mangroves.
4. Prepare proposals for potential donors to assist in the conservation and management of the mangroves of Kiribati.
5. Conduct surveys and evaluations of other islands to get more information regarding the occurrence and condition of mangroves.
6. There is a great need for training in mangrove management for personnel in the Ministry of Environment. It is recommended that some personnel be sent on study tours to some of the larger countries with active mangrove management programs.

5.0 DISCUSSION AND CONCLUSIONS OF MISSION

The status of mangrove management on small islands in the South Pacific is not very good at this time. Many countries have experienced a 50% reduction in their mangrove ecosystems during the last 50 years. Much of the damage is irreversible and unless action is taken soon even more damage will occur. This is in part due to the lack of appreciation of the benefits of the mangrove ecosystem and the lack of commitment by government officials to pursue a management strategy. Specific recommendations for the individual countries visited on this

mission have been presented. Additional suggestions that apply to these countries and other island countries in the Pacific are included in this discussion.

5.1 What strategy is needed to conserve and manage mangroves on small islands in the South Pacific?

There are many considerations that go into developing a strategy for conserving and managing mangroves on small islands in the South Pacific. Many of the suggestions that follow have been presented in various publications, reports and personal communications. Some of the most notable sources of information for developing a mangrove management strategy include Lal (1991), FAO (1985), Melana et al. (2000), FAO (1994), Hamilton and Snedaker (1984), USAID (1999) SPREP (1999) Ward et al (1998), Macintosh and Ashton (2003).

Activities or components suggested for the development of a mangrove management strategy for small islands in the South Pacific include the following suggestions:

- The government should develop a legal framework (legislation) to state the country's intent to conserve and manage the mangrove ecosystem resources and the basic strategy of the enabling legislation.

- The government should designate a responsible agency (ies) of the government to develop and implement the legislation requiring the conservation and management of mangroves.

- The government should provide funds (at some level) to develop and implement a strategy for conserving and managing the mangrove resources.

- The implementing agency should establish a Mangrove Action Committee including representatives from all sectors involved and especially leaders from the communities as well as experts on mangroves.

- Collect baseline information on the inventory, uses, location of environmentally sensitive areas and threats to the mangrove ecosystem.

- Evaluate cultural and community issues associated with the mangrove ecosystem.

- Evaluate the socio-economic as well as the ecological benefits of the mangrove ecosystem to the communities and the island country as a whole.

- Develop a comprehensive awareness and training program to inform people at all levels of society on the importance of mangroves with an emphasis towards encouraging active participation to conserve and manage the mangroves.

- Use an integrated approach with other sectors including agriculture, fisheries, environment, transportation and coastal development programs.

- Evaluate the role and attitudes concerning mangroves as perceived by national regional and international planning initiatives.

- Establish land use classifications (such as Mangrove Preserves, Mangrove Parks, Mangrove Community Forests and Mangrove Conservation Areas) to mangroves in the country.

- Develop a mangrove management plan for the country including site-specific plans with participation of the national mangrove management committee and the local communities. Make sure the local communities are involved in the decision-making process.

- The designated agency should take the leadership in mobilizing resources both inside and outside the country to implement the management strategy.

- Encourage research to gain additional information for making decisions regarding the mangrove ecosystem.

- One of the most important factors is to have dedicated and committed people and organizations to implement the management strategy. Without committed people, agencies and organizations prepared management plans will sit around for another five to ten years while the mangrove resource is further depleted.

5.2 Developing mangrove management plans

Developing plans to manage mangroves is a start in the right direction. However just having a management plan does not guarantee implementation of the plan as we can see in the countries involved in this evaluation.

Every management plan is unique. Some plans are short and simple. Others are long and comprehensive outlining every detail and activity for management. Management plans are made to be frequently revised. As additional knowledge is gained thru monitoring and research the plan must be changed to reflect the new information. There is no set rule for making a plan for managing mangroves. However, there are some general guidelines for developing a mangrove management plan. The following topics should be addressed in the plan:

- INTRODUCTION-State laws policies, background, uses of mangroves, threats, description of the resource, justification or need for a plan. State how the plan will affect fisheries, wildlife mangrove vegetation, communities, shorelines, recreation, tourism, historical and cultural areas, biodiversity, products from the mangroves and sustainability.

- MANGROVE WETLANDS MANAGEMENT DIRECTION-This component expresses national wetland strategies that can be stated in a mission statement, goals and objectives, standards and guidelines and the desired future condition of the

mangrove ecosystem as it relates to vegetation, fisheries, tourism, global warming, flora, fauna and other resources or considerations.

- MANGROVE WETLAND USE CLASSIFICATION SYSTEM- A wetland use classification system (Devoe 1991)(Lal 1991) has been generally adopted in many parts of the Pacific The purpose for having this classification it that it helps to develop a management strategy for each classification category. System. The classes are I - Mangrove Preserve, II - Mangrove Park, III - Mangrove Community Forest and IV - Mangrove Conservation Area. These classes are discussed in detail in the references provided and in the individual management plans for Kiribati, Pohnpei, Kosrae and Palau. Another version of these classes has been described as I – Sanctuary, II – Recreation, III – Traditional, IV – Commercial and an added class V – Conversion. Considering the status of mangroves in the Pacific conversion is not widely acceptable but with appropriate environmental assessments it must be considered as an alternative in certain situations.

- IMPLEMENTATION OF THE MANGROVE MANAGEMENT PLAN-This section describes the activities and expected outcomes of the various activities such as developing community awareness and participation, monitoring, training, forming a mangrove committee, cooperation with other organizations, reforestation, nursery establishment etc. It should state who or what agency is responsible for each activity planned.

- BUDGET FOR FULL OR ALTERNATIVE FUNDING LEVELS-It is difficult to implement a mangrove management plan without a source of funding. The implementing agency should explain what activities could be accomplished with at least three levels of funding such as low, medium and fully funded.

A more detailed example of an outline for a mangrove management plan is presented in Workshop Proceedings in Part II of this report. This outline was used in an exercise in the Workshop for each country to develop a draft Mangrove Management Plan.

5.3 The Importance of Community Involvement

Many programs to conserve and manage the mangroves have failed around the world because they did not call for an active and continuous participation from the local communities adjacent to the mangroves. These communities often resent the government dictating what can and can't be done in a forest they have utilized for hundreds of years. All of the science and technology in the world is of no use if the communities and especially the leaders are not convinced that there is a need to conserve and manage the mangroves. Some of the best examples of programs to conserve mangroves around the world are ones that promote active community involvement.

5.4 Coastal Resource Management

The mangrove ecosystem is linked to both the aquatic and terrestrial ecosystems that are often managed by other organizations and institutions. The mangrove ecosystem does not

stand alone but is closely linked to these other ecosystems. What occurs in one ecosystem can greatly affect the other ecosystems.

Traditionally the management of mangrove forests has resulted from a sectorial approach that usually results in the responsibility given to the Forest Department or Ministry of Environment in a given country. This would be suitable if the Forestry Departments also included departments and agencies from other sectors in the planning and decision-making for the resource. However, in many instances other government agencies are usually not included as full partners if they are consulted at all.

The situation was described by Tomlinson "A forestry department will emphasize utilization that may degrade the resource, a fisheries department will emphasize conservation with a minimum of disturbance and an agricultural department may advocate conversion and replacement by some putatively more valuable resource" (Tomlinson, 1986). This is not to say that a forestry department could not provide the leadership to manage mangrove forests. It must be clearly understood that a multi-sectorial approach is necessary because of the overlapping complexity of the terrestrial and aquatic ecosystems.

Lal (1991) stated, "the management of land, forestry and fisheries resources should be carried out in an integrated and coordinated manner." The need for integrated coastal zone management was rated high by all of the countries included in this mission during a conference held in Apia, Western Samoa (SOPAC, 1994). There was little evidence of this new process taking place during the current mission.

SOPAC (1994) describes "Integrated Coastal Zone Management as a comprehensive, multi-sectoral, integrated approach to the planning and management of coastal areas. It encompasses a process of assessment, planning and management for the sustainable development, multiple use and conservation of coastal areas, resources and ecosystems."

In a document prepared by FAO interactions, both positive and negative are presented regarding the integration of forestry into coastal area management (Workshop Handouts in Part II of this report).

5.5 Potential Sources Of Cooperation To Conserve Mangrove Ecosystems In the South Pacific.

There are numerous agencies and organizations concerned about mangroves in the South Pacific and it would be advantageous if these organizations worked together to conserve and manage the mangroves. At a minimum there should be a clearinghouse that would keep up with the interests and activities of the various organizations. This would eliminate duplication of efforts and keep the other organizations and countries informed. There are also global organizations that would appreciate an information clearinghouse. This could be accomplished by use of a website designated for mangroves. Establishing linkages would be even better that a clearinghouse. Some of the organizations interested in mangroves in the Pacific include:

a.	SPREP	South Pacific Regional Environment Programme
b.	USAID	United States Agency for International Development
c.	SPC	Secretarit of the Pacific Community
d.	USDA	Forest Service, Institute of Pacific Islands Forestry
e.	AusAid	Australian Aid
f.	SOPAC	South Pacific Geoscience Commission
g.	UNDP	United Nations Development Programme
h.	World Bank	
i.	UNESCO	United Nations Educational, Scientific and Cultural Org.
j.	SPRIG	South Pacific Regional Initiative on Forest Genetics Resources
k.	ITTO	International Tropical Timber Organization
l.	ISME	International Society for Mangrove Ecosystems
m.	MAP	Mangrove Action Project
n.	RAMSAR	Convention on Wetlands
o.	GLOMIS	Global Mangrove Database Information System
p.	CSIRO	Commonwealth Scientific Industrial & Research Organization

Many of these organizations work together not only with each other but with NGOs and national governments. Several of them sponsor training programmes, workshops and in many cases they support research efforts and projects to conserve and manage mangrove ecosystems. They also produce many types of training and awareness materials such as brochures, posters and training and information modules. More information on their programmes and activities can be acquired from their individual web sites.

Recently SPREP has established a Mangrove Task Force with the purpose of assessing and reporting on the status of mangroves in the Pacific (SPREP Newsletter, 2003). The Task Force is comprised of mangrove experts throughout the Region. Several workshops will be held with special reference to developing awareness and developing management plans based on local needs and concerns. It would be beneficial if they would include the organizations listed above as well as representatives from the various small island governments. To conserve and maintain the mangrove resource in the Pacific will require more than discussions among experts. As mentioned earlier conserving mangroves should include many sectors and especially input from the communities.

6.0 WORKSHOP SUMMARY

After visiting Pohnpei, State of the Federated States of Micronesia, Tuvalu and Kiribati to observe the condition of the mangroves and the status of their management the consultant led a workshop in Kiribati from 25-30 July, 2003. Discussions with government officials, NGOs and international organizations assisted in determining the emphasis for the workshop. It was decided that preparation of management plans and developing awareness would be the focal points of the workshop.

The objective of the Workshop was to discuss mangrove management to aid participants from each country to develop a strategy that could be successfully implemented in their

respective countries in the South Pacific. Participating countries in the workshop included Tonga, Tuvalu, Kiribati and Palau.

During the first part of the workshop participants presented the status of mangroves in their respective countries. They outlined the past and present use of mangroves as well as current threats. Workshop participants emphasized that the greatest threat in their respective countries was the conversion of mangrove forests to other uses. As an example, 70% of the mangroves on Tarawa, Kiribati, have been converted to other uses since the 1940s. Tuvalu has less than 40 hectares remaining after converting their mangrove forests primarily to build an airport. With increasing populations and a greater demand on natural resources, overexploitation is also considered a potential threat for the future.

Representatives from local, national and international agencies gave presentations on the biology and ecology of mangroves, the status of mangroves on small islands in the South Pacific, threats to the mangroves, biodiversity of mangrove ecosystems, the role of mangroves in fisheries, creating awareness and community participation.

The second part of the workshop involved discussions of the more practical aspects of managing mangroves such as conducting an inventory, developing awareness and community participation, preparing mangrove management plans, conducting environmental impact analyses, restoring of mangrove forests and other topics. All of the participants agreed that gathering input and participation from the local communities was essential in conserving and managing the mangrove resources. The group indicated that it should be the national government's role to prepare management plans and to implement conservation and management of mangrove ecosystems.

On the final day of the workshop participants had the opportunity to outline a new or revised mangrove management plan for their respective countries. They also spent time fudging a drawing contest for a local elementary school, as part of an awareness exercise for local school children. Fifty students drew pictures depicting the mangroves and the biodiversity supported by these valuable forests. The prize-winning drawing is shown in Appendix ---.

Although much information was available in the presentations and handouts the most valuable information came from informal discussions during the workshop.

Two of the four countries had prepared mangrove management plans during the mid to late 1990s with the assistance of the USDA Forest Service. These plans were never implemented for various reasons including lack of money and no designated agency for implementation. The workshop participants agreed that it is important that national plans be prepared or revised with community input to get the mangroves under some type of management.

There were many good comments raised by the participants in the discussion groups. It was agreed by all that legislation, developing a national management plan and making people and organizations aware of the status of mangroves were good first steps in the conservation and management of mangroves. However, even more important than these the success in conserving the mangroves can only be achieved when it is accepted and adopted by the

individuals living and working in the local communities. This will require responsible agencies to work closely and honestly with the traditional leaders and local people.

Evaluation sheets completed by the participants indicated that the workshop had met its objective and that another follow-up workshop should be held in the future.

7.0 RECOMMENDATIONS TO HEADS OF FORESTRY AND THE SPC FOREST & TREES SUPPORT PROGRAMME FOR MANGROVE FOREST MANAGEMENT IN THE SOUTH PACIFIC

During this mission it became evident that there were issues that had hampered the implementation of recommendations made during the previous missions. Some of the problems had resulted from changes in personnel, changes in organizational structure, lack of human and monetary resources and a lack of communication and lack of interest. Observations with suggestions on some of these issues are as follows:

1. There was a serious lack of available information regarding mangroves and their management in the countries evaluated. It is recommended that a package of information including scientific publications and books be purchased and distributed to small island states concerned with the management of mangroves in the South Pacific.

2. Conserving and managing mangroves on small islands is very much different than managing extensive mangrove forests found in Indonesia, Africa Central America or Australia. The mangroves occurring on small islands are no less important than the larges expanses found in these places. It would be useful if an updated Handbook of guidelines for managing mangroves on small islands in the South Pacific could be developed

3. The Programme should continue to train the staff of member countries in the technical aspects of mangrove management. Use of materials presented during the current workshop as well as information from previous missions could be beneficial in planning a training program but it is only a start. There are many separate training programs and workshops on mangroves held annually in the Pacific Region by several of the organizations listed earlier. Some efforts should be made to list these events in the Programme Newsletter for possible attendance of representatives from member island countries with mangroves. If possible SPC should sponsor study tours for individuals working in mangroves to obtain on the job training in mangrove management.

4. The Programme should encourage activities to create public awareness on the importance of mangrove management in all small island countries. Making governments aware of the importance of mangroves and the role that government should play may be necessary in some island countries. The island of Palau has an excellent example of a public awareness and education program that could be used as a model or prototype.

5. The responsibility for conservation and management of mangroves usually involves at least four government agencies in each island country. It is important that a mangrove management committee be selected with members from all the agencies, organizations and communities participating. The committee should provide input in shaping policies and getting laws passed to protect the mangroves.

6. It is obvious from this mission and from publications and reports on Pacific mangroves that an integrated approach based considering both terrestrial and aquatic ecosystems needs to be taken to manage the mangrove resource on small islands in the South Pacific.

7. Implementing conservation and management of mangroves on small islands in the South Pacific should involve coordination and collaboration among the many national and international organizations involved with mangroves. SPC should make some effort to bring together the international organizations while the national governments should try to organize communication and coordination within their own countries.

8. There is much work to be done that requires some level of funding to island countries that want to develop and implement a strategy to conserve and manage the mangroves. Unless SPC has the resources to fund these activities it is recommended that SPC assist the island countries to obtain funding from their individual governments and from international donors.

9. There should be some way to measure the accomplishments of work sponsored by SPC. When SPC sends a consultant to a member country usually recommendations are made. Often there is a lack of resources to carry out all of the recommendations. Many times there are recommendations that have little or no cost associated with them such as organizing a Mangrove Action Committee, writing an article for the newspaper, develop information sheets or write a proposal to a potential donor. It is unfortunate that many tens of thousands of dollars are spent to improve conservation activities and there are no follow-up results shown by the receiving country. Member countries should submit accomplishment report to show progress or lack of progress in areas when SPC has provided assistance.

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APPENDIX A
ITINERARY FOR MANGROVE MISSION FOR SMALL ISLAND COUNTRIES IN THE SOUTH PACIFIC
(2003)

July 03	Depart from Fiji
July 04	Arrive in Pohnpei
July 11	Depart from Pohnpei
July 14	Arrive in Tuvalu
July 21	Depart from Tuvalu
July 22	Arrive in Kiribati
July 25-30	Workshop in Kiribati
July 31	Depart from Kiribati
July 31	Arrive in Fiji
Aug. 02	Depart from Fiji
Aug. 02	Arrive in US

APPENDIX B

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PART II

MANGROVE WORKSHOP

NORTH TARAWA, KIRIBATI

JULY 25-30, 2003

FACILITATOR
James D. Ward
USDA Forest Service

Introduction

This section of the report contains information presented during the Mangrove Workshop held on North Tarawa, Kiribati. It includes the workshop agenda, introduction, country reports, presentations and handouts given to the participants. Several of the presentation are lacking due to the unavailability of materials submitted for the proceedings. Most of the invited speakers had only two days to prepare for the workshop. The country reports are provided without editing. The materials used in this workshop drew heavily on previous reports, research publications, personal communications and internet sites. Where possible, credit is given, but in some cases the source of the information is unknown.

Unfortunately the material in this section cannot relay the most important aspect of the workshop which was the many excellent discussions by the participants. It was a great learning experience for the facilitator which hopefully can improve future workshops and activities for the participants and the facilitator.

I have never attended a resource management workshop where the participants were so dedicated to learning and sharing information. It is hoped that future workshops on conserving and managing the mangroves will be sponsored by SPC.

Thank You

James Denny Ward

LIST OF MATERIALS PRESENTED IN THE MANGROVE WORKSHOP, NORTH TARAWA, KIRIBATI

1. Workshop Agenda
2. Welcoming Address
3. Background, Objectives, and Overview of the Workshop
4. Introduction To Mangroves
5. Kiribati Country Report on Mangroves
6. Tuvalu Country Report on Mangroves
7. Tonga Country Report on Mangroves
8. Palau Country Report on Mangroves
9. Management of Mangrove Ecosystems
10. Manual for Mangrove Forest Inventory, Kosrae State, FSM
11. Resource Inventory and mapping
12. Community Participation and Awareness
13. Role of Mangroves in Fisheries
14. Guidelines for Preparing a Mangrove Management Plan
15. Outline of a Management Plan Used as an Exercise for Participants
16. Environmental Impact Assessment
17. Role of Mangroves in the ecosystem (from the internet)
18. Threats To Mangrove Ecosystems (from the internet)
19. The Mangrove Forest: by Alfredo Quarto, MAP (from the internet)
20. Mangroves: Small Island Environmental Management (from the internet)
21. Integration of Forestry Into Coastal Area Management (FAO internet)
22. First Place Drawing by Kiribati School Children judged by Participants
23. Mangrove Forests of Palau (Information Sheet)
24. How do you know Your Mangrove Forest is Healthy?
25. Best Estimates of Mangrove Extent For the Oceania Region
26. Selected Mangrove web sites
27. ITTO web site
28. Mangrove Action Project web site
29. FAO Mangrove Forest Management (from the internet)
30. List of Participants attending the Mangrove Workshop
31. Evaluation Sheet
32. Mangrove Fact Sheets provided by FSP

CONSERVATION AND MANAGEMENT OF MANGROVES ON SMALL ISLANDS IN THE SOUTH PACIFIC

BACKGROUND

In the small island countries of the South Pacific mangroves are a priceless resource. Not only have they yielded valuable products for hundreds or thousands of years to the islands indigenous people, they have protected shorelines and performed other ecological services such as serving as breeding grounds for life-sustaining fisheries.

Until recent history the mangrove forests have been used by the local communities in a sustainable way without any planned management. Now with increasing populations and demands for land for development the mangroves are beginning to disappear in some countries. World-wide about %50 of the mangrove resource has been destroyed primarily due to over-harvesting and conversion of mangrove forests to shrimp farms and other uses.

To curtail this destruction of this valuable resource environmental laws have been passed in some countries and management plans have been developed.

Although many of these plans were developed in the mid 90s they are yet to be approved by the governments or accepted by the communities for implementation.

I believe that to protect and conserve the mangrove forests four conditions must be achieved:

1. There must be a mandate/laws/policy/national directive that requires the conservation of mangroves/a government agency (agencies) should be designated to implement the programme and held accountable for the task.
2. There must be a national or state plan developed to conserve and manage the mangrove resource
3. There must be input, acceptance and participation in implementing the plan by the communities living near the mangroves.
4. There must be coordination, cooperation and collaboration among government agencies, NGOs, communities and regional /or international organizations.

OBJECTIVE OF THIS WORKSHOP- The objective of this workshop is to work together to develop a mangrove management strategy that should be acceptable to the people and to the governments of small island countries in the South Pacific. The strategy (plan) must simple but comprehensive and be a plan that can be successfully implemented by the governments and their collaborators.

What we have now are plans that are not implemented. We want to find out why they were never implemented and see what changes or approach is needed to encourage implementation of mangrove management plans in the future.

This workshop is sponsored by SPC's Pacific Islands Forests and Trees Support Programme located in Suva, Fiji.

During the 9th Session of the Pacific Islands Heads of Forestry held in Nadi, Fiji in May of 2000 the participating countries made the decision to conduct the current workshop.

OVERVIEW OF WORKSHOP

This workshop will include presentations on various subjects pertaining to mangroves by local area experts representing government agencies and NGOs and participants from other island countries. The workshop will also include presentations on the status of mangrove management by representatives of the participating countries.

Some countries are more advanced and we hope to learn from them and benefit from their experience.

Discussions will be held with all participants including other agencies and NGOs regarding the conservation and management of mangroves.

Exercises will be conducted to develop an outline of a management plan for each country. In addition each country will be requested to prepare an information brochure for their respective countries that may be suitable for creating awareness.

A field trip to the mapping unit of the Lands Division (GIS demonstration) and to various mangrove sites on the island will be made during the workshop.

25-30 July 2003 Tarawa, Kiribati

FRIDAY

1:00	**Registration**	
	Opening Prayer	
	Welcoming Address	**Hon. Martin Tofinga Minister for Environment Lands and Agriculture**
	Introductions	**Tokintekai Bakineti, Training Officer, Ministry of Environment , Lands and Agriculture**
	Background	**James D. Ward(USDA Forest Service) for SPC Forest and Trees Support Programme**
	Objectives	
	Overview of workshop	
2:30	**Afternoon Tea**	
3:00	**Biodiversity in the Mangroves**	**Mrs Nenentecti Rautu, Biodiversity and Conservation Officer, Ministry of Environment, Lands & Agr.**
3:30	**North Tarawa Conservation Project**	**Mr. Bwere Eritaia, NBSAP Proj. Coord. Ministry of Environment, Lands & Agr.**
4:00	**Adjourn**	

SATURDAY

9:00 AM	**Country Reports**
	Kiribati
	Tuvalu
9:30	**Morning Tea**
10:00	**Tonga**
	Palau
10:30	**Introduction to mangroves in the South Pacific**
11:00	**How to Evaluate a Mangrove Management Program**
11:30	**Basics in Managing Mangroves**
12:30	**Lunch**
1:30	**Conducting an Inventory in the mangroves (Palau)**
2:00	**Tour of the island**

MONDAY

8:30	**Community Participation(Aude Chenet, FSP)**
9:00	**Creating Awareness (FSP) (awareness exercise assigned)**
9:30	**Morning Tea**
10;00	**FSP Mangrove Project**
10:30	**Role of Mangroves in Fisheries**
11:00	**Video on Mangroves**
12:00	**Lunch**
1:00	**Visit to GIS Mapping for Coastal Resources**
	Field Visit to Mangroves

TUESDAY

0830AM	**Developing a Mangrove Management Plan**
0930	**Morning Tea**
10:00	**Begin Exercise to Dev. Mgt. Plan for each Country (outline form)**
12:00	**Lunch**
1:00	**Discussion of plans prepared for exercise**
2:00	**Participants show results of awareness exercise**
2:30	**Participants judge student drawing contest**
3:00	**Misc. Topics**
	Restoration and Nurseries **Ecotourism** **Environmental Assessments** **Resources for mangrove information** **Resources for information on mangroves**

KIRIBATI REPORT ON STATUS OF MANGROVE

COUNTRY REPORT

Mangrove is an indigenous forest grown along the shorelines of the islands and very unique in that they live in a salt-water environment. Traditional uses for the mangrove in Kiribati include fuel wood, post, poles and structural materials for boats, houses, fences, walls and furniture. It has also been used for seaweed cultivation, fish traps, dyes for preserving coloring, canoe sails, and clothing. Leaves and flowers are used for garlands, leis and as well as for medicinal purposes.

There four identified species of mangrove trees in Kiribati and they are known as *Rhizophora stylosa* (te tongo), *Sonneratia alba* (te nikabubuti), *Bruguiera gymnorhiza* (te buangi), and *Lumnitzera littorea* (te aitoa). Two of the varieties **te nilabubuti** and **te aitoa** are found on Butaritari and Makin, the two islands in the Northern part of Kiribati.

Many I-Kiribati are unaware that mangrove forests have other important roles such as shoreline protection from erosion, and breeding and feeding places for many fish, crabs and prawns. The services the mangrove forest provided to the livelihood of the island growing population has been affected quite dramatically at the fast rate and therefore it needs urgent action to sustain the mangrove forest.

The Government realizes the importance of this resource thus, strengthening the environmental laws so that this delicate ecosystem can be protected and used sustainability. The implementation of the Kiribati Mangrove Management Plan (KMMP) was seen as a starting inisitive on the part of the government. However, the lack of funding and technical people has been the major course of the downfall of the plan.

The assistance from outside donors is greatly appreciated to help the country in promoting the protection of this delicate resource.

MANGROVES OF TUVALU

COUNTRY REPORT

Introduction

Tuvalu is comprised of nine coral atolls and is located in the South Pacific. The maximum elevation is about 4 meters above sea level. One of the major concerns is the possibility of rising sea levels from global warming and increasing coastal erosions from the impact of tidal movement, as well as the incursion of saline or brackish waters in to pulaka (babai) pits from adjacent ground holes and flooding during spring tides.

Pulaka or babai pits are basically dug out pits from many generations ago where our staple food pulaka commonly known as the giant swamp taro (Cyrtosperma chamissonis) are cultivated in up to this day. The majority of the outer islands mainly Vaitupu, Niutao, Nanumaga and Nukulaelae islands have raised concerns over this incursion of saline waters in their pulaka pits and the government though has agreed in principle to look into possible measures to investigate this problem has done very little to this day because of funding problems and the lack of local experts to undergo a feasibility study of the problem.

Description of the Resource

The vegetation of Tuvalu includes over 200 plant species including indigenous and introduced species. There are five species of mangroves (togo) including Rhizophora mucronata, R stylosa, Bruguiera gymnorrhiza and Lumnitzera littorea. The exact area they cover is not known but on record is 40 plus hectares. These are located on the island of Niutao. Nanumaga is the other island known to have a rich resource of mangroves perhaps even larger than that of Niutao island.

The rest of the islands also have mangroves but to a lesser extent compared to Niutao and Nanumaga islands. Nukulaelae is exceptional and does not have any togo species where the women from this particular island have shown their interest to have them established if possible at appropriate locations around the island because of the mangrove uses particularly in handicraft making.

They are commonly found inside the lagoons scattered around the shorelines. They are also found in salt-water pools where the water level rises and falls with the tide.

Uses of the Mangroves

The traditional use of the mangroves has declined over the years but they are still used for making dye for handicrafts, minor amounts of fuel wood and as a place to catch crabs and

fish. The country also benefits from the ecological services of the mangroves, which include shoreline protection from the waves and as habitats for birds and fish.

Threats to the Mangroves

Mangroves are considered a threatened species in Tuvalu. Major threats are land conversion, pollution from piggeries, which are obvious on the capital island of Funafuti atoll. Natural threats include storms, flooding during very high tides and sea level rise from global warming.

Current/Future Program for Mangroves

There is currently no management or plans for mangroves in Tuvalu. The government recognizes that this is a threatened species in the country and would like to take measures to insure the continued existence of mangroves. There are several agencies and NGO's that share this view. We would like to see a program that includes preserved areas (parks), sustainable use areas and restoration of previously damaged mangroves.

We believe this can best be accomplished by developing a plan that includes strong awareness and community participation components.

Current Staff and Resource Needs

At this time the Forestry staff does not have the resources or manpower to assist in this effort. We would like to apply for minimum funding to assist our department and our cooperators to insure the continued existence of the mangroves in Tuvalu.

MANGROVES IN TONGA

- Largest mangrove areas occur in Tongatapu

- Eight mangrove species are found in Tonga:

    1. Tongo (kalasi ‘e 2)
    2. Tongota’ane (used for tapa dye)
    3. Feta’anu
    4. Hangale
    5. Mamea
    6. Lekileki (kalasi ‘e 2)

- Ko e kalasi eni ‘oku faka’au ke mole: Tongota’ane, hangale, mamea mo e lekilcki.

Functions

- Acts as a buffer (coastal protection) between land and sea from strong winds, minimizes the impacts of waves during storms, and inundation
- Acts as a trap for sediments, nutrients, rubbish from dirtying land disturbance and runoff. This promotes coral reef and seagrass growth offshore
- Fish habitat, not only for fish, but also mud crabs, mollusks and birds

Utilization

- Mangrove areas are used for:

    1. fishing
    2. gathering of clams and crabs
    3. wood for construction and handicrafts
    4. fuel
    5. tapa dye
    6. tannins to protect nets and fish traps
    7. medicinal purposes

Issues

- Some causes from removal of mangroves:

    1. inundation
    2. no sediment trap – sediments will silt nearby coral reefs
    3. fishery will decline and will move elsewhere (fish migration)
    4. no protection from storms

- Some impacts on mangroves:

    1. reclamation – developments
    2. digging of pigs – pigs should be penned or mangroves fenced; and
    3. cutting of mangroves, with no replacements

An example are the coasts around Fanga' uta Lagoon and along the Hihifo areas. People have been removing mangroves for either reclamation, medicinal use, tapa dyes, etc., but no one has seemed to think whether this resource would tend to disappear over time. Even when they can see it is starting to disappear, we have to do something about if it's going to affect us.

Everywhere in the world has now realized the importance of mangroves for their livelihoods and they're starting to look after this resource.

What is happening now are the following:

- replanting of mangroves in 4 areas now (Havelu, Popua, "Alaki and Hoi).
- there are 10 other mangrove communities now who will carry out the same programme, including this community
- there will be 3 main species to be planted (Tongo, Hangale and Feta'anu), however, we will try and get some Tongota'ane and Lekileki as well
- about 300 plants will be delivered for planting, however, if the community is willing to plant more, they can just request for some mangrove seedlings any time after the planting day
- it would take 5 to 10 years for a seedling to reach maturity

Ways for sustainable use of mangroves:

<u>Stripping of mangroves for tape dye</u>:

Do not strip to the roots, preferably strip from the branches or random stripping
From the bark, but leave at least 60% of the bark on the tree so it may recover

<u>For construction or firewood</u>:

Allocate areas to be used for this purpose and replant as many as possible and
Harvest at a sustainable rate

Overall, there is no reason why one cannot plant mangroves for any of the above reasons.

PALAU COUNTRY REPORT

1.0 Background

Palau's mangroves are confined to the intertidal coastal flats where they are generally subject to tidal over wash twice daily. Palau has 19 mangrove vegetation species found within the different mangrove habitat types. The total mangrove forest area is approximately 12,000 acres (19 mi.2) or roughly 10% of the total land area of Palau. Palau's mangrove resources have been used for traditional subsistence needs for hundreds of years. Mangroves are used for fuel wood, structural materials for boats, houses, roofs, floors and fences, posts and poles, handicrafts and storyboards, fish traps and dyes for preserving fishing nets.

Today, mangrove continues to be harvested primarily for subsistence uses on Palau. Evidence of cutting is present in just about every mangrove stand. Current mangrove species supply and demand dynamics are unknown for Palau. Presently, Palau has no mangrove forest products industry. Mangrove resource influence in the national economy is virtually nonexistent on a wood commodity/production level.

The real socioeconomic issue of the mangrove forests on Palau is not as a forest industry, but for maintaining and enhancing island ecological processes. When related to coastal shoreline protection and stabilization, primary productivity and energy flow, nutrient buffering and release, sediment screens and filters, marine and fisheries habitat, salt spray deflection and storm energy dissipation – the Palau mangrove resource exhibits a virtually priceless economic and ecological benefit.

In Palau, the biggest threat to mangroves today is clearing and filling activities associated with infrastructure improvements and commercial and residential developments along coastal areas. Mangroves have also been lost ot construction of fishponds and inter-islet causeways. Dumping of rubbish to the mangroves has also degraded dections of stands around Palau. Losses and degradation of mangroves are expected to increase with the growing populationi and development pressures.

2.0 Proposed Legislation

Legislation is currently being considered by the Palau National Congress (Olbiil Era Kelulau or OEK) to set the national policy framework for protection and management of mangrove forests via a management plan to be drafted by the Bureau of Agriculture of the Ministry of Resources and Development in cooperation with the state governments and communities. The management plan will allow for traditional and sustainable uses of the mangroves and will aim to prevent uses that damage the future health of the mangroves or the benefits that come from them.

3.0 Need for the Palau Mangrove Management Plan

Mangroves are critical to Palau's island ecosystem. Mangroves provide a variety of important goods and values as they transform both organic and inorganic inputs from the uplands and ocean, produce wood and non-wood products, maintain fresh and coastal water quality, provide shoreline protection, support variety of habitats and biodiversity, and serve as a visually pleasing landscape. Understanding the importance and best uses of mangrove ecosystems will help formulate management policies that support the sustained supplies of mangrove goods and services.

The management plan centers on the need for a cooperative national and state management strategy that sustains Palau's mangrove ecosystems over time. It will help safeguard mangroves for the goods and services of society, while maintaining their critical ecological role. The management plan is driven by the need to regulate human activities within and next to mangroves; and to provide consistent guidance to the state governments in the management of their mangrove resources. The compact road construction, cottage industries, oceanfront resort development, and the increasing production and consumption by Palau's growing and shifting population will likely have adverse impacts on Palau's mangrove ecosystems.

4.0 Plan Relationship to Laws and State Government Levels

In Palau, under a Constitutional provision, States have exclusive ownership of their living and non-living land and sea resources out to twelve (12) nautical miles. States are responsible for the management and development of resources within these boundaries. Therefore, mangrove management implementation activities fall under the direction of the state governments.

State governments, with their exclusive ownership of mangrove resources, must be fully involved in the management plan implementation. Plan success is dependant on the strong partnership with the state and local traditional leaders.

5.0 Existing Management Framework

The intertidal and coastal lands where mangroves are generally found are often under constant pressure for development and as sites for the disposal of waste. In spite of the constant pressure being placed on these fragile resources, there is currently no existing forest or mangrove legislation from the national government that regulates or manages the utilization of these natural resources. Several states have passed legislations that set aside portions of mangroves for preservation and conservation purposes. However, due to shortage of human and financial resources regular monitoring and enforcement at these conservation areas are generally nonexistent.

Meanwhile, on the national government level, the only management or protection afforded the mangroves of Palau is thru the Environmental Quality Protection Board (EQPB) regulations. Under Palau National Cod (PNC) Title 24, EQPB has developed set of Earthmoving Regulations to regulate activities such as dredging and quarrying which take place anywhere, especially in vulnerable parts of the littoral zone.

Any person wishing to engage in an earthmoving activity must apply for a permit from the EQPB. An application must be supported by an Erosion and Sediment Plan and any other document required by the EQPB, including an environmental impact assessment report, if the Board deems the activity to have significant environmental impacts. Before a permit is issued, the Regulations mandate that a public hearing be called to solicit comments from the public. If the EQPB considers that the activity will result in significant environment degradation, conditions can be incorporated in the permit to protect the environment or the permission denied altogether.

6.0 Conclusions

The priceless mangroves may be completely lost or permanently degraded if they are not protected and managed now. Proper protection and management can only be done with cooperation of both state and national governments, and careful consideration of Palau's sustainable development and environmental management needs. An important step to ensure wise management of mangroves is the preparation of nationwide management plan that meets the needs of local people, state government and national priorities. Finally, the plan must be practical and implement able and reflects the concerns and desires of the state governments and protects the future health of the mangrove ecosystems.

Appendix A

Palau's Mangrove Vegetation

Local Name	Scientific Name	Type of Vegetation
Kollil	Acanthus ebracteatus	Shrub
Okuam	Acrostichum speciosum	Fern
Dadait	Avicennia alba	Tree
Denges, Kodenges	Bruguiera gymnorrhiza	Tree
Biut	Ceriops tagal	Tree
*Not known	Cynometra iripa	Tree
Rriu	Dolichandrone spathacea	Tree
Ias	Excoecaria agallocha	Tree
Ebibech	Heritiera littoralis	Tree
Mekekad	Lumnitzera littorea	Tree
Toechel	Nypa fruticans	Palm Tree
Ngis	Pemphis acidula	Tree
Bngaol	Rhizophora apiculata	Tree
**Tebechel	Rhizophora X lamarckii	Tree
Tebechel	Rhizophora mucronata	Tree
Bngaol	Rhizophora stylosa	Tree
Kuat	Scyphiphora hydrophyllacea	Tree
Urur	Sonneratia alba	Tree
Meduulokebong	Xylocarpus granatum	Tree

* Reported by Norman Duke, 1998.
* Hybrid of R. stylosa and R. apiculata. Newly reported on Palau.

INFORMATION NEEDED TO EVALUATE THE STATUS OF CONSERVATION AND MANAGEMENT OF MANGROVES IN ISLAND COUNTRIES OF THE SOUTH PACIFIC

1. Are there laws protecting the mangrove ecosystem, national policy statements, or other written commitments by the government?
2. Is there a designated agency or agencies for management of mangroves?
3. What agencies are involved in the management of mangroves?
4. Is there a mangrove action committee? Who belongs?
5. How many hectares of mangroves and where are they located?
6. Who owns the mangroves? Does ownership play a role in the mgt.?
7. Is there an inventory of the mangrove resource?
8. Are there inventory plots in the mangroves?
9. How often are they checked? What are the plots telling?
10. What are the greatest threats to mangroves in the country?
11. What uses or products come from the mangroves?
12. What are your short term and long term goals for the mangroves?
13. Is there any funding for management of the mangroves? (How much?)
14. What is the level of awareness in the island population?
15. What has the government done to improve awareness?
16. Have any materials been developed for awareness?
17. Which NGOs have an interest in mangroves? What are they doing?
18. What are your specific needs for training in the conservation and mgt of mangroves?
19. Is there any outside funded projects or activities for mangroves?
20. Are there maps showing the location of the mangroves?
21. Are there any efforts in coastal zone management which includes the mangroves?
22. Is there an active program of community participation about mangroves?
23. Is there a mangrove management plan?
24. When was it prepared and who prepared it.
25. Was there community input?
26. At what level was the plan approved
27. Was the plan adequately funded?
28. When was the plan implemented and how many years for plan?
29. Who are the cooperators and collaborators?
30. Are there annual reviews of the plan and activities described in it.
31. Are goals and objectives outlined in the plan being accomplished?
32. Does your government have an environmental review process?
33. Is there a real concern in the government forestry agency about the status of the mangroves?

DEVELOPING AWARENESS AND COMMUNITY PARTICIPATION

The management and protection of mangrove forests should be a cooperative effort among communities, individual landowners and government agencies. Products from the mangroves certainly benefits individuals and one or several communities. Therefore it is of utmost importance that communities play a role in the establishment and management of mangroves Although everyone in the community wants the benefits of the mangroves, educating and reminding individuals in the community what they must and must not do to ensure the continuous use of the mangroves is a never-ending task.

This task is even more difficult if it is a government agency dictating what the landowners in the mangroves should and should not do. The management of mangroves is much easier when the government owns the mangroves and has complete control of the activities on the land. Unfortunately on small islands there may be numerous people living in the in or adjacent to the mangroves who use them every day. Traditionally the village or community has utilized the mangroves for their own purposes for a long period of time and they consider the mangroves as a part of the community regardless of the legal ownership.

It is important that the community understand the greatest threats to their mangroves. The most obvious threats are potential overexploitation and conversion to other uses. It is important that the community understand the consequences of these activities so it is the responsibility of the resource managers to inform the community of the potential problems.

There have been many published materials on creating awareness programs and enlisting community participation. One of the best guides to encourage community involvement in the management of forest resources is entitled "A forester's guide for community involvement in upland conservation" written by French and Gecolea and published by FAO in 1986. The following are suggestions from this guide:

ESSENTIAL ELEMENTS

1. Start where the people are
2. Involve local leaders in the planning
3. Work through community institutions
4. The forester should stimulate action among local leaders by working with them, not taking over from them.
5. Increased income and improved standard of living should go hand-in-hand with conservation of watersheds.
6. Appropriate policies and government regulations are necessary.
7. The costs and benefits of the programme should be distributed equitably.
8. Initial conservation measures must show quick results to gain the confidence of the community.
9. In the long run, priority should be given to conservation measures, which can be implemented by villagers themselves.
10. Reliable technical, social and economic data should be maintained.

ROLE OF GOVERNMENT ORGANIZATIONS

- Draft policies/legislation, which promote conservation activities.
- Promote community involvement in management of watersheds.
- Collect and analyze data on the condition of the watershed and its inhabitants.
- Provide technical recommendations regarding conservation measures.
- Facilitate access to required inputs and services (supplies, credit, planting material extension/information, markets, etc.)
- Strengthen the infrastructure needed to support upland conservation (roads, community organizations, dams/irrigation systems, nurseries, etc.)
- Encourage a more participatory style of management within government organizations themselves.

ROLE OF COMMUNITY ORGANIZATIONS

- Tell people about government policies and regulations.
- Organize the people to identify potential conservation activities.
- Promote group action among community members in undertaking conservation activities
- Actively seek out government inputs and services.
- Monitor the progress of conservation activities at the local level.

ROLE OF THE FORESTER

- Identify formal and informal leaders in the community
- Work with community leaders and outside specialists in assessing physical and socio-economic conditions of the watershed.
- Encourage group discussions among local leaders and other community members to identify their problems, and formulate possible solutions.
- Share relevant conservation information and techniques that may not be available to the community.
- Teach the community how to gain access to inputs and services and advise in implementation of conservation measures.
- Help communities establish a process of self-development through strengthening local institutions and training of its leaders.

ROLE OF VILLAGERS

- Discuss ways of getting more benefits from the physical environment without permanently damaging it.
- Contribute time, labor and other resources that can yield benefits to them and to community.
- Work with other community members to identify common goals and solve common problems.
- Actively seek the help of qualified persons and organizations outside the community, but refuse to depend entirely on them.
- Aim for as much community self-reliance as possible.

During the process of encouraging community participation the community will have to be trained or educated in the management of watersheds and the processes that occur in them. There are many ways to accomplish this. Usually a mix or combination of several means of communication is used. The methods used should be discussed with leaders in the village. Some of the tools for creating awareness and educating the community include:

DIRECT CONTACT

- Home visits
- Field visits
- Office calls
- Correspondence
- School Programs

GROUP MEDIA

- Flip Charts
- Models
- Transparencies
- Chalkboards
- Games
- Wall Charts
- Extension Kits
- Drama
- Slides
- Film Strips
- Computer Presentations

MASS MEDIA

- Radio
- Television
- Pamphlets
- Newspapers
- Banners
- Calendars
- Exhibitions
- Notice Boards
- Internet

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French, James H. and Romeo H. Gecolea. 1986. A Forester's Guide for Community Involvement in Upland Conservation. With Special Reference to the Asia and Pacific Region. Food and Agricultural Organization of the United Nations. Rome Italy. 125 pages.

THE _____ MANGROVE MANAGEMENT PLAN

Prepared for

_____

_____

Prepared By

_____

_____

_____

(FIRST DRAFT)

JULY 28, 2003

APPROVED BY

_____

_____

THE _____ MANGROVE MANAGEMENT PLAN

EXECUTIVE SUMMARY

1.0 INTRODUCTION

Laws/Policy/Regulations/or Directives that support mangrove management

General description of the mangrove resource

Uses of the mangrove ecosystem

Threats to the mangrove ecosystem

Justification or need for this mangrove management plan

Overall goal of mangrove management in _____

Purpose of the _____plan (What is this plan supposed to do)(page 1 Pohnpei plan)

How will this plan benefit the people of _____ and future generations?

How will this plan affect the following:

A. Mangrove vegetation

B. Fisheries, Marine and Wildlife Resources

C. Coastal Lands (shorelines)

D. Recreation for _____ citizens

E. Tourism

F. Special Areas (historical, cultural, religious, natural)(MCAs, MSEAs page 12)

G. Biodiversity and rare natural flora and fauna

H. Availability of a sustainable source of products for traditional uses

I. The well-being of local communities living near the mangroves

2.0 MANGROVE WETLANDS MANAGEMENT DIRECTION (Strategy) (page 9 in Pohnpei Plan)

Give Specifics Here of any Laws/Policies/Directives That Give Direction

Give Specific Direction / Standards and Guidelines for the following areas(start on page 10, kiribati plan)

Mangrove Vegetation

Fisheries, Marine and Wildllife Resources

Coastal Lands

Recreation

Special Areas (historical, Cultural, Religious)

Biodiversity and Rare Natural Flora and Fauna

Ensuring a Sustainable Source of Products For Traditional Uses

Role of the Community for Enforcing the Regulations in the Plan?

Establishing a National Mangrove Management Committee for Additional Guidance and Direction.

3.0 MANGROVE WETLAND USE CLASSIFICATION SYSTEM (page 18 KMMP)

Proposed Areas For Each Classification I, II, III

4.0 IMPLEMENTATION OF THE _____MANGROVE MANAGEMENT PLAN

Describe in general the activities that will be implemented in the plan. If possible include an estimated cost for each activity that you are going to implement and indicate the year of the plan that it will be implemented. (assume a 5-year plan)

Community Participation

Awareness

Harvesting

Training

Institutional Building (staff and equipment)

Nursery establishment

Replanting

Inventory

Monitoring

Research

Forming a National Mangrove Committee

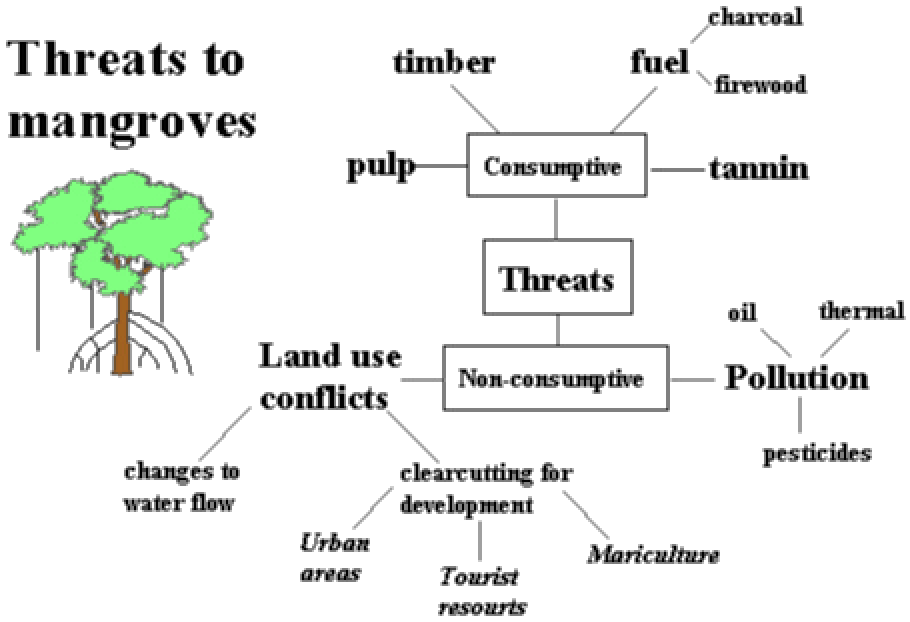
Cooperation and Partnering With Other Organizations

Mangrove Forests: Threats

Human threats to mangrove ecosystems may be loosely divided into two categories: *consumptive*, in which whole trees, or parts of them, are cut for products such as timber, fuel, or pulp; and *non-consumptive*, in which a forest is threatened by human activity other than direct exploitation of the trees themselves (*see below*). Adverse effects on mangrove ecosystems as a result of both consumptive and non-consumptive activity are increasing in the tropics as a result of increasing human populations, and attempts to improve or modernize the living standards of coastal peoples.

In areas where trees are cut to supply timber, fuel or pulp, it is important that managers and coastal planners be aware of the need for careful planning to ensure that the forest is not overexploited, or threatened from other sources. On Zanzibar, mangrove trees are exploited to provide building materials and for making charcoal, and cutting is managed with the goal of long-term sustainability in mind. In some areas, such as Malaysia, India, and Bangladesh, mangrove forests are managed silviculturally on a sustainable-yield basis, just as are terrestrial forests. Even where mangroves are used extensively, many countries retain a protective fringe of mangrove trees along shorelines and waterways to reduce erosion and to provide a seed source.

Non-consumptive threats to mangrove ecosystems may be further divided into two categories: *pollution* and *land-use conflicts*. One of the more serious forms of pollution is oil, for this substance can foul gas exchange surfaces of the exposed roots, and lead to death as a result of oxygen starvation. Toxic substances in oil can also poison both the roots and important soil micro-organisms. Cintron *et al*. (1981) documented the effects of an oil spill in a mangal Puerto Rico and noted that in the areas receiving the heaviest impact, 50% of the forest canopy was lost after 43 days, and 95% after 85 days.



Some of the threats facing mangrove ecosystems worldwide.

The Ramsar Convention on Wetlands

The Mangrove Forest: background paper

The Mangrove Forest

background paper by Alfredo Quarto, Mangrove Action Project

The Mangrove Forest

Probably no other distinct plant community has attracted as much curiosity and scientific attention for as long as have the mangrove forests. "Rollet's (1981) annotated bibliography lists 5,608 published titles through 1975 with one of the first being the written account from the chronicle of Nearchus, dating back to the Greek mariners of 325 BC." (S. C. Snedaker, University of Miami, Division of Marine Biology and Fisheries)

Living at the Edge of the Sea

"One perceives a forest of jagged, gnarled trees protruding from the surface of the sea, roots anchored in deep, black, foul-smelling mud, verdant crowns arching toward a blazing sun. . . . Here is where land and sea intertwine, where the line dividing ocean and continent blurs, in this setting the marine biologist and the forest ecologist both must work at the extreme reaches of their disciplines" ("Caribbean Mangrove Swamps", by Klause Rutzler and Ilka C. Feller, *Scientific American*, March 1996, p. 94)

Mangroves are the rainforests by the sea. "The majority of the subtropical and tropical coastline is dominated by mangroves, estimated to cover an area of 22 million hectares. However, over the past several decades, the global area in mangroves has increasingly diminished as a result of a variety of human activities, such as overharvesting, freshwater diversion and conversion to other uses." (Snedaker, University of Miami, personal correspondence)

Mangrove forests are comprised of taxonomically diverse, salt-tolerant tree and other plant species which thrive in intertidal zones of sheltered tropical shores, "overwash" islands, and estuaries. Mangrove trees have specially adapted aerial and salt-filtering roots and salt-excreting leaves that enable them to occupy the saline wetlands where other plant life cannot survive.

A Cornucopia of Life

Mangrove forests are vital for healthy coastal ecosystems. The forest detritus, consisting mainly of fallen leaves and branches from the mangroves, provides nutrients for the marine environment and supports immense varieties of sea life in intricate food webs associated directly through detritus or indirectly through the planktonic and epiphytic algal food chains. (Note: Plankton and benthic algae are primary sources of carbon in the mangrove ecosystem, in addition to detritus.)

The shallow intertidal reaches that characterize the mangrove wetlands offer refuge and nursery grounds for juvenile fish, crabs, shrimps, and mollusks. Mangroves are also prime nesting and migratory sites for hundreds of bird species. In Belize, for instance, there are over 500 species of birds recorded in mangrove areas. Additionally, manatees, crab-eating monkeys, fishing cats, monitor lizards, sea turtles, and mud-skipper fish utilize the mangrove wetlands.

The Origin of the Species

Scientists theorize that the earliest mangrove species originated in the Indo-Malayan region. This may account for the fact that there are far more mangrove species present in this region than anywhere else. Because of their unique floating propagules and seeds, certain of these early mangrove species spread westward, borne by ocean currents, to India and East Africa, and eastward to the Americas, arriving in Central and South America during the upper Cretaceous period and lower Miocene epoch, between 66 and 23 million years ago. During that time, mangroves spread throughout the Caribbean Sea across an open seaway which once existed where Panama lies today. Later, sea currents may have carried mangrove seeds to the western coast of Africa and as far south as New Zealand. This might explain why the mangroves of West Africa and the Americas contain fewer, but similar colonizing species, whereas those of Asia, India, and East Africa contain a much fuller range of mangrove species.

The Ecology of Mangroves

These complex ecosystems are found between the latitudes of 32 degrees north and 38 degrees south, along the tropical coasts of Africa, Australia, Asia, and the Americas. There are varying scientific classifications of what constitutes a mangrove plant. According to two reputable scientific studies, mangroves include approximately 16-24 families and 54-75 species (Tomlinson (1986) and Field (1995) respectively). The greatest diversity of mangrove species exists in Southeast Asia. For example, there are only twelve mangrove species in the New World and only four species of mangroves exist along portions of the coasts of the southern USA.

Mangrove forests literally live in two worlds at once, acting as the interface between land and sea. Mangroves help protect coastlines from erosion, storm damage, and wave action. The stability mangroves provide is of immense importance. They prevent shoreline erosion by acting as buffers and catch alluvial materials, thus stabilizing land elevation by sediment

accretion that balances sediment loss. Vital coral reefs and sea grass beds are also protected from damaging siltation.

A primary factor of the natural environment that affects mangroves over the long term is sea level and its fluctuations. Other shorter-term factors are air temperature, salinity, ocean currents, storms, shore slope, and soil substrate. Most mangroves live on muddy soils, but they also grow on sand, peat, and coral rock. If tidal conditions are optimal, mangroves can flourish far inland, along the upper reaches of coastal estuaries.

Mangroves vary in height according to species and environment, from mere shrubs to 40 meter trees. The prop roots of some mangrove species, such as Rhizophora or "red mangrove", and the pneumataphores of others, such as Avicennia or "black mangrove", contain many small "breathing" pores, called "lenticels." These allow oxygen to diffuse into the plant, and down to the underground roots by means of air space tissue in the cortex, called "aerenchyma." The lenticels are inactive during high tide.

Evolutionary adjustments to varying coastal marine environments have produced some astounding biological characteristics within mangrove plant communities. Certain species of mangroves exclude salt from their systems, others actually excrete the salt they take in via their leaves, roots, or branches. In salt excluding mangrove species , the mangrove root system is so effective in filtering out salt that a thirsty traveler could drink fresh water from a cut root, though the tree itself stands in saline soil.

Certain mangrove species can propagate successfully in a marine environment because of special adaptations. Through "viviparity," embryo germination begins on the tree itself; the tree later drops its developed embryos, called seedlings, which may take root in the soil beneath. Viviparity may have evolved as an adaptive mechanism to prepare the seedlings for long-distance dispersal, and survival and growth within a harsh saline environment. During this viviparous development, the propagules are nourished on the parent tree, thus accumulating the carbohydrates and other compounds required for later autonomous growth. The structural complexity achieved by the seedlings at this early stage of plant development helps acclimate the seedlings to extreme physical conditions which otherwise might preclude normal seed germination.

Another special adaptation is the dispersal of certain mangroves' "propagules" which hang from the branches of mature trees. These fall off and eventually take root in the soil surrounding the parent tree or are carried to distant shorelines. Depending on the species, these propagules may float for extended periods, up to a year, and still remain viable. Viviparity and the long-lived propagules allow these mangrove species to disperse over wide areas.

"Zonation" often characterizes mangrove forests. Certain tree species occupy particular areas, or niches, within the ecosystem. Some mangrove species occur close to shore, fringing islands and sheltered bays; others are found further inland, in estuaries influenced by tidal action.

The Importance for Local Communities

Mangrove ecosystems have traditionally been sustainably managed by local populations for the production of food, medicines, tannins, fuel wood, and construction materials. For millions of indigenous coastal residents, mangrove forests offer dependable, basic livelihoods and sustain their traditional cultures.

The protective mangrove buffer zone helps minimize damage of property and losses of life from hurricanes and storms. In regions where these coastal fringe forests have been cleared, tremendous problems of erosion and siltation have arisen, and sometimes terrible losses to human life and property have occurred due to destructive storms. Mangroves have also been useful in treating effluent, as the plants absorb excess nitrates and phosphates thereby preventing contamination of nearshore waters.

The Greatest Threats: an Ecosystem in Peril

Naturally resilient, mangrove forests have withstood severe storms and changing tides for many millennia, but they are now being devastated by modern encroachments. Today, mangrove forests are among the most threatened habitats in the world -- disappearing at an accelerating rate, yet with little public notice. Lenticels in the exposed portions of mangrove roots are highly susceptible to clogging by crude oil and other pollutants, attacks by parasites, and prolonged flooding from artificial dikes or causeways. Over time, environmental stress can kill large numbers of mangrove trees. In addition, the charcoal and timber industries have also severely impacted mangrove forests, as well as tourism and other coastal developments. The rapidly expanding shrimp aquaculture industry poses the gravest threat to the world's remaining mangroves. Literally thousands of hectares of lush mangrove forests have been cleared to make room for the artificial shrimp ponds of this boom and bust industry. This highly volatile enterprise has grown exponentially over the last 15 years, leaving devastating ruin in its wake.

Until recently, mangrove forests have been classified by many governments and industries alike as "wastelands", or useless swamps. This erroneous designation has made it easier to exploit mangrove forests as cheap and unprotected sources of land and water for shrimp farming. The amount of mangrove forest destruction is alarming. Thailand has lost more than half of its mangrove forests since 1960. In the Philippines, mangroves have declined from an estimated 448,000 hectares in the 1920s to only 110,000 hectares by 1990. In Ecuador, estimates of mangrove loss range from 20% percent to nearly one half of Ecuador's once 362,000 ha. of mangrove forested coastline. The Muisne region of Ecuador alone has lost nearly 90% percent of its mangroves. Globally, as much as 50% percent of mangrove destruction in recent years has been due to clear cutting for shrimp farms.

Towards Solutions: Protecting Mangrove Forests

The failure of national governments to adequately regulate the shrimp industry, and the headlong rush of multilateral lending agencies to fund aquaculture development without meeting their own stated ecological and social criteria, are other important pieces to this unfortunate puzzle. The fate of remaining mangrove forests may now rest in the hands of the consumers from the wealthy nations that import these luxury shrimp products. Since a highly profitable and expanding market is the driving force behind the shrimp industry, a worldwide reduction in consumer demand for pond-raised shrimp is called for.

Meanwhile, stricter local governmental regulations and enforcement protecting mangroves are necessary. Also, involvement of local communities in sustainably managing and protecting their coastal resource base, including the nearby mangrove forests, is essential.

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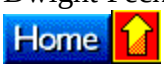

Unit C10

MANGROVES

Mangroves are a group of unusual trees that can live in salt water from the oceans. Most land plants are killed by salt, but mangroves are able to get rid of the salt. Most plants die if their roots are drowned in water and have no oxygen, and in the mud of mangrove swamps, the rotting leaves usually use up all the oxygen. However mangrove trees have developed special kinds of roots that stick up out of the mud into the air to get oxygen. As a result, mangrove forests (or at least a fringe of mangroves) are common along the coasts of many tropical islands wherever the shore is soft and muddy enough for them to take root.

In the Pacific, the number of kinds of mangrove trees is greatest in the west, and gets smaller going to the east across the Pacific until the mangroves disappear. Mangrove forests in the western Pacific and Indian Ocean are bigger and richer, with different kinds of mangroves growing under different conditions. Mangroves are also very important in the Caribbean. Some mangroves prefer water that is not as salty as seawater, and they are thus more common at the mouths of rivers where fresh-water and salt-water mix.

Usefulness of mangroves

Most people have thought of mangroves as noxious impenetrable swamps full of diseases, and they used to be destroyed as a public health measure, but now we know better. Mangroves are very productive coastal resources that are useful in many ways. Mangrove trees grow well in their special conditions, and, like the tropical forest, they produce a lot of leaves and other organic matter. Instead of accumulating in the soil, the leaves fall in the water, where they rot and provide food for microbes and many tiny animals. This rich food is not only eaten in the mangrove swamp, but much of it may be carried out into the lagoon or to coral reefs and other coastal fisheries areas, where it helps to feed the fish. The areas near mangroves are thus often very important for fishing.

Because there is lots of food in mangrove areas, and good shelter among the mangrove roots, some kinds of fish come there to reproduce, and many baby fish grow up there before going to live in the lagoon or on the reef. The mangroves are a critical habitat upon which these species depend for survival, and if something happens to the mangroves, the future of these kinds of fish will be affected.

Mangroves also build land or keep it from being washed away, which can be very important on islands where land is so limited. Mud and sediment are often washed down rivers and streams. When there is a mangrove swamp at the river mouth, the water spreads out into the mangroves, and the sediment settles to the bottom where it is trapped by the mangrove roots. As the bottom gets shallower, the mangroves can grow further out, while those on the inside eventually find themselves on dry land, where they are replaced by land plants. In this way the mangrove forest advances slowly outward, leaving land behind. Even in areas where there is not enough sediment to build new land, the mangroves protect the shoreline from being washed away in storms. The roots and trunks break the force of the waves, and the leaves and branches reduce the effects of the wind and rain. There are examples of islands which were built by mangroves, and then washed away when the mangroves were cut.

Mangroves are an important source of food and materials for many coastal people. Crabs, clams, oysters, fish and other food are often collected there. Even the mangrove fruits are sometimes eaten. Mangrove wood is often collected as firewood, and it can also be used for building. The bark has tannin which has craft and medicinal uses.

Even in the city, mangroves can be important. The city wastes run off and pollute the nearby coastal waters. When the wastes from all the people run into a mangrove swamp, they can be taken up and used by the plants and animals in the swamp. In a way the swamp filters the water, leaving clean water to go out the other side. As long as there is not too much waste for the mangroves, and no poisonous wastes from industries, the mangroves are an excellent waste treatment system, and much cheaper than a sewage treatment plant.

Threats to mangroves

Unfortunately in spite of their usefulness, mangroves are being destroyed in many places. Sometimes they are drained as a sanitary measure, although mosquitos, for instance, do not like the salty water of most mangrove swamps. Often mangrove areas are used to dump rubbish or garbage. On islands where unoccupied land is in short supply, mangroves are often cleared to make agricultural land, or filled in for construction. Large areas have been lost to development in this way. However, such low-lying land may be vulnerable to flooding in storms, so the development is not always so successful.

In some places mangroves are cleared to make aquaculture ponds for raising fish or shrimp. Ponds may also be built to treat the wastes from cities, towns or factories. Other kinds of construction can also damage mangroves. Anything that changes the way water circulates or its saltiness can kill the affected mangroves. Taking water from rivers for irrigation can reduce the amount of fresh-water available to mix with the salt-water. Frequently a causeway for a road, or some other construction project, may keep the sea-water from coming into the mangroves. As the sea-water is replaced by fresh-water, the mangroves will die.

Mangroves are also sensitive to pollution, particularly oil pollution. If an oil spill goes into a mangrove area, the oil covers the aerial roots, and the tree roots can no longer get the air they need to live. The roots will die, and with them the whole forest. Mangroves are also very sensitive to herbicides.

With all these different threats, and the fact that few people appreciate how important the mangroves really are, it is no wonder that the area of mangroves is getting smaller. The steady reduction in mangroves means the loss of an important resource. As each little bit is taken, the remaining natural area becomes that much more important for such things as fish breeding and nursery areas. On some islands, only tiny areas of mangroves remain. Their loss could be a tragedy for coastal fisheries.

Mangrove management

On islands where many different needs must be fit together, the careful management of mangrove areas is important. If there are large areas of mangrove forest, then some parts can probably be developed, allowing for a balance of uses. Special attention needs to be paid to the percentage of the total area developed, and to avoiding critical breeding habitats and other areas of particular interest. Where only small areas of mangrove remain, they probably should be protected.

Every effort should be made to avoid changes in salinity or water circulation in mangrove swamps. If a road needs to be built through a swamp, enough bridges or culverts should be provided to allow water movement into and out of the swamp. In areas where sedimentation is important, the mangroves should be allowed to go ahead with their stabilizing and protective role. Similarly mangroves should be strictly protected wherever they are important in controlling coastal erosion.

Because of their vulnerability to oil pollution, mangroves should receive special attention for protective measures in oil spill contingency plans. Oil loading and storage facilities should not be located near mangrove areas.

Not all uses of mangroves will go together. A forest that is heavily cut for firewood will not produce as much food for the lagoon and reef. The mangroves areas in a city that are used for waste treatment should probably be closed to fishing to avoid the danger that shellfish and other seafood from the area might pick up and spread diseases.

Fortunately a mangrove forest can often be replanted if it is damaged, just like a forest on land, assuming that the conditions are still good. Where temporary damage at a construction site cannot be avoided, at least the trees can be replaced afterwards. It is even possible to require a developer who destroys part of a mangrove swamp to replace it with an equal area somewhere else, so that the total area of mangroves does not change. However, it is much easier to keep the mangrove that is already there than to try to replace it once it has been lost.

QUESTIONS

Are there mangroves in your area? What are they like?

What is unusual about a mangrove forest?

How can mangrove roots live in the swamp mud where there is no oxygen?

Why do many people think mangroves are bad? Is this true?

Why are mangroves important for baby fish?

How do mangroves build or protect the land?

What are other ways that mangroves are important?

What are the most important uses of mangroves in your area?

What are the threats to mangroves?

Have mangrove areas been lost where you live? Why?

How much of the original area of mangrove still remains on your coast?

Is anything now being done to manage your mangroves?

What do you think needs to be done so that the mangroves will meet all of your requirements?

Do you know of places where it might be good to replant mangroves?

Instructions for trainers in the use of this unit

Return to Small Island Environmental Management Home Page
Return to Islands Home Page

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Unit G1

RESOURCE INVENTORIES AND MAPPING

One of the first steps in managing something, whether a resource or anything else, is finding out where it is and how much there is. You cannot manage your pigs or chickens without knowing how many you have and of what age and sex, nor can you manage a bank account without knowing how much money is in it. In the same way, you must have some evaluation of an environmental resource in order to manage it. In a forest plot, you need to know how

many trees there are, and of what kinds and ages. For an agricultural area, it is necessary to measure how much there is of each soil type, slope and exposure, and what these areas are capable of producing. Since water is often limiting, it helps to know how much is available and at what times of year. A fisherman would like to know how many fish there are if he wants to fish the resource sustainably. These measures do not have to be exact, but they should be close enough to give an estimate of how much is available and how it might be changing with time.

For many resources, the first step is to determine the area covered by the resource, usually by making a map of the area with its boundaries. A map is like a drawing or picture of the land taken from high in the air. It usually shows the coastline, mountains, rivers, roads, villages and other features of the land. It can also show resources such as forests, plantations and coral reefs. You can put many kinds of information on a map, such as what kinds of crops are grown in each field, how many cattle there are in each pasture, and where the best fishing areas are. This is one way of making an inventory, which is a quantitative list or description of your resources.

A map is usually made to scale. This means that some small measure on the map is the same as some large measure on the land. On a map of a whole country, 1 centimetre on the map might be 1 kilometre or 100 kilometres on the ground. For detailed local resource maps, an appropriate scale might be 1 centimetre on the map for 10 metres or 100 metres on the ground.

Sometimes there are existing maps available from the government or in the lands department from which the general outlines of your area can be determined. For marine areas, there may be nautical charts that give the outline of the reefs and lagoons. Aerial photographs may also be available, perhaps in some government department, from which the outlines of the areas can be traced. If it is possible to make at least a base map in this way, it will be easier to note the areas or boundaries of particular resources on it.

If no maps of your area are available, or if you need a more detailed map of certain places, then it will be necessary to make a simple one using one of the following methods.

Sketch map

A simple rough sketch map can be made using only a pencil, a ruler or other very straight piece of wood or metal with regular markings on it, and a piece of paper on a board or other drawing surface that is flat and hard enough to write on.

Look over the area to be mapped and decide what points, places or objects you need to locate on the map in order to draw in the important boundaries and features. These may be roads, rivers, buildings, boundary markers, large trees, the limits of watersheds, and other points of reference. Then choose the place where you are going to start making the map. This first point on the map is marked and labelled, and the board is set on the ground there. The ruler is laid on the board crossing through the first point. It is aimed at the second point by sighting along it, and a line is drawn. The distance from the first to the second point is then paced off, using steps of the same length and counting the steps. (Try pacing the same line several times to make sure your steps are the same length and the counts agree. This may take some practice.) The number of paces is written along the line, and the length from the first to the second point is marked on the line at an appropriate scale. For example, 260 paces could be 13 centimetres, for a scale of 20 paces per centimetre. The board is then taken to the second point, laid on the ground, and oriented by sighting along the line drawn on the paper with the help of the ruler so that the line is lined up pointing back to the first point. Holding the board carefully so that it does not move, the ruler is then placed so that it crosses through the second point and is sighted at the third point. A line is then drawn, paced and measured as before, and the third point is marked and labelled.

At each corner or point along the boundary to be mapped, the board is placed on the ground and the same procedure is followed. If there is some error in closing the boundary when returning to the first point, it can usually be adjusted in redrawing the map.

If the area to be mapped is very large, it is best to subdivide it into smaller sections, map them separately, and then join the pieces of the map together. Other features to be added to the map that are not on the boundary lines can be added by sighting to them and pacing off the distance. If they are far off the line, it is best to sight and

pace from two points on the line, forming a triangle, at the point of which the feature is marked.

Plane table survey

If a more accurate map is needed, then it will be necessary to work with a flat (plane) table or board with a sheet of paper attached to it, a good ruler or alidade (a ruler with sights), and a measuring tape or other means of measuring.

The plane table should be sturdy so that it will not move during the survey, and it will need to be as horizontal as possible (a carpenter's level can help with this). A thick ruler or a ruler with sights (alidade) makes it easier to sight on points above or below the horizontal. The ruler needs some kind of regular markings or graduations so that you can scale the measurements. For measuring distances along the ground, a long tape measure of perhaps 30 metres is ideal. It can be laid end to end for longer distances. If a tape measure is not available, a rope (but not one that stretches like nylon) or a chain of known length can be used. You can even make a measuring rope yourself by taking a long piece of rope or heavy cord and tying knots at regular intervals of say 5 metres. Pacing can also be used if no alternative is available, but the map will not be as accurate.

There are three methods of mapping with a plane table. The first is similar to the sketch map method shown above, with the table being moved from point to point around the boundary to be mapped. The improved equipment brings some improvement in accuracy.

In the second method, the table is placed either within or outside the area to be mapped at a point where all parts of the area can be seen. The position of the table is marked at an appropriate place on the paper, and lines of sight are drawn to each point to be mapped. It may be necessary to put a pole or stick at these points to make them easier to sight on. The distance from the plane table to each of these points is then measured with the tape or rope and marked with the ruler at an appropriate scale on the lines of sight drawn on the paper. The boundaries and labels are then added to make the final map.

The third method requires placing the table at two locations some distance apart. It must be possible to see all the points to be mapped, including the other location of the table, from both of these locations. The only measurement necessary is the distance between the two locations of the table, which should be shown by a line drawn to scale on the paper. This line is used to position the table at each location by sighting along it to the other location. While the table is at the first location with the baseline properly oriented, lines of sight are drawn toward each point to be mapped. These lines do not have to be measured or drawn to scale. The table is then moved to the other location and oriented by sighting back to the first location along the baseline. Lines of sight are again drawn to each of the points to be mapped. The places where the two lines of sight cross are the positions of the points on the map at the scale of the baseline. Be sure to label these points before moving the table.

Once the positions of the major reference points have been located on the map, it should not be too difficult to draw in boundaries, important landmarks, and detailed features, and to add appropriate labels to make the final map. The sight lines used to prepare the map can be erased when they are no longer needed, or the map can be recopied in its final form.

These mapping techniques can be used for areas that are reasonably flat and of moderate size. The larger or more irregular an area is, the more points will be needed to map it properly; it may also be necessary to subdivide such areas and map the different parts separately. Simple mapping techniques are not practical for very large areas with distances too great to measure, or for forested or hilly areas where it is not possible to see the boundaries. For such areas, using an existing map and then adding local details may be the only solution.

Using maps for resource inventories

A map of your lands and waters will be very useful for planning how to use or manage your resources. By showing the position of each resource, it may help to show where to plan for development, and where to leave resources protected or undisturbed. Since a map is drawn to scale, it is possible to measure areas on the

map and then multiply by the scale to get the actual area of each resource. You can thus calculate the total area covered by forest or coconut palms, or the area of shallow reef flats.

Measurements from a map are enough to evaluate some resources like the amount of agricultural land or the area of a water catchment. For other types of resources, the area covered may need to be combined with some other measure. The size of a taro crop depends not only on the area planted but also on how closely the plants are spaced. A count of a sample of the area may make it possible to estimate the resource for the whole area. For instance, suppose your map shows a large field 100 paces wide and 200 paces long planted in taro, and you want to know how many taro are growing in the field. It would take too long to count every taro, but if the taro seem to be planted at the same density all over the field, you could count just a sample or small part of it. You would pace off a square of perhaps 10 paces by 10 paces (10 x 10 = 100 square paces) and count all the taro in the square. Since there are 100 x 200 = 20,000 square paces in the field and your sample is one two hundredth of this, you would multiply your count by 200 to get an estimate of the total number of taro. If you counted 120 taro plants in your sample square, there would be about 24,000 taro in the whole field. The same procedure can be used for forest trees, reef fish, or other resources.

Other inventory techniques

Not all resources can be evaluated on a map or in relation to a certain area, but they can sometimes be estimated along a line of known length, or over a set period of time. For instance, forest birds can be estimated by counting the number seen or heard while walking along say 1 kilometre of forest path at dawn, and trying to avoid counting the same bird more than once. Fish can be counted while swimming along a known length of reef front. Mosquitos can be evaluated by counting the number that come to bite you on the arm while sitting still for 15 minutes at nightfall. While these methods may not give total numbers, they can be repeated in exactly the same way to measure changes over time, such as the effects of heavy fishing or of spraying for mosquito control.

Estimates for a limited area can often be projected to the whole larger area of interest to give a value for the whole resource, as was done for the sample of the taro field above. Suppose that your community has 15 kilometres of shoreline with a fringing reef, and that there is no reason to think that there will be more fish on one part of the reef than another. If you have swum several times along 100 metres of reef edge, and each time you counted at least 3 large fish, then you can estimate the total number of such fish along the 15 km (15,000 metres) of reef at 3 x 150 = 450 fish. Knowing this, the community could plan on catching perhaps 50 to 90 such fish during the year and still leave a population able to reproduce and grow to a reasonable size (say 5 years old). The simple inventory has permitted a first step towards management. If you repeat the survey a year later and find that there are now fewer fish, then the community catch level may be too high and may need to be reduced. This repeated measurement is monitoring of the resource to see how it may be changing.

The same type of inventories can be made for valuable trees in a forest, or for garden areas planted or resting in fallow. Making a complete inventory of the resources available to a community can help to suggest where development can take place and where resources are already being used to their limit, or even being pushed past their limit towards exhaustion.

QUESTIONS

What is the first thing you need to do in order to manage a resource?

What is a map? What does it show?

Are there already maps available for your area? If not, do you think it would be useful to make one?

Do you need complicated equipment to make a map? What do you need?

What kinds of resources can be shown on a map?

What resources would it be useful to map in your area?

What are some other techniques that can be used to estimate resources?

Why is it useful to repeat an inventory exactly the same way sometime later?

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Return to Small Island Environmental Management Home Page
Return to Islands Home Page

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Mangrove Forest Management

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Summary

Mangroves are the characteristic littoral plant formations of tropical and subtropical sheltered coastlines and are at the interface between the land and the sea. The importance of mangroves stems from their pivotal role in both terrestrial and aquatic production, and by the many amenities provided within and beyond its boundaries. The paper advocates a multi-sectorial approach to mangrove ecosystem management and conservation within the framework of an integrated coastal area management plan; and provides a broad overview of management systems in mangrove areas of tropical Asia, Africa and America.

Key words: *mangroves, forest management, silviculture, integrated coastal zone planning.*

1. Introduction

The purpose of this paper is to highlight the distinctive characteristics of mangrove forests and the specific planning and information requirements for their management. Mangroves are at the interface between the land and the sea and

their forest ecosystem is substantially different from that of the inland tropical and subtropical forests.

Basic characteristics of mangroves and the importance of mangrove products and services are identified in Section 1. Section 2 emphasises on the management planning principles and information needs to facilitate the required multidisciplinary approach for successfully managing mangroves. Section 3 provides a broad overview of silvicultural systems in mangrove areas of tropical Asia, Africa and America. In Section 4, the need for developing and managing mangroves within a larger framework of a coastal area management plan is highlighted. Section 5 concludes the document.

1.1 Basic characteristics of mangrove forest ecosystems

Mangrove forests are the characteristic littoral plant formations of tropical and subtropical sheltered coastlines. Generally, mangroves are trees and bushes growing below the high- water level of spring tides. Their root system is regularly inundated with saline water, even though it may be diluted due to freshwater surface run-offs and only flooded once or twice a year.

The mangrove forests are evergreen. The paucity of tree species occurring in them is due to the peculiar conditions of their existence, few plants being able to tolerate and flourish in saline mud and to withstand frequent inundation by sea-water. They also differ from inland forests in that certain tree species are practically gregarious over extensive areas.

Due to their situation along the coast, mangrove formations are constantly controlled by marine and terrestrial factors such as coastal erosion or accretion by the sea or by rivers, tidal waves, high salinity, water-logged soils and other edaphic characteristics. These, together with the distance from the sea, the frequency and duration of inundation and tidal dynamics, govern to a great extent the local distribution of mangrove tree species and their succession. Best developments of mangrove forests are found at locations with deep soils, rich in organic matter and low in sand, usually in river estuaries.

1.2 Importance of mangrove resources

The uses of mangrove products are many and important. The importance of the resource stems from the many products taken directly from the mangroves, including wood and non-wood products, as well as products and amenities provided from within and beyond its boundaries, such as coastal fish resources. Wood products range from timber, poles and posts to firewood, charcoal and tannin. Non-wood products include thatch, honey, wildlife, fish, crustaceans, fodder and medicinal plants. Among the "intangible" benefits of mangroves, often taken for granted, are:

1. coastal protection against wave and wind erosion;
2. moderating the effects of coastal storms and cyclones;
3. shelter and habitat for diverse wildlife, particularly avifauna;
4. nutrient sink-effect and reduction in large amounts of pollutants coming either from the sea or from rivers passing through mangroves;
5. entrapment of upland run-off sediments thus protecting near-shore reefs and reducing sea water turbidity;

opportunities for recreation and ecotourism.
In addition, mangrove forests provide land for conversion to salt ponds, shrimp farms or for agriculture or aquaculture.

2. Mangrove Management Planning

2.1 Information requirements for mangrove management

Studying mangrove ecosystems for management purposes requires a broader multi-disciplinary approach as compared with inland forests. The complex nature of the mangrove resources, where both terrestrial- and aquatic (sea, lagoon and riverine) ecosystems are very closely interrelated, calls for the concourse of expertise from various disciplines including Forestry, Fishery, Wildlife, Ecology, Geomorphology, Hydrology, Aquaculture and Agriculture.

The ultimate goal of managing mangrove resources, the economic considerations aside, is to exploit and/or conserve to the fullest, the natural energies and resources available for any given site so as to produce maximum carrying capacity for the production of the desired products and services. In this respect, a careful examination of the site conditions (terrestrial and aquatic) and the collection of all relevant information regarding the objectives for managing the mangroves, will prove to be a worth while investment both in time and effort for any manager, in so far as it

portrays the potential site productivity under ideal conditions. Secondly, but equally important, is the full assessment of the socio-economic benefits and environmental impact of managing these mangrove resources.

For most of the mangrove areas, such primary information needs include the extent, distribution and dynamic's of the forest cover and of the water/river bodies situated in the mangroves; the identification and the assessment of the available and potential forest and aquatic resources; and an assessment of the biomass, including vegetative and animal production. Due to the particular forest structure, composition and difficult accessibility of mangrove forests and the mangrove area in general, the task of collecting this information is complex, time consuming and more expensive as compared to similar assessments of inland forests.

Given their multiple-use potential, the successful and sustainable management of mangroves depends on the understanding of, firstly, the ecological parameters for the primary production of forest-based biomass; and secondly, the biological role that the primary forest production has for the aquatic biomass (secondary production). This implies that no single resource use (aquatic or terrestrial) can be maximized to the point where the sustainable potential of the other resources are adversely affected.

2.2 Planning principles

Given the many types of products and services which might be obtained from forest and aquatic resources in mangroves, a multidisciplinary approach towards their management is essential. The following principles can be used as a guide when preparing management plans for mangroves:

1. *Wood, non-wood and aquatic resources are managed in an integrated way and used to meet local, regional or national needs:*
   Managing natural resources to meet peoples' needs implies a knowledge of what people want. An assessment of needs and public participation is an integral part of the planning process. The importance of a resource supply is not determined by it's physical or biological characteristics only but by the priority that society places on its use. This prioritization among the management objectives should be clearly reflected in the management plan's activities.
2. *Plans must be objective oriented:*
   When the problems or issues are understood, a set of objectives should be framed to

address key issues. Objectives should be quantifiable targets that serve to focus management effort and measure performance.

3. *Plans must try to achieve the greatest good for the greatest number of people in the long run:*
   Minority interests must be weighed in relation to the general well-being of larger communities. In practice it is impossible to achieve a complete or unanimous support for all the management objectives. Compromises between local level and national level interests are necessary.
4. *The ecological carrying capacity should never be exceeded and resource sustainability should be given high priority:*
   This is a non-negotiable requirement, if sustainable production is to be achieved. This requirement should be given high priority in the management planning agenda and for example a code of conduct for responsible harvesting of given products (forest-based or aquatic) should be elaborated.
5. *The need for the conservation of biological diversity and wildlife should be recognized:*
   This should be incorporated into the plan appropriate to the scale of the management area. For a small and/or highly fragmented area, it will be impractical to reserve large tracts of pristine vegetation for conservation purposes. Instead, the establishment of well placed control plots may be more feasible.
6. *Planning is an on-going dynamic process:*
   Planning must be flexible enough to accommodate shifts in demand/supplies and priorities. Because societal values change over time, planning is an on-going dynamic process.
7. *The plan must provide for improvements in data collection to reduce areas of uncertainty associated with an incomplete or weak information base:*
   The ultimate objective may be achieved in phases, taking into account an improved information base over time and applying a conservative approach where the uncertainty is perceived to be great.
8. *The decision-making process must be visible and equitable:*
   Involving the public in the decision-making process is necessary to promote local support and acceptance for integrated forest management planning. It is the duty of the forest service to explain to the public the implications of various decisions. Customary rights should be respected where possible. Decision- making should not marginalize the traditional incomes of local people nor their access to reasonable amount of forest products without offering practical and acceptable alternatives.
9. *Planning functions and responsibilities*
   The responsibility for planning functions should be clearly spelt out at different levels, from the local forest management unit level towards the national level.

3. Mangrove Silviculture

For those mangrove areas set aside for forest production purposes, a silvicultural system must be in place to support the intended management objectives and

operational goals. A silvicultural plan is a tool to gradually transform the forest stands into more manageable and efficient productive entities.

3.1 Silvicultural systems

The silvicultural system to be applied depends on the ease with which the desirable species can regenerate themselves naturally in the disturbed environment caused by the forest harvesting and/or the degree to which they lend themselves to artificial regeneration methods. There are few ready made silvicultural systems which can be used directly in mangrove forests without some adaptations to suit local situations. Clear- and selection-felling are the two major silviculture systems that are applied to mangroves. Their main advantages and disadvantages are briefly discussed and summarized in the following:

3.1.1 Clear-felling systems

For those mangrove forests composed of a single dominant tree species in even-aged stands, clear felling systems are often the most appropriate. Clear-felling systems aim to re-establish an even-aged stand by removing the mature stand in a single operation. Where the principal species are light demanding and can regenerate naturally, and the sites are favourable, such systems may be very cost-effective. The Matang mangroves in Malaysia, with *Rizophora apiculata* as the main species, have been managed over three rotations using clear-felling systems in blocks without any major problems, except that the more marginal sites have to be artificially regenerated. The visual impact after logging can be very disconcerting to non-foresters and conservationists. It should not be practised in areas where ecotourism is contemplated and the felling coupes should not be too extensive. A "clear-felling in alternate strips" system, with and without retained standards (seed-bearers) is practised in several countries (Thailand, Venezuela, Cuba and Costa Rica). Felling strips are aesthetically more acceptable. The prospects of natural regeneration are enhanced due to the narrow width and the long borders relative to the size of the area felled and management control is simple to apply. This system, due to its simplicity, is recommended where there is a shortage of trained personnel and/or skilled workers. It is also suitable for those countries where mangroves are newly brought under management.

3.1.2 Selection systems

Where mangrove forests are composed of a mixture of species, selection systems are more appropriate. Selection systems are characterised by two conditions: viz., the stands are uneven-aged, and the forest cover is never completely removed so as to deprive advance growth and seedlings of shelter and shade. Generally, such systems favour shade tolerant species but the degree of canopy opening may be manipulated to favour light demanders as well. A selection system has been practised in the Sundarbans Reserved Forests in Bangladesh for a long time and also in the Ayeyarwady mangroves in Myanmar. This is an environment-friendly system in that the merchantable trees are harvested periodically and over all parts of the forests without major disturbances in the forest canopy. As logs are usually floated out of the forest and transported out of the mangroves by using river barges, damages caused by road building and skidding are minimal or either non- existent in mangroves. In practice, however, unless the forests are adequately stocked, and the technical and subordinate staff are well trained coupled with responsible timber contractors, management can be very complex.

A variant of the Selection method is Group Selection. This system creates larger felling gaps, that favours the regeneration of light demanding species and promotes the formation of small groups of even-aged stands. Consequently, harvesting costs are lower and wood extraction is simpler.

3.2 Choice of species

A species preference list, based on ecological, silvicultural and marketing requirements, should be drawn up as a guide in prioritising treatment. The species, which are selected as desirable, vary according to ecosystem type, location and market demand. In Costa Rica, *Rhizophora harrisonii* and *R. mangle* are desirable species, whereas in Sierra Leone, West Africa, *R. mangle* is a dwarf form and *R. racemosa* is the preferred species. In Malaysia, Thailand and the Mekong Delta in Vietnam *Rhizophora conjugata, R. apiculata* and *R. mucronata* are highly favoured. In the Bangladesh Sundarbans, Sundri (*Heritiera fomes*) is the prime timber species, followed by Gewa (*Excoecaria agallocha*) a proven pulp species. In the Guanal

mangroves in Cuba *Avicennia germinans* is the favoured species as the wood is suitable for railway ties and utility timber.

4. Integration and Interaction of Mangrove Management with the Development of Other Sectors in Coastal Zones

Policy and decision-making is still rarely implemented in mangroves with sufficient understanding of the impact the development of one sector bears on an other and on the complex environmental interactions in coastal areas. The fragility of mangrove ecosystems on one hand, and the fast increasing coastal population (leading to many conflicting demands on the existing coastal natural resources) on the other hand, calls for a greater effort to ensure the integration of mangrove management activities into the overall planning and development programmes for the entire coastal zone of the country or region.

Clearly, it is becoming more and more difficult to manage any one particular coastal natural resource, such as a mangrove forest, in the absence of a comprehensive, integrated, framework for policy planning and management of the entire coastal zone. The overall objective of Integrated Coastal Zone Management (ICZM), is to provide for the best long-term and sustainable use of coastal natural resources in the country and for the maintenance of the most beneficial natural environment. ICZM is an interdisciplinary planning exercise. It considers, coordinates and integrates the interests of all appropriate economic sectors involved in the utilization of coastal resources. It is particularly useful in solving problems that exist between the various users groups in mangroves. In the Sundarbans mangroves of Bangladesh for example, an ICZM plan assists in resolving conflicts among fishermen, foresters, tourism operators, oil and gas development agencies, and public works where all these sectors are all attempting to use mangrove lands simultaneously.

The planning effort to achieve an adequate ICZM is launched by consultations among the many resource user groups in and around the mangroves. A crucial step, once the planning area has been defined, is an exchange of information about the basic characterization of the land itself, the socio-economical situation of the people concerned, their political commitment with the aimed targets of the plan; and the

organization of administrations and services. The range of information and amount of detail needed will vary according to the level of planning.

There are still many constraints which impede a successful integration of mangrove forest development within ICZM. These constraints are mainly of a socio-economic nature. In addition, forests are often seen as an obstacle to development rather than a resource to support, and direct and indirect contributions of forests to food security are underestimated. ICZM can serve as a framework to correct some of these misconceptions among politicians, the public opinion and the media.

5. Conclusions

Worldwide, mangrove forests are coming under increasing pressure as a result of population growth in coastal regions and expanding (non-forest based) economic activity in mangroves such as commercial shrimp farming. Increasing and conflicting demands on mangrove resources requires governments to establish criteria, priorities and actions, based on available information and its analysis, to regulate the uses of mangroves within the framework of an Integrated Coastal Zone Management plan. Such analysis has to focus on the number of people affected and benefiting from alternative land use options, the degree of social disruption and the economic, financial and environmental costs. The setting of priorities raises, in turn, a number of institutional issues and capability requirements.

For a successful conservation and management of mangroves, people and governments alike must be convinced that the land planned to remain under forest cover is at least equally or more valuable when kept as forest than if converted into another form of land use. Social and economic benefits emanating from mangroves, and their sustainable use, must be maintained and enhanced at the local as well at the national level. People living in or adjacent to these forests must be closely involved in all stages of formulation and implementation of mangrove management plans and be given the chances to gain an equitable share of the revenues generated from managing these resources.

Bibliography

This document is largely based on the following two FAO publications:

FAO, 1993. *Integrated Management of Coastal Zones.* FAO Fisheries Technical

Paper nr. 327, 167 p.

FAO, 1994. *Mangrove Forest Management Guidelines.* FAO Forestry Paper nr. 117, 319 p.

PART C
INTEGRATION OF FORESTRY INTO COASTAL AREA MANAGEMENT

1. Forests and forestry activities in coastal areas

Forests are defined by the FAO Forestry Department as `all vegetation formations with a minimum of 10 percent crown cover of trees and/or bamboo with a minimum height of 5 m and generally associated with wild flora, fauna and natural soil conditions'. In many countries, coastal areas such as beaches, dunes, swamps and wildlands - even when they are not covered with trees - are officially designated as `forested' lands and thus fall under the management responsibility of the Forestry Department or similar agency.

Forest resources (including wildlife) of coastal areas are frequently so different from their inland counterparts as to require different and special forms of management and conservation approaches. Mangroves and tidal forests for example have no parallels in terrestrial uplands. As a result, the information, policy and management requirements concerning integrated coastal area management (ICAM) for forestry are also different.

1.1 COASTAL FOREST ECOSYSTEMS

In each of the climatic regions of the world, inland forests and woodlands may extend to the sea and thus form part of the coastal area. In addition to such formations, controlled by climatic factors, special forest communities, primarily controlled by edaphic factors and an extreme water regime, are found in coastal areas and along inland rivers. Such forest communities include: mangroves, beach forests, peat swamps, periodic swamps (tidal and flood plain forests), permanent freshwater swamps and riparian forests. Of these, the first three types are confined to the coastal area, whereas the remaining types can also be found further inland.

1.1.1 Mangroves

Mangroves are the most typical forest formations of sheltered coastlines in the tropics and subtropics. They consist of trees and bushes growing below the high water level of spring tides. Their root systems are regularly inundated with saline water, although it may be diluted by freshwater surface runoff. The term `mangrove' is applied to both the ecosystem as such and to individual trees and shrubs.

Precise data on global mangrove resources are scarce. Estimates are that there are some 16 million ha of mangrove forests worldwide (FAO, 1994a). The general distribution of mangroves corresponds to that of tropical forests, but extends further north and south of the equator, sometimes beyond the tropics, although in a reduced form, for instance in warm temperate climates in South Africa and New Zealand to the south and in Japan to the north.

Mangrove forests are characterized by a very low floristic diversity compared with most inland forests in the tropics. This is because few plants can tolerate and flourish in saline mud and withstand frequent inundation by sea water.

There are two distinct biogeographic zones of mangroves in the world: those of West Africa, the Caribbean and America; and those on the east coast of Africa, Madagascar and the Indo-Pacific region. While the first contain only ten tree species, mangroves of the Indo-Pacific are richer, containing some 40 tree species (excluding palms).

Most of the animal species found in mangroves also occur in other environments, such as beaches, rivers, freshwater swamps or in other forest formations near water. On the whole, animal species strictly confined to mangroves are very few (crabs have a maximum number of species in mangroves). In many countries however, the mangroves represent the last refuge for a number of rare and endangered animals such as the proboscis monkey (*Nasalis larvatus*) in Borneo, the royal Bengal tiger (*Panthera tigris*) and the spotted deer (*Axix axis*) in the Sundarbans mangroves in the Bay of Bengal, manatees (*Trichechus* spp.) and dugongs (*Dugong dugon*). Mangroves are also an ideal sanctuary for birds, some of which are migratory. According to Saenger *et al.* (1983), the total list of mangrove bird species in each of the main biogeographical regions include from 150 to 250 species. Worldwide, 65 of these are listed as endangered or vulnerable, including for instance the milky stork (*Mycteria cinerea*), which lives in the rivers of mangroves.

1.1.2 Beach forests

This type of forest is in general found above the high-tide mark on sandy soil and may merge into agricultural land or upland forest. Sand dune and beach vegetations are mostly scrub-like with a high presence of stunted tree growths. These coastal forest ecosystems are adapted to growing conditions that are often difficult as a result of edaphic[1] or climatic extremes (strong winds, salinity, lack or excess of humidity). They are very sensitive to modifications of the

ecosystem. A slight change in the groundwater level for example might eliminate the existing scrub vegetation. Sand dune and beach vegetations have an important role in land stabilization and thus prevent the silting up of coastal lagoons and rivers, as well as protecting human settlements further inland from moving sand dunes.

The dominant animal species on the adjacent beaches are crabs and molluscs. The beaches are also very important as breeding sites for sea turtles and, therefore, attract predators of turtles' eggs, such as monitor lizards (*Varanus* sp.).

1.1.3 Peat swamp forests

This is a forest formation defined more on its special habitat than on structure and physiognomy. Peat swamp forests are particularly extensive in parts of Sumatra, Malaysia, Borneo and New Guinea, where they were formed as the sea level rose at the end of the last glacial period about 18 000 years ago. Domed peat swamps can be up to 20 km long and the peat may reach 13 m in thickness in the most developed domes. Animals found in peat swamps include leaf-eating monkeys such as the proboscis monkey and the langurs found in Borneo.

1.1.4 Periodic swamps

As with peat swamp forests, these are defined mainly by habitat and contain a diverse assemblage of forest types periodically flooded by river water (daily, monthly or seasonally). Periodic swamps can be further subdivided into tidal and flood plain forests. Tidal forests are found on somewhat higher elevations than mangroves (although the term is sometimes used to describe mangroves as well). Such forests are influenced by the tidal movements and may be flooded by fresh or slightly brackish water twice a day. Tidal amplitude varies from place to place. Where the amplitude is high, the area subject to periodic tidal flushing is large

and usually gives rise to a wide range of ecological sites. The natural vegetation in tidal forests is more diverse than that of mangroves, although still not as diverse as that of dense inland forests.

Flood plains are areas seasonally flooded by fresh water, as a result of rainwater rather than tidal movements. Forests are the natural vegetation cover of riverine flood plains, except where a permanent high water-table prevents tree growth.

The Amazon, which has annual floods but which is also influenced by tides to some 600 km inland, has very extensive permanent and periodic swamp forests. The alluvial plains of Asia once carried extensive periodic swamp forests, but few now remain as these have mostly been cleared for wetland rice cultivation. The Zaire basin is about one-third occupied by periodic swamp forests, many disturbed by human interventions, and little-studied (Whitmore, 1990).

Throughout the world, flood plains are recognized as being among the most productive ecosystems with abundant and species-rich wildlife.

1.1.5 Freshwater swamp forests

The term is here used for permanent freshwater swamp forests. As opposed to periodic swamps, the forest floor of these is constantly wet and, in contrast to peat swamps, this forest type is characterized by its eutrophic (organomineral) richer plant species and fairly high pH (6.0 or more) (Whitmore, 1990).

1.1.6 Riparian forests

Also called riverine or gallery forests. These are found adjacent to or near rivers. In the tropics, riparian forests are characterized as being extremely dense and productive, and have large numbers of climbing plants.

In addition to their aesthetic and recreational values, riparian forests are important in preserving water quality and controlling erosion and as wildlife refuges especially for amphibians and reptiles, beavers, otters and hippopotamus. Monkeys and other tree-dwelling mammals and birds are often abundant in riparian forests.

1.1.7 Other coastal forest ecosystems

Other coastal forest ecosystems include: savannah woodlands, dry forests, lowland rain forests, temperate and boreal forests and forest plantations. Many of the natural coastal forests are under severe threat. Most of the lowland rain forests have vanished as a result of the ease with which commercial trees, standing on slopes facing the sea or other accessible coastal waters, could be harvested merely by cutting them down and letting them fall into the nearby water. As a consequence, most coastal dry forests and savannah woodlands have been seriously degraded by overexploitation for fuelwood and construction poles, and conversion to agriculture or to grazing lands through the practice of repeated burning.

Coastal plantations have often been established for both production and protection purposes. As an example of the latter, coastal plantations were established in Denmark as far back as the 1830s to stabilize sand dunes which were moving inland and which had already covered several villages.

1.2 THE SOCIO-ECONOMIC IMPORTANCE OF COASTAL FORESTS

The total economic value of coastal forests stems from use values (direct uses, indirect uses and option values) and non-use values (existence and bequest values).[2] Table C.1 gives examples of the different values as related to coastal forests. Table C.4 gives

examples of valuation approaches applicable to the various types of forest products or services.

TABLE C.1

Values related to coastal forests

Use values	**Use values**	**Use values**	**Non-use values**
Direct uses	**Indirect uses**	**Option values**	**Existence and bequest values**
Timber	Nutrient cycling (including detritus for aquatic food web)	Premium to preserve future direct and indirect uses (e.g. future drugs, genes for plant breeding, new technology complement)	Forests as objects of intrinsic value, or as a responsibility (stewardship)
Non-timber forest products (including fish and shellfish)	Watershed protection		Endangered species
Recreation	Coastal protection		Charismatic species
Nature tourism	Air and water pollution reduction		Threatened or rare habitats/ecosystems
Genetic resources	Microclimate function		Cherished landscapes
Education and research	Carbon store		Cultural heritage
Human habitat	Wildlife habitat (including birds and aquatic species)		

Source: adapted from Pearce, 1991.

Direct use values, in particular the commercial value of timber and other forest products, often dominate land-use decisions. The wider social and environmental values are often neglected, partly as a result of the difficulty in obtaining an objective estimate of these, even though in many cases these values exceed the value of traded and untraded forest products.

Indirect use values correspond to `ecological functions' and are at times referred to as environmental services. Some of these occur off-site, i.e. they are economic externalities and are therefore likely to be ignored when forest management decisions are made.

The option existence and bequest values are typically high for coastal forests - especially for tropical rain forests or forests containing endangered or charismatic animal species.

1.2.1 Direct use values of coastal forests

In addition to the activities carried out within the coastal forests (see below), small- and large-scale forest industries are also often found in coastal areas, taking advantage of the supply of raw materials and the ease of transport by waterways and roads, the existence of ports for export, etc. In addition to sawmills and pulp and paper mills, these forest industries may include veneer and particle board factories, charcoal kilns (particularly near mangrove areas), furniture makers and commercial handicraft producers. There is little information available on the value of marketed goods from coastal forests. In general, their contribution to national gross domestic product (GDP) is small and this fact may lead to their being neglected. Commercial wood production from coastal forests ranges from timber, poles and posts to fuelwood, charcoal and tannin. Non-wood products include thatch, fruits, nuts, honey, wildlife, fish, fodder and medicinal plants. A list of forest-based products obtainable from mangroves is shown in Box C.1.

BOX C.1

Products obtainable from mangroves

A. Mangrove forest products

Fuel	**Food, drugs and beverages**
Fuelwood	Sugar
Charcoal	Alcohol

Construction Timber, scaffolds Heavy construction Railway sleepers Mining props Boat building Dock pilings Beams and poles Flooring, panelling Thatch or matting Fence posts, chipboards	Cooking oil Vinegar Tea substitute Fermented drinks Dessert topping Condiments (barks) Sweetmeats (propagules) Vegetables (fruit/leaves)
Fishing Fishing stakes Fishing boats Wood for smoking fish Tannin for net/lines Fish attraction devices	**Household items** Glue Hairdressing oil Tool handles Rice mortar Toys Match sticks Incense
Textile, leather Synthetic fibres (rayon) Dye for cloth	**Other products** Tannin to preserve leather and tobacco Medicines Packing boxes Wood for smoking sheet rubber Fuelwood for salt making, brick making and bakeries
Agriculture Fodder	
Paper products Paper - various	
B. Other natural products Fish/Crustaceans Honey Wax Birds Mammals Reptiles Other fauna	

Source: adapted from FAO, 1984a.

Accounts of government forest revenues are often a poor indication of the value of the forest products. As an example, in 1982/83, in the Sundarbans mangroves of Bangladesh, some of the royalties collected by the forestry department were exceedingly low: for sundri (*Heritiera fomes*) fuelwood for instance, the market rate was nearly 40 times the royalty rate; and for shrimps the minimum market rate to royalty rate ratio at the time was 136:1 (FAO, 1994a).

Frequently, the value of untraded production (e.g. traditional fishing, hunting and gathering) in mangrove forest areas is substantial, the value often exceeding that from cultivated crops and from formal-sector wage income (Ruitenbeek, 1992).

Other direct use values of the coastal forests include their social functions. Coastal forests provide habitat, subsistence and livelihood, to forest dwellers, thereby supplying the means to hold these communities together, as well as opportunities for education, scientific research, recreation and tourism. Worldwide, the lives of millions of people are closely tied to productive flood plains, the associated periodic river floods and subsequent recessions. The socio-economic importance of these areas is especially evident in the more arid regions of the developing world. The seasonal ebb and flood of river waters determines the lifestyles and agricultural practices of the rural communities depending on these ecosystems.

Examples of the educational value of coastal forests are found in peninsular Malaysia, where more than 7 000 schoolchildren annually visit the Kuala Selangor Nature Park, a mangrove area with boardwalk, education centre, etc. (MNS, 1991). In nearby Kuantan, along the Selangor river, a main tourist attraction are evening cruises on the river to watch the display of fireflies and,

along the Kinabatangan river in Sabah, cruises are undertaken to watch the proboscis monkeys as they settle in for the night in the riparian forest.

In terms of employment opportunities in coastal forests, ESCAP (1987) estimated the probable direct employment offered by the Sundarbans mangrove forest in Bangladesh to be in the range of 500 000 to 600 000 people for at least half of the year, added to which the direct industrial employment generated through the exploitation of the forest resources alone equalled around 10 000 jobs.

1.2.2 Indirect use values of coastal forests

A prominent environmental role of mangroves, tidal, flood plain and riparian forests is the production of leaf litter and detrital matter which is exported to lagoons and the near-shore coastal environment, where it enters the marine food web. Mangroves and flood plains in particular are highly productive ecosystems and the importance of mangrove areas as feeding, breeding and nursery grounds for numerous commercial fish and shellfish (including most commercial tropical shrimps) is well established (Heald and Odum, 1970; MacNae, 1974; Martosubroto and Naamin, 1977). Since many of these fish and shellfish are caught offshore, the value is not normally attributed to mangroves. However, over 30 percent of the fisheries of peninsular Malaysia (about 200 000 tonnes) are reported to have some association with the mangrove ecosystem. Coastal forests also provide a valuable physical habitat for a variety of wildlife species, many of them endangered.[3]

Shoreline forests are recognized as a buffer against the actions of wind, waves and water currents. In Viet Nam, mangroves are planted in front of dykes situated along rivers, estuaries and lagoons under tidal influence, as a protection measure (L¿yche, 1991). Where mangroves have been removed, expensive coastal

defences may be needed to protect the agricultural resource base. In arid zones, sand dune fixation is an important function of coastal forests, benefiting agricultural and residential hinterland.

In addition, mangrove forests act as a sediment trap for upland runoff sediments, thus protecting sea grass beds, near-shore reefs and shipping lanes from siltation, and reducing water turbidity. They also function as nutrient sinks and filter some types of pollutants.

1.2.3 Option value of coastal forests

The option value of coastal forests - the premium people would be prepared to pay to preserve an area for future use by themselves and/or by others, including future generations - may be expected to be positive in the case of most forests and other natural ecosystems where the future demand is certain and the supply, in many cases, is not.

An example of how mangrove values are estimated is given in Box C.2.

BOX C.2

Net present value of mangrove forestry and fisheries in Fiji

Using data on the amounts of wood and fish actually obtained from mangrove areas and their market value and harvesting costs, the net present value (NPV) of forestry and fisheries were estimated for three mangrove areas in Fiji, using the incomes or productivity approach with a 5 percent social discount rate and a 50-year planning horizon.

Forestry net benefits

Commercial net benefits were calculated as wood harvested multiplied by market value, minus harvesting costs.

Subsistence net benefits were calculated using the actual amount of wood harvested multiplied by the shadow value in the form of the price for inland or mangrove fuelwood sold by licensed wood concessionaires.

Taking the species composition of the mangrove area into account, the weighted average NPV was estimated for each of the three main mangrove areas yielding the following:

NPV: US$164 to $217 per hectare.

Fisheries net benefits

In only one of the three areas was the fisheries potential judged to be fully utilized and the data are based on this area.

Annual catch (commercial and subsistence): 3 026 tonnes. Area of mangroves: 9 136 ha, thus averaging 331 kg per hectare, equalling $864 per hectare in market value annually.

By taking harvesting costs into account, the following result was obtained:

NPV: $5 468 per hectare, or approx. $300 per hectare per year.

This is assuming a proportionate decline in the fisheries. With only a 50 percent decline (as some of the fish are not entirely dependent on the mangroves) the figure for the NPV is $2 734 per hectare.

Other services

The value of mangroves for nutrient filtering has been estimated, using the alternative cost or shadow project method, by Green (1983), who compared the costs of a conventional waste water treatment plant with the use of oxidation ponds covering 32 ha of mangroves. An average annual benefit of $5 820 per hectare was obtained. This figure is, however, only valid for small areas of mangroves and, as it represents the average, not the marginal value, it should be treated with caution.

The option value and the existence value of mangroves are not captured using the above incomes approach and an attempt to include these values was made by using the compensation approach, as the loss of fishing rights in Fiji caused by the reclamation of mangroves has been compensated by the developers. The recompense sum is determined by an independent arbitrator within a non-market institution. Large variations in recompense sums

were however recorded ($49 to $4 458 per hectare) according to the end use and the bargaining power of the owner of the fishing rights. Using 1986 prices the following results were obtained:

Average: $30 per hectare for non-industrial use and $60 per hectare for industrial use.

Maximum: $3 211 per hectare.

By adding the benefits foregone in forestry and fisheries, it can be concluded that the minimum NPV of the mangroves of Fiji is $3 000 per hectare under present supply and demand and existing market and institutional organizations.

Source: Lal, 1990.

1.3 SPECIAL CHARACTERISTICS OF FORESTS AND FORESTRY ACTIVITIES IN COASTAL AREAS

1.3.1 Diverse natural and human-incurred ecosystems

The term coastal forests covers a wide range of different ecosystems many of which can still be classified as natural ecosystems, although - particularly in the temperate region - they may have been modified through human interventions over the years. However, they still generally contain a greater biological diversity (at genetic, species and/or ecosystem levels) than most agricultural land.

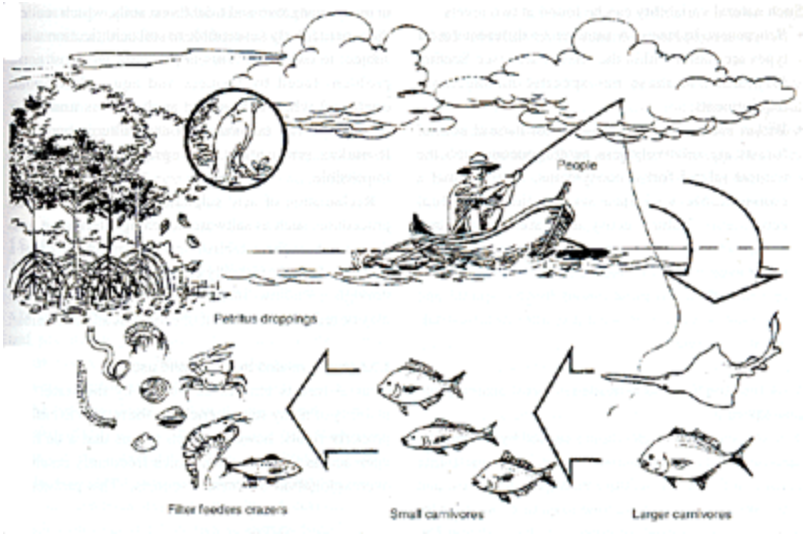
1.3.2 Links with other terrestrial and marine ecosystems

The most important characteristics of coastal forests are probably their very strong links and interdependence with other terrestrial and marine ecosystems.

Mangroves exemplify such links, existing at the interface of sea and land, and relying, as do tidal and flood plain forests, on fresh water and nutrients supplied by upland rivers to a much larger extent than more commonly found inland forest types. Figure C.1 illustrates the mangrove-marine food web.

FIGURE C.1

The mangrove-marine food web



Source: CV-CIRRD, 1993.

In the arid tropics, there may be no permanent flow of fresh water to the sea, and the leaf litter and detritus brought to the marine ecosystem by tidal flushing of coastal mangrove areas, where these exist, is the only source of nutrients from the terrestrial zone during the dry season. This further magnifies the role of mangroves in the marine food web. In the Sudan, for example, such a role is considered to be a crucial function of the narrow mangrove fringe found along parts of the Red Sea coast (L¿yche-Wilkie, 1995).

As for the wildlife species found in coastal forests, most are dependent on other ecosystems as well. Mammals may move between different ecosystems on a daily or seasonal basis, water birds are often migratory, and many commercial shrimps and fish use the mangroves as spawning ground and nursery sites but move offshore in later stages of their life cycle. Anadromous species, such as salmon, spawn in freshwater rivers, but spend most of their life cycle in marine waters; catadromous species on the other hand, spawn at sea, but spend most of their life in freshwater rivers. These species probably thus pass through coastal forests at some point in their life.

1.3.3 Large risks and pervading uncertainty

A variety of natural or human-incurred risks and uncertainties affect the sustainable management of coastal forest resources. Some natural risks may be exacerbated by human activities. Uncertainty arises from: the natural variability inherent in coastal forest ecosystems; the incomplete knowledge of the functioning of complex natural ecosystems; the long time-frame needed in forest management; and the inability to predict accurately the future demands for goods and services provided by natural and cultivated forests.

Natural risks. These include strong winds, hurricanes and typhoons, floods (including tidal waves) and droughts, which can all cause considerable damage to coastal forests.

Global climate change caused by human actions may, through a rise in temperatures, result in `natural' risks such as a rise in sea level, changes in ocean currents, river runoff and sediment loads, and increases in the frequency and severity of floods, drought, storms and hurricanes/typhoons.

Human-incurred threats. Human-incurred threats to coastal forests stem mainly from the competition for land, water and forest resources. These include conversion of coastal forest to other uses, building of dams and flood control measures, unsustainable use of forest resources both within the coastal area and further upland, and pollution of air and water.

In many developing countries, deforestation continues to be significant; the annual loss of natural forests resulting from human pressures amounted to an estimated 13.7 million ha in the 1990 to 1995 period (FAO, 1997d). Human-incurred threats to forests are often more pronounced in coastal areas as a result of the relatively high population density of such areas caused by the availability of

fertile soils, fishery resources and convenient trade links with other domestic and foreign markets.

Natural variability. One particular uncertainty faced by forest managers relates to the natural variability exhibited by the coastal forest and wildlife resources. Such natural variability can be found at two levels:

- *Between ecosystems*. A number of different forest types are found within the coastal area (see Section 1.1). Each of these has specific management requirements.
- *Within ecosystems.* Although most natural coastal forests are relatively less heterogeneous than the natural inland forest ecosystems, there is still a considerable variation within the individual ecosystems. Natural ecosystems are dynamic and changes in forest structure and species composition occur even without human intervention. In addition, and in contrast to most inland forests, spatial and temporal instability is a main feature of terrestrial-aquatic ecotones.

1.3.4 The long time-frame needed in forest planning and management

The above risks and uncertainty caused by incomplete knowledge are compounded by the long time-frame needed in forest and wildlife management. Trees, and some animals, need a long time to mature: 30 years for mangrove forests used for poles and charcoal; and 150 years for oak (*Quercus*) grown for timber in temperate forests. This long period between regeneration and harvesting makes the selection of management objectives more difficult because of further uncertainty regarding future market preferences for specific forest and wildlife products or services, future market prices, labour costs, etc.

1.3.5 Irreversibility of certain actions

An important characteristic of natural ecosystems (including natural coastal forests) is that once a natural ecosystem has been significantly altered, through unsustainable levels or inappropriate methods of use, it may be impossible to restore it to its original

state. Conversion of natural coastal forests to other uses is an extreme example.

It may be possible to replant mangrove trees in degraded areas or in abandoned shrimp ponds, but the resulting plantation will have far fewer plant and animal species than the original natural mangrove ecosystem.

Acid sulphate soils. A particular cause of concern with regard to irreversibility is the high pyrite (FeS_2) content in many mangrove and tidal forest soils, which renders them particularly susceptible to soil acidification when subject to oxidation. This is probably the most acute problem faced by farmers and aquaculture pond operators when converting such forests and other wetlands to rice cultivation or aquaculture ponds, and it makes restoration of degraded areas almost impossible.

Reclamation of acid sulphate soils requires special procedures such as saltwater leaching alternating with drying out, or the establishment and maintenance of a perennially high, virtually constant groundwater-table, through a shallow, intensive drainage system. These may be technically difficult or economically unfeasible.

1.3.6 Issues related to tenure and usufruct

Coastal forests tend to be owned by the state. The inability of many state agencies in the tropics to enforce property rights, however, often means that a de facto open access regime exists, which frequently results in overexploitation of forest resources.[4] This problem is only partly overcome by awarding concessions and usufructuary rights as these are often short-term in nature and not transferable and, therefore, fail to provide incentives for investments and prudent use of the resources.

Where the state agency has the ability to enforce laws and regulations and the government has a policy of promoting

multipurpose management of state-owned forests, sustainable forest management can be achieved (Box C.3).

BOX C.3

Mangrove stewardship agreement in the Philippines

One example of successful multipurpose management of a state-owned coastal forest using a participatory approach and aiming to restore the more traditional communal ownership of forests, is the issuing of `Mangrove Stewardship Agreements' in the Philippines. Local communities (or private individuals) obtain a 25-year usufruct lease over a given mangrove area with the right to cut trees selectively, establish new mangrove plantations and collect the fish and shellfish of the area based on a mutually agreed mangrove forest management plan. The Department of Environment and Natural Resources (DENR), which implements this scheme, will assist the local communities and individuals in preparing this management plan if needed. Local NGOs are also contracted by DENR to assist in the initial `Community Organizing' activities, which include an awareness campaign of the benefits obtainable from mangrove areas and an explanation of the steps involved in obtaining a Stewardship Agreement.

1.3.7 Institutional issues

As a result of the variety of goods and services provided by coastal forests and their links with other ecosystems, a large number of institutions often have an interest in, and sometimes jurisdiction over parts of, the coastal forest ecosystems. This raises the risk of conflict between institutions, even within a single ministry.

The forestry department or its equivalent generally has jurisdiction over the coastal forest resources. However, the parks and wildlife department, where it exists, may have jurisdiction over the forest wildlife, and the fisheries department almost certainly has jurisdiction over the fisheries resources found in the rivers within coastal forests, and may regulate the use of mangrove areas for cage and pond culture. Other institutions with an interest in coastal forests include those related to tourism, land-use planning, mining, housing, ports and other infrastructure.

1.3.8 Lack of awareness of benefits and their economic value

In many countries, there is often little public awareness of the variety of benefits provided by coastal forests, and campaigns should be conducted to overcome this. Mangroves and other swamp forests in particular have often been regarded as wastelands with little use except for conversion purposes. As a result of the low commercial value of wood products compared with the potential value of agriculture or shrimp production, conversion has often been justified, in the past, on the basis of a financial analysis of only the direct costs and benefits. Such analyses, however, do not take into account the value of the large number of unpriced environmental and social services provided by coastal forests, which in many cases far outweigh the value of any conversion scheme.[5]

1.3.9 Implications for the management of coastal forests

The ecological links between coastal forests and other terrestrial and marine ecosystems and the institutional links between the forestry sector and other sectors, must be addressed through an area-based strategy that takes a holistic approach to sustainable development. An ICAM strategy provides the appropriate framework for such an approach.

The nature of coastal forests as described above calls for a precautionary approach[6] to the management of their resources and the adoption of flexible strategies and management plans drawing on the knowledge of the local communities.

The precautionary principle can be incorporated into coastal forest management by imposing sustainability constraints on the utilization of coastal forest ecosystems. Other measures include environmental impact assessments, risk assessments, pilot projects and regular monitoring and evaluation of the effects of management. Research, in particular on the interdependence of

coastal forests and other ecosystems and on the quantification and mitigation of negative impacts between sectors, is also needed. Environmental impact assessments[7] should be undertaken prior to conversions or other activities that may have a significant negative impact on coastal forest ecosystems. Such activities may arise within the forest (e.g. major tourism development) or in other sectors outside the forest (e.g. flood control measures). Where there is insufficient information on the impact of proposed management actions, applied research and/or pilot projects should be initiated.

Public participation in the management of coastal forest resources will increase the likelihood of success of any management plan and should be accompanied by long-term and secure tenure/usufruct.

[1] See Glossary.
[2] For a description of these concepts, see Part A, Box A.24.
[3] See Section 1.1.
[4] See Part A, Section 1.6.1 and Box A.2. Also Part E, Box E.7.
[5] See Part A, Section 1.6.1 and Boxes A.22 and A.24.
[6] See Part A, Section 1.6.3 and Boxes A.3 and A.5.
[7] See Part A, Box A.6.

BACK TOP PAGE

Mangrove Forest Ecology

THE MANGROVE FOREST
MAP Working Paper by Alfredo Quarto,
Director, Mangrove Action Project
Probably no other distinct plant community has attracted as much curiosity and scientific attention for as long as have the mangrove forests. "Rollet's (1981) annotated bibliography lists 5,608 published titles through 1975 with one of the first being the written account from the chronicle of Nearchus, dating back to the Greek mariners of 325 BC." (Snedaker, S.C., University of Miami, Division of Marine Biology and Fisheries)

LIVING AT THE EDGE OF THE SEA
Photo - Mangrove Forest, Bhitankanika,Orissa, India

"One perceives a forest of jagged, gnarled trees protruding from the surface of the sea, roots anchored in deep, black, foul-smelling mud, verdant crowns arching toward a blazing sun...Here is where land and sea intertwine, where the line dividing ocean and continent blurs, in this setting the marine biologist and the forest ecologist both must work at the extreme reaches of their disciplines..." ("Caribbean Mangrove Swamps" by Klause Rutzler and Ilka C. Feller, Scientific American, March 1996, p. 94)

Mangroves are the rainforests by the sea. "The majority of the subtropical and tropical coastline is dominated by mangroves, estimated to cover an area of 22 million hectares. However, over the past several decades, the global area in mangroves has increasingly diminished as a result of a variety of human activities, such as overharvesting, freshwater diversion and conversion to other uses."(Snedaker, S.C., University of Miami, Division of Marine Biology and Fisheries, personal correspondence.)
Mangrove forests are comprised of taxonomically diverse, salt-tolerant tree and other plant species which thrive in inter-tidal zones of sheltered tropical shores, "overwash" islands, and estuaries. Mangrove trees have specially adapted aerial and salt-filtering roots and salt-excreting leaves that enable them to occupy the saline wetlands where other plant life cannot survive.

A CORNUCOPIA OF LIFE
Mangrove forests are vital for healthy coastal ecosystems. The forest detritus, consisting mainly of fallen leaves and branches from the mangroves, provides nutrients for the marine environment and supports immense varieties of sea life in intricate food webs associated directly through detritus or indirectly through the planktonic and epiphytic algal food chains. (Note: Plankton and benthic algae are primary sources of carbon in the mangrove ecosystem, in addition to detritus.)
The shallow inter-tidal reaches that characterize the mangrove wetlands offer refuge and nursery grounds for juvenile fish, crabs, shrimps, and mollusks. Mangroves are also prime nesting and migratory sites for hundreds of bird species. In Belize, for instance, there are over 500 species of birds recorded in mangrove areas. Additionally, manatees, crab-eating monkeys, fishing cats, monitor lizards, sea turtles, and mud-skipper fish utilize the mangrove wetlands.

THE ORIGIN OF THE SPECIES
Photo - Red Mangroves, Trang, Thailand

Scientists theorize that the earliest mangrove species originated in the Indo-Malayan region. This may account for the fact that there are far more mangrove species present in this region than anywhere else. Because of their unique floating propagules and seeds, certain of these early mangrove species spread westward, borne by ocean currents, to India and East Africa, and eastward to the Americas, arriving in

WORKSHOP PHOTOS