ISME/cenTER/LABOMAR

Report on the Central and South America Regional Workshop on the Sustainable Management of Mangrove Forest Ecosystems




Universidade Federal do Ceará, Instituto de Ciência do Mar (LABOMAR)

Fortaleza, Ceará, Brazil, March 17-20th 2003

Edited by

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Participants in the World Bank Financed "Code of Conduct for Sustainable Mangrove Management" Workshop, LABOMAR, Fortaleza, Brazil, March 17-20th 2003

Cover Photos

Eroding coastline at the mouth of the Jaguaribe River, Brazil	Roots of *Rhizophora mangle*, Jaguaribe Estuary, Brazil
Large shrimp farm in Ceara with *Laguncularia racemosa* colonising canals, Brazil	Edible mangrove crab *Ucides cordatus* on the table, Brazil

All Cover photos by Dr Elizabeth Ashton, University of Stirling, UK

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PROGRAMME

Monday 17th March

08:30	Registration of Workshop participants.
09:00	Opening ceremony – Prof. de Lacerda & Prof. Sobreira Rocha (Director of LABOMAR)
09:15	Introduction to Workshop objectives – Prof. Macintosh.
10:00	Coffee break and group photograph
10:30-12:00	Session I: Presentation of prepared country case studies (Ecuador, Colombia and Brazil) and discussions.
12:00-13:30	Lunch
13:30-15:00	Session II: Discussion of conceptual framework for a Code of Conduct for Mangrove Forest Ecosystems – Preface, Introduction and Articles 1 and 2.
15:00-15:30	Coffee break
15:30-16:30	Session III: Working group discussions, including follow up to Code.
16:30-17:00	Presentation of the working groups conclusions from Sessions II and III.
19:30	Welcome dinner at a local restaurant.

Tuesday 18th March

08:30-10:00	Session IV: Discuss articles 3, 4 and 5.
10:00-10:30	Coffee break
10:30-12:00	Session V: Discuss articles 6, 7, 8 and 9.
12:00-13:30	Lunch
13:30-15:00	Session VI: Working group discussion and presentation of conclusions.
15:00-15:30	Coffee break
15:30-16:30	Session VII: Discuss articles 10 and 11.
16:30-17:00	Working group discussions and presentations.

Wednesday 19th March

08:00-16:00	Field trip to the mangroves of the Jaguaribe river and to a shrimp farm

Thursday 20th March

08:30-10:00	Session VIII: Discuss articles 12, 13, 14 and 15.

10:00-10:30	Coffee break
10:30-12:00	Session IX: Working groups complete drafting of Code of Conduct.
12:00-13:30	Lunch
13:30-17:00	Session X: Preparation and review of Draft Code of Conduct and Workshop Report.
17:00	Close of Workshop

Friday 21st March

10:00	Visit to the Mangrove Wetland Park in Fortaleza (Projeto Parque Vivo) by Macintosh and Ashton.

OPENING PROGRAMME - CHAIRMAN'S INTRODUCTION

PROF. LUIZ DRUDE DE LACERDA

LABOMAR, FORTALEZA, BRAZIL

Prof. Luiz Drude de Lacerda, acting as ISME's representative, warmly welcomed the audience to the workshop. He briefly described the workshop's planned activities, explaining the great importance of the meeting.

He invited all the attendants to express and share their ideas about the issues that would be discussed in the working sessions, pointing out the need for the wide participation of all the involved parties. He remarked that all the workshop materials are available upon request, to any person.

Finally, he made some observations about web-based databases covering the fields of mangrove research and management, especially the GLOMIS (GLObal Mangrove Information System) database, provided by ISME, which includes thousands of citations of scientific works related to mangrove ecosystems.

OPENING ADDRESS

PROF. CARLOS ARTUR SOBREIRA ROCHA DIRECTOR LABOMAR

(INSTITUTO DE CIENCIAS DO MAR), FORTALEZA, BRAZIL

The Director of Labomar warmly welcomed all the workshop participants and introduced those who had traveled from Ecuador and Colombia.

The Director observed that the Code of Conduct for Sustainable Management of Mangrove Forest Ecosystems was very important to discuss. He thanked the World Bank, ISME (International Society for Mangrove Ecosystems) and CenTER (Centre for Tropical Ecosystems Research) for supporting the meeting and for choosing Fortaleza as the venue.

The Director concluded by hoping that everyone would enjoy the workshop, and that they were most welcome to request any help they might need during their stay in Fortaleza. Finally, Prof. Sobreira Rocha wished all the workshop participants a very successful workshop and declared the meeting open.

WELCOME ADDRESS

PROF. DON MACINTOSH, DIRECTOR, CENTRE FOR TROPICAL ECOSYSTEMS RESEARCH
UNIVERSITY OF AARHUS

It is my great pleasure to be here in Fortaleza, and to welcome you to this important workshop. I am extremely grateful to The Director of Labomar, Prof. Carlos Artur Sobreira Rocha, for agreeing to host our meeting, and for supporting all the arrangements for your participation. Prof Luiz Drude de Lacerda has also been invaluable in co-organising the workshop and putting in place all the logistical requirements. I shall now give you a brief summary of the events leading up to this workshop, explain its main purpose and expected outputs, together with the objectives for the workshop. I would like to thank Mr. Ariel Vaisman for translating this presentation into Portuguese for you, and for his general assistance to the workshop organisers.

The Code of Conduct comes as a concept out of a number of projects. During the World Bank Thematic Review of Shrimp Farming and the Environment, mangroves were repeatedly discussed and reported on. In December 2000, discussions with the World Bank led to an agreement that we would prepare a review report on the status of mangrove biodiversity and conservation, which would serve as a reference text for the subsequent development of a Code of Conduct for the Sustainable Management of Mangrove Ecosystems. The review was prepared as a desk study and submitted to the World Bank in June 2001. The review report included case studies from three pilot countries that we were already familiar with, and where mangrove resource utilisation and conservation management efforts are very important, namely Malaysia, the Philippines and Thailand; a start was also made on a case study from Vietnam, based on our experience there from previous research projects. The preparation of these, and other country case studies follows a standard format set out as a template listing the topics to be covered and the kind of information under each topic.

From this experience, the World Bank then agreed to finance a second contract to expand the work to cover a further 10 countries (as case studies), which are representative of the three main regions of the tropics, South and Southeast Asia, Africa, and Central and South America. With support from a Danida CZM project, Cambodia was also included, making 14 countries in total at the present time. Reflecting the general geographical distribution and importance of mangroves worldwide, seven of the selected countries are in South and Southeast Asia, four in Africa, and four in Central and South America. In recognition of its outstanding role in mangrove conservation and research worldwide, and wide network capacity, ISME (International Society for Mangrove Ecosystems) was then requested to be the contract holder for this second phase of the project.

The first workshop, for South and Southeast Asia, was held in the Institute of Technology (AIT) in Bangkok in October 2002. The second workshop was convened in Accra, Ghana in February 2003 and this is the third and final workshop, in Labomar, Fortaleza, Brazil, to review the draft articles for a Code of Conduct which were formulated in Asia and Africa and to adapt them to make them equally appropriate for Central and South America. It is also an opportunity to seek your expert advice regarding practical examples of mangrove management or problems for management in your countries that we can use to illustrate the

Code of Conduct (these are the boxed examples referred to in the draft code). The supporting work for the Code of Conduct also includes substantial case studies from the 14 selected countries mentioned earlier, and for Central and South America these are Brazil, Colombia and Ecuador. We would of course also welcome case studies from any of the other countries, either now as part of the present phase of the study, or at a later date as a follow on activity.

The draft Code of Conduct, based on the three workshops and other consultations, will be submitted to the World Bank on 30th March 2003. With your help, we can meet this deadline and present a carefully formulated draft Code of Conduct for consideration and endorsement by the World Bank, other concerned international agencies, such as FAO, ITTO and IUCN, and by governments in the many countries throughout the world where the conservation of mangrove forests is an important issue in coastal zone management.

INTRODUCTION TO CODE OF CONDUCT OBJECTIVES

PROF. DON MACINTOSH

The project of which this workshop is a component has the title

"Mainstreaming Conservation of Coastal Biodiversity through Formulation of a Code of Conduct for Sustainable Management of Mangrove Forest Ecosystems".

Workplan

There are FOUR tasks (activities) specified in the contract for the work signed between ISME and the World Bank. Activity 3 includes three regional consultation workshops, this is the third and final workshop for Central and South America. The project terms of reference provided in the next section explain the scope and format for each regional workshop.

ACTIVITY 1

Complete a further 10 country case studies from countries representing major regions of the world where mangroves are a significant natural resource (Bangladesh, India, Vietnam, Ghana, Kenya, Mozambique, Senegal, Brazil, Colombia, Ecuador). In addition, a case study from Cambodia is being contributed from a Danida funded project. National experts assisted by the consultants prepared each case study.

ACTIVITY 2

Consult with policy makers, environmental managers and mangrove specialists in all the countries selected (for case studies), in order to critically examine the information documented in the review and case studies to date, and to prioritise topics to be included in the draft Code of Conduct

ACTIVITY 3

Undertake three regional workshops to consult with institutions and experts, and others concerned with environmental management, in the countries participating in the case studies. The workshops will cover (a) South and Southeast Asia; (b) Africa; and (c) Central and South America.

ACTIVITY 4

To formulate, as outputs from the case studies and workshops, a draft Code of Conduct for consideration by the Bank and its development partners, and a clear strategy recommended to help the countries adopt the Code of Conduct.

Program of Activities

The work is being undertaken by consultants from ISME (International Society for Mangrove Ecosystems, based in Okinawa Japan) in association with CenTER Aarhus (Centre for Tropical Ecosystems Research, University of Aarhus, Denmark). ISME operates four regional centres in Brazil, Fiji, Ghana, and India while CenTER Aarhus has offices in Stirling, Scotland, Bangkok, Thailand and Cantho, Vietnam. The country offices of ISME and CenTER will be used to co-ordinate the regional activities leading to the three planned workshops covering South and Southeast Asia, Africa and Central and South America.

Country Case Studies

The country case studies were based on a structured template to enable standard reporting on the national legal and management framework for mangroves in each country, plus national and local experiences in managing mangroves sustainably. A national expert, assisted by the consultants has prepared each case study.

The countries selected for case studies and follow up consultations are listed below, by region:

South and Southeast Asia

- Bangladesh
- India
- Malaysia
- Philippines
- Thailand
- Vietnam (additional financial support requested from Danida)
- Cambodia (financial assistance requested from Danida)

Africa

- Ghana
- Kenya
- Senegal
- Mozambique (financial support to be requested from Danida)

Central and South America

- Brazil
- Colombia
- Ecuador
- Nicaragua

Template for Preparation of Country Case Studies

Note to authors: Please use a hierarchical pattern for each case study.

Follow these guidelines (adapting where necessary):

- **Brief background to the country**
  - Regional setting
  - Size
  - History
  - Population
  - Short summary of mangrove resources and biodiversity
    (to include genetic level resources, species and habitats)

- **Give examples of the cross-sectoral issues involved in mangrove management**
  - Forestry
  - Fisheries
  - Aquaculture
  - Other sectors (e.g. agriculture, mining)
  - Coastal protection
  - Tourism and recreation
  - Biodiversity conservation
  - Research and education
  - Others

- **Provide information on the existing legislation**
  - Regulatory frameworks
  - Laws and legal status
  - Zoning plans
  - Any other actions enacted by governments to protect mangroves
    (Copies of any written legislation covering mangrove wetlands would be very helpful).

- **Institutional responsibilities for mangroves**

- **Implementation issues**
  - **Are the policy measures working well, or are enforcement or other measures still inadequate?**

- **Co-operation, feedback mechanisms and monitoring**
  - Co-management and other initiatives
  - Role of major stakeholders. Explain how far consultation and co-operation among the main stakeholders has been achieved to date, namely:
    - Governmental departments and agencies
    - Local coastal communities
    - Private sector interests
    - NGOs
    - International community and agencies

- Other problems or constraints

Workshop Conduct

Each regional workshop will bring together 8-10 national representatives and mangrove experts from the above regions, in order to combine knowledge of the legal framework for mangroves in each country with practical experiences of mangrove ecosystem management.

Present Status of the Code of Conduct

Based on our earlier work, plus the consultations during and after the Bangkok workshop for South and Southeast Asia and the Accra workshop for Africa, the Conceptual Framework for a Draft Code of Conduct has developed into a document with 15 major Articles, plus introductory sections, a glossary of terminology used in mangrove management, and a reference list. This is the draft document that we shall follow during the workshop for Central and South America. A summary of its contents is provided below in Table 1.

Table 1: Outline and Articles of the Draft Code of Conduct for the Sustainable Management of Mangrove Forest Ecosystems (version 17th March, 2003)

A Code of Conduct for the Sustainable Management of Mangrove Forest Ecosystems

Macintosh D. J. and Ashton E. C.

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OBJECTIVES OF THE CENTRAL AND SOUTH AMERICA REGIONAL WORKSHOP

Labomar, Fortaleza, Brazil

17-20th March, 2003

The opening session of the workshop ended with a presentation of the six main objectives identified for the working sessions.

1. To review the draft articles for a Code of Conduct which were developed for South and Southeast Asia and Africa, and to adapt them to make them equally appropriate and useful for Central and South America.
2. To discuss and agree good practical examples of mangrove management in Central and South America to illustrate the Code of Conduct (boxed examples in the draft code).
3. To discuss and recommend mechanisms to ensure that the Code of Conduct is widely accepted and used in Central and South America to support the sustainable management of mangrove ecosystems.
4. To finalise responsibilities and deadlines for producing the country case studies (presently Brazil, Colombia, Ecuador and Nicaragua are included), but additional country case studies from the region would be much appreciated at a later date.
5. To integrate into the Code other guidelines, conventions, strategies and actions for sustainable management of mangroves in Central and South America (e.g. UN Forum on Forests, Ramsar, ITTO Workplan for mangroves and draft workplan from the expert workshop in Managua 3-5 March 2003).
6. Discuss and recommend any other follow up actions to support sustainable mangrove management in Central and South America as "downstream activities" from the Code of Conduct.

The task for the next few days is to address these six objectives and involve everyone present in the consultation process to develop an agreed draft Code of Conduct.

ECUADOR: Alejandro Bodero[1] and Roberto Retamales[2]

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Brief Background on Ecuador

Ecuador is located in the Northwest of South America. It has a coastline of approximately 1200 km. The maximum and minimum temperatures are 34°C and 18°C, respectively. Rainfall is 500 mm per year in the central and south of Ecuador and up to 3000 mm per year in the north in Esmeraldas Province.

In Ecuador the mangroves are found in the four coastal provinces of Esmeraldas, Manabi, Guayas and El Oro. The environmental impacts on the mangroves are different in each case because of the different local user groups in each of the provinces. For example, in the north the principal use of mangroves is for fuelwood and in the south it is for fisheries.

In Ecuador in 1999, the total surface area of mangroves was 149,556 ha, the total surface area of shrimp farms was 175,253 ha and for salinas was 4,530 ha. The distribution of mangroves, shrimp farms and salinas varies from Province to Province (Table 1).

Table 1: Change in total surface area of mangroves, shrimp farms and salinas for the four coastal provinces of Ecuador

	1984	1987	1991	1995	1999
Esmeraldas					
Mangrove	30,152	29,257	26,796	24,226	24,155
Shrimp farms	1,596	2,644	6,280	12,785	13,127
Salinas	0	0	0	0	0
Manabi					
Mangrove	7,992	6,401	4,547	2,778	1,958
Shrimp farms	8,377	10,238	12,579	17,124	17,564
Salinas	164	164	164	164	272
Guayas					
Mangrove	119,526	116,097	109,928	102,412	104,568
Shrimp farms	52,812	75,127	91,586	109,742	107,720
Salinas	18,811	9,607	4,520	3,929	3,289
El Oro					
Mangrove	24,456	23,403	21,960	17,529	18,876
Shrimp farms	26,484	29,721	33,006	38,236	36,842
Salinas	2,520	2,503	1,637	1,016	970

In Esmeraldas the mangroves are concentrated in two estuaries, Cayape-Mataje in the north and Muisne-Cojimies in the south.

In Manabi Province, the mangrove areas are in the Cojimies River in the north and the estuary of the Chone River in the centre. In the Chone river estuary there is the highest conversion rate of mangroves to shrimp farms in the country. Almost 90% of the mangrove

area has been converted to shrimp farms since 1980. The impact of this conversion rate has resulted in deterioration of water quality, increased sedimentation and less water flow down river.

The province of Guayas has the largest area of mangroves in Ecuador and these are found concentrated in the Gulf of Guayaquil. In 1999 about 104,000 ha of mangroves were recorded. This is compared to only 18,000 ha in El Oro, the province where shrimp farm activities first started. Since 1970 large areas have been converted to shrimp farms. In 1999 there were 36,842 ha of shrimp farms, but in El Oro not only mangrove areas were converted to shrimp farms, but also agricultural areas.

Table 2 shows the decline in mangrove area by Province from 1984 to 1999. There has been an overall decrease of 18% in the past 20 years but this varies depending on the province and mangrove area.

Table 2: Total mangrove forest area in Ecuador by Province (in Ha)

Province	1984	1987	1991	1995	1999	% Change
Esmeraldas	30,151.80	29,257.40	26,796.43	24,226.00	24,154.47	20
Manabí	7,991.50	6,400.70	4,547.22	2,777.74	1,958.09	76
Guayas	119,557.90	116,096.60	109,927.62	102,411.69	104,567.75	13
El Oro	24,456.10	23,402.70	21,959.79	17,529.39	18,876.08	23
Total	182,157.30	175,157.40	163,231.06	146,944.82	149,556.39	18

Physiographic types of mangrove forests in Ecuador

According to Cintron and Lugo (19) the physiographic type of mangrove forest in Ecuador are Bank mangrove, Edge or island mangrove and Basin mangrove.

The structural characteristics of each physiographic type are:

Bank mangrove: 550 trees, 12m^2 of basal area and 200m^3 of wood.

Edge or island mangrove: 620 trees, 11 m^2 of basal area and 118 m^3 of wood.

Basin mangrove: 554 trees, 10 m^2 of basal area and 99 m^3 of wood.

Mangrove species in Ecuador

The mangrove tree species found in Ecuador are shown in Table 3. Six species representing five genera occur.

Table 3. The mangrove tree species found in Ecuador

Genus	Species	Common name
Rhizophora	*mangle*	Mangle gateado, mangle caballero, mangle rojo.
Rhizophora	*harrisonii*	Mangle gateado, mangle caballero, mangle rojo.
Avicennia	*germinans*	Mangle negro, mangle salado.
Laguncularia	*racemosa*	Mangle blanco, mangle amarillo, mangle hembra, mangle bobo.
Conocarpus	*erectus*	Mangle jeli, mangle prieto, mangle macho.
Pelliceria	*rhizophorae*	Piñuelo

Mangrove uses in Ecuador

Mangrove species are used for tannin, wood for construction and fuel, poles and crafts. Mangrove areas are also used to exploit mollusks, crustaceans and fish.

Mangrove areas have been converted into shrimp farms, agriculture and cattle fields, salt extraction ponds and settlement areas.

Effects on mangrove forest as a consequence of its use

- A drastic reduction of mangrove areas.
- Reduction of phytomass production rates.
- Changes in the quality of estuarine waters.
- Coastline erosion.
- Sediment accumulation.
- Floods in the coastal zone.
- Reduction of molluscan and crustacean populations.
- Reduction of employment opportunities.
- Modification of the local populations' diet.

Administrative aspects of mangrove management

The administration of mangrove areas is performed by federal and provincial institutions. Such institutions are the main players in the application of strategies, plans, programs, and projects related to mangroves, having a decentralized structure. The counties must abide to the national laws, applying them through municipal laws that regulate the mangrove management.

- The Ministry of the Environment
- The Ministry of Defence
- The Ministry of Commerce, Integration and Fisheries.
- Provincial Councils.
- Counties
- Coastal Resources Program (PMRC)

Legal Framework

The management of mangroves in Ecuador is regulated by the law and its application norms. Regarding implementation, the state develops a coordinated, interministerial committee, the UCV, which applies the legislation in the context of the national strategy for the management of mangrove forests. This approach to implementation was proposed by the PMRC.

- Fisheries Act (date)
- Forestry Act – 1981
- Environmental Management Act – 1999
- Municipal Management Act (date)

Norms for the regulation, conservation management and use of mangrove forests

In recent years, the importance of the mangrove forests in Ecuador has been reflected by the implementation of Ministerial Agreements 3327 and 3399, which promote the sustainable management of the different goods and services provided by the mangroves, ensuring the participation of the local communities by the writing and signing of a User Agreement, a letter of intention detailing how the mangroves will be used.

- Definition of the mangrove ecosystem.
- Zoning and classification of mangrove forests.
- Permitted activities on mangrove areas.
- Implementation of Environmental Impact Studies.
- *Incorporation of the mangrove users as its concessionaries*

Discussion

Question 1: *How many mangrove areas have been restored or reforested in Ecuador?*

Answer: There are no more than 2,000 ha in conjunction with the community and the PMRC program (Management Programme of Coastal Resources). The PMRC has helped the community with technical assistance (e.g. how to plant the propagules) but the community did the planting. Most of the mangrove species planted have been *Rhizophora*, *Avicennia* and *Conocarpus*.

Question 2: *How is the legislation now about the shrimp farms?*

Answer: Nowadays there is NO permission for shrimp farming construction in any mangrove area (since about 1992/3) but shrimp farming can continue in agricultural and inland areas. The law and legislation came too late in many cases because many of the mangroves had already disappeared. The law has resulted from past experiences and was not predictive.

Question 3: *Has there been some change in water quality in mangrove areas?*

Answer: Yes there have been changes in mangrove quality because of the destruction of mangrove areas and also the addition of nutrients from aquaculture

activities. However, there has been no eutrophication (nitrogen and phosphorus).

Question 4: *What is the conversion rate of mangroves to shrimp farms?*

Answer: In some areas such as in the Chone River estuary there has been up to 90% conversion of mangroves for shrimp farms but in general it has been 30% overall for total conversion, including shrimp farms, tilapia farms and agricultural, tourism and urban areas.

Question 5: *What is the origin of white spot disease in shrimp is it related to water quality?*

Answer: There is no specific relation between white spot and water quality. However, water could act as a transfer medium of the white spot from Asia to USA/Mexico, Central and South America.

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Brief Background on Colombia

Colombia is a coastal nation (Caribbean Sea and Pacific Ocean), rich in biodiversity and natural resources. The country covers an area of about 2,070,408 km^2, the limit to the north is the Caribbean Sea (1,300 km), and to the west with the Pacific Ocean (1,600 km).

The total area of mangroves in Colombia in 1996 was 379,034.9 ha along the two coastlines (292,724.4 ha on the Pacific Ocean and 86,407.5 ha on the Caribbean Sea) i.e. 70-80% of the mangrove is on the Pacific coast and 20-30% mangrove on the Caribbean coast. However, there have been no updated figures for the last 10 years. By area, Colombia would be the 10th ranked country for mangroves in the world.

There are eight mangrove species in Colombia (Table 1), five species on the Caribbean coastline, *Avicennia germinans, Conocarpus erecta, Laguncularia racemosa, Pelliciera rhizophorae* and *Rhizophora mangle* and eight species on the Pacific coastline *A. germinans, C. erecta, L. racemosa, Mora oleifera, P. rhizophorae, R. harrisoni, R. mangle* and *R. racemosa*.

Table 1: Present mangrove species on the coasts of Colombia

Family and Species	Pacific Ocean Vernacular name	Caribbean Sea Vernacular Name
Avicenniaceae		
Avicennia germinans (L.)	Black mangrove, salted, blackish, iguanero	Black mangrove, salted, blackish, iguanero, sietecueros, smoke, utta, salted-colorao
Rhizophoraceae		
Rhizophora harisoni	Red mangrove	
Rhizophora mangle L.	Red mangrove, pineapple, gentleman	Red mangrove, coloured mangrove, canillon, junna
Rhizophora racemosa G.F.W. Meyer	Mangrove implant, red mangrove	
Combretaceae		
Conocarpus erecta L.	Zaragoza mangrove, jeli, garbancillo, button, trough mangrove	Zaragoza mangrove, zaragoza black, zaragozo
Laguncularia racemosa Gaertn. f.	White mangrove, stupid	Yellow mangrove, fool, sweet, guaton, conchudo, more conchudo, botoncillo, maliiwalaa, white mangrove
Theaceae		
Pelliceria rhizophorae Triana & Planchon	Pinuelo mangrove, good fortune	Pinuelo mangrove, pinuelo
Caesalpinaceae		
Mora oleifera (Triana) Ducke	Born mangrove, born	

In general the Colombian mangroves consist of developed and young mangroves with a volume per acre of 43.0 m^3 in the Pacific and 40.0 m^3 in the Caribbean. The most recent national evaluation is by the Project Mangroves of Colombia MMA / ITTO. In 1995 and 1996 they were able to specify with field work, cartography, air photographs, images of radar, INTERA for the Pacific and images of the satellite LANSAT for the Caribbean the national cover of mangroves. A multitemporal evaluation for the Pacific coast was also carried out, in 1969 there were 306,436.6 ha of mangroves and in 1996 there was 292,724.4 ha, a loss of 13,712.2 in 27 years, and that of the total lost in 1996 27,337.11 ha were due to anthropogenic reductions and alterations; in the Caribbean it was detected that of the total 21,921.50 ha lost most were due to problems of mortality.

The mangroves of Colombia are found in salty water and humid areas. They are used for industry, energetic, economic and fluorescing purposes. Recently they have began to be looked upon as an ecosystem; mainly because of the negative consequences of the traditional way of handling this resource. Even though there is bibliography regarding the Colombian mangrove, more information is needed on Pacific species taxonomy, productivity in both coastlines (Pacific and Caribbean), ecological damage due to man's action, and possible ecological-economic benefits.

Archeological findings as well as oral tradition (indians, whites, blacks and half-breed) demonstrate how mangroves have been exploited as a source for bark, leaves, wood and the animal life associated to it (mollusks, crustaceans, birds, reptiles and mammals). The use of the resources has been different in both coasts, determined by the development of the settlers and the communities from nomads to sedentary people (7000 AC - 10000 AC).

The process of using mangrove resources has been clearly established in Colombia and related to the development of the culture in the rest of the continent. The most ancient ceramic dated IV AC was found in the Atlantic coastline mangroves. The nomads located marshes and lagoons rich in molluscs near the coastline. As they settled, the cleaning of crustaceans and molluscs provided the material for the accumulation of an enormous amount of shells. Today these communities have been named "the inhabitants of the shell-fields": due to their well established eating habits. Different models of cultural adaptation, both, on the Pacific and Atlantic mangroves were developed acting as a basis for the further exploitation of the mangrove resources that still exist today.

Cross-sectoral issues in mangrove management

The high productivity of the mangroves in fishery and forest products has enabled Colombia to develop economically.

Fisheries

In Colombia the exploitation of fishing resources has been considerable due to the abundance and preference of not only the fishermen but also national consumers and the increasing demand from the international market. The fisheries resources include molluscs (chipi-chipis, clams, oysters, cockles, snails, octopuses, squids), crustaceans (shrimps, portunid crabs, crabs) and fish (tarpon, gerrids, catfishes, hoarse, corvine, mullets, bass, snooks, snappers, groupers, sharks). These resources have been traditionally valued and

appreciated for their excellent protein and nutritional value. These strange species that are not tied to the mangrove swamps and can be associated to the platform offshore are in fact closely associated to mangroves. In Panama for example, it has been demonstrated that practically 95% of the yield of industrial shrimps and white fish depend on the protection capacity and feeding that is offered by the mangrove swamps and other related coastal areas that harbour them (marshes, estuaries, deltas, swamps, lagoons, tidelands) (Alvarez-León, 1984).

The fisheries sector contributed 0.43% of GDP in 2001, with marine fisheries, large scale commercial off-shore trawling and small-scale coastal fishing, contributing 86% of the total production value. The consumption *per capita* of the fishing products in Colombia was 6.5 kg/year in 2001.

Aquaculture

There has been a gradual reduction of the natural self-sufficiency of the coastal systems, due to the modification of mangroves for the express development of coastal infrastructure and the destruction of big quantities of forests in the heads of the rivers (at natural sources of sweet water). This has resulted in a need to recover a sustained extraction of some resources of national acceptance (oysters, cockles, snails, blue crabs, portunid crabs, tarpon, cat fishs, flat, mullets, gerrins, red tilapias) and international importance (microalgae, artemia and shrimp). Therefore a number of investigation projects for production in Colombia have been carried out and they have produced very flattering results. There have even been zoological projects with species related with the swamp, such as iguanas, crocodiles, stifles, boas, manatees and chiguiros that have great international demand (Alvarez-León, 1982; 1984).

The aquaculture sector has also been promoted strongly in Colombia. Coastal aquaculture takes place in mangrove waterways, on mangrove-associated mudflats and in ponds constructed in mangroves. The former is more ecologically compatible and includes floating cage cultures for rearing red tilapia (*Oreochromis* spp.), tarpon (*Tarpon atlanticus*) and growing of mullets (*Mugil incilis* and *M. liza*) in the Caribbean and snappers (Lutjanus spp.) in the estuaries of the Pacific coast. Oyster culture (*Crassostrea rhizophorae*) on mud banks in the Caribbean and growing of cockles (*Anadara* spp.) on mud banks in the Pacific (Alvarez-León, 1982, 2000).

In contrast, construction of ponds for the intensive culture of the tiger prawn (*Penaeus vanamei and P. stilyrostris*) has negative ecological impacts (MMA, 2002). In a relatively short time this activity has become widespread in most of the mangroves in Colombia, in particular the mangroves of south Cartagena Bay, and Cispatá Bay in the Caribbean and, Ensenada of Tumaco in the Pacific. Prawn aquaculture has high economic returns, but also high risks involved. The shrimp culture in Colombia is a reality and from the first shrimp export cultivated in 1984 has increased from 11,308 pounds (US$55,000). At the end of the decade of the 1990s export of shrimp reached 10 million pounds (3,571 kg/ha); for a total of 20 properties, 15 laboratories for larvae and 2,400 ha of water (Boyd, 1999). However, feed, seed, maintenance and infrastructure costs are high. For this reason large areas of abandoned ponds are now evident in the Pacific Colombian mangroves.

Restoration of Mangrove Areas

The vulnerability of the mangrove ecosystem and the constant pressure to which they have been subjected to by anthropogenic actions has generated diverse rehearsals for its recovery in the Colombian coasts. Due to climatic and environmental conditions the studies have been more frequent in the area of Cartagena and of the Rosario's Islands. Studies have been on natural propagation by means of propagules of *Rhizophora mangle*, as well as of induced techniques of transplanting wildlings of *R. mangle*, air-layering and sowing of seedlings of *R. mangle*. Together with reconditioning of forest floors with *A. germinans, L. racemosa* and *R. mangle* affected by hydrocarbons, handling and storage of embryos of recalcitrant seeds (*A. germinans, L. racemosa* and *R. mangle*), biochemical aspects as the action of the polyamines about the growth of seedlings of the red mangrove (*R. mangrove*) (Alvarez-León, 1997; 2003).

On the Caribbean coast the registered survival of restoration with *R. mangle* is 100% for seedlings from nurseries and 87.34% for the plantation in a parcel, of 81% in tree nurseries and 95% in plantation in another parcel and of 67.36% for direct sowing in another parcel. The development of *R. mangle* seedlings reached rates of 1.60 mm per day. For *A. germinans* a growth of 42.67 cm was obtained. *Rhizophora* reaches 45.78 cm after 270 days. The results obtained from transplanting with seedlings from tree nurseries, was much improved compared to those that were obtained by direct sowing of propagules (Ulloa-Delgado *et al*., 1998a, 1998b; Sánchez-Páez and Ulloa-Delgado, 2000).

On the Pacific coast the restoration was also more successful with vegetable material used from tree nurseries, which presented a more positive answer with regard to seedlings taken place by direct sowing, the survival for *R. mangle* was 94% and of 84%, respectively. This was also the case with the other three species, because *L. racemosa* hardly reached 3.4% survival with the method of direct sowing. In the case of tree nurseries material the survival in the area of the transplant for *A. germinans* was of 42% and *P. rhizophorae* of 96%. In the analysed parcels *A. germinans* presented answers of survival in direct seed of 52% after the first month and of 44% after a period of three months. With direct sowing, after five months, the seedlings of *R. mangle* obtained an average height of 34 cm and a maximum of 80cm, while in tree nurseries the average height of 38.9 cm and a maximum of 83 cm was recorded (Sánchez-Páez *et al*., 1997b; Guevara-Mancera *et al*., 1998).

Between September 1995 and July 2000 on the Colombian coast the Project PD 171/91 Rev. 2 (F) was developed "Conservation and Handling for Multiple the Uses and the Development of the Mangrove in Colombia" Phases I and II (Stages I and II). This was favoured and financed by the Ministry of the Means Environmental (MME) and the International Tropical Timber Organization (ITTO), in collaboration with the National Corporation of Investigation and Forest Development (CONIF), the Colombian Association of Reforesting (ACOFORE), Regional Autonom Corporations (CAR's) and Sustainable Development Corporations (CDS's).

During Phase I, diagnosis, preliminary zonification, cartography and the socio-economic approach, of the mangrove swamps and people of the Colombian swamps was carried out in the 14 coastal Departments of the two coasts. During Phase II, alternative pilot projects, recuperation of degraded areas and the socio-economic approach with the mangrove swamps and people of the Colombian swamps, in the 13 coastal Departments of the two coasts was carried out.

Recently, between September 2001 and July 2003 in the Caribbean Colombian coasts another project was developed. The Project PD 60/01 Rev. 1 (F) "Management Sustainable of Mangroves for Local Communities of the Caribbean of Colombia" Phases I and II. This was favored and financed by the Ministry of the Means Environmental (MME) and the International Tropical Timber Organization (ITTO), in close collaboration with the National Corporation of Investigation and Forest Development (CONIF), Regional Autonom Corporations (CAR's) and Sustainable Development Corporations (CDS's).

Discussion

Question 1: *What restrictions are there at the Government level for shrimp farming? And what norms exist at the moment? (Roberto Retamal, Ecuador).*

Answer: There are no restrictions for shrimp farming projects, except when there may be direct or indirect actions to mangrove areas. When a project is presented they should offer alternative sustainable and environmental development and if once it is evaluated, environmental viability, the project is approved according to some specific parameters.

The norms that exist are the following:

Resloution 1602 of 1995, general law on the mangroves in Colombia

Resolution 020 of 1996, which clears up the Head. 1602 of 1995 and other dispositions plows dictated.

Resolution 257 of 1997, which sets minimum controls to contribute to the guarantee for the basic conditions of sustainability.

Resolution 924 of 1997, which sets down reference terms for studies on the current state and proposals of zoning of the mangrove area.

Resolution 233 of 1999, which modifies the Resolution 924 of 1997 and the term is continued foreseen in the fourth article of the Resolution 1602 of 1995.

Resolution 271 of 2002 that approves the zoning applications by Corporations and with the support of the Ministry of Environment.

Question 2: *How is mangrove restoration carried out? (Tarcisio Alvez, Brazil)*

Answer: The communities have been the main characters involved in mangrove restoration because of their help and conscientious efforts success has been achieved with a number of different actions. The local communities build, maintain and administer the nurseries. They have the headquarters of red mangrove which they take charge of to promote and to diffuse the advantages of the activity and they transport the seedlings and if they are requested the seed and they give consultant ship.

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Environmental setting

The Mangrove Coast of Brazil (MCB) stretches for about 6,300 km along the South Western Atlantic, from Oiapoque in Amapá, at the border with French Guiana (Lat. 4º 30'N), to Sonho Beach at Santa Catarina (3º50' S). Along this coast, the diversity of climates, water masses and coastal features, and consequently of eco-regions, is greater off the coast than within the same areas in the open ocean, because of the presence of transitional type structures, salinity modification and topographic isolation of water masses. Also, boundaries between adjacent water masses, in particular at the temperate southern end, and off the major river estuaries (Amazon, Parnaíba, São Francisco and Paraíba do Sul rivers), vary considerably with season (Semenov and Berman, 1977). As a result, Brazil harbours a large diversity of natural mangrove communities defining typical eco-regions with intimate interactions at the land-sea interface.

Table 1 summarises the landscape results from the Late Quaternary evolution of the coastline. Sand barrier, estuaries and coastal lagoons attained their expansion peak during two major sea level highs. The first, corresponding to the last Pleistocene interglacial, occurred 123,000 years BP, raising the sea level to about 8 meters above the present level. The second, corresponding to the Holocene, occurred 5,000 years BP, with sea level about 5 meters above the present level (Martin et al., 1996; Domingues and Bittencourt, 1996). The present MCB can be roughly sub-divided in to four sections based on climate, geology and geomorphology criteria of the coast (Lacerda et al., 1993; Ekau and Knoppers, 1996).

A) - The northern quaternary coast (NQC), extending from Oiapoque, Amapá (4º30'N) to the Parnaíba River Estuary, Piauí (3º25'S), including the Amazon River estuary. Climate in this section is tropical-humid (Af), with annual precipitation typically ranging from 1,200 to 2,800 mm, with a relatively dry winter and rainy summers. Yearly average temperature ranges from 24 to 27ºC. The coast is characterized by large quaternary plains, dominated by mangrove forests and extensive mud flats under a macro tidal regime (4 to 8 m). Freshwater inputs are large and marked by a typical unimodal seasonal flow pattern with the Amazon and Tocantins Rivers (about 135,000 $m^3 s^{-1}$), as major contributors. Average total annual fresh water discharge is about 190,000 $m^3 s^{-1}$ (ANEEL, 1998).

B) - The northeast semi-arid coast (NSAC), extends from Camocin, Ceará (3º65' S) to the Potengui River Estuary, Rio Grande do Norte (6º22'S). Climate is mostly tropical semi-arid (BS), with average annual precipitation of less than 800 mm. Freshwater inputs are small with an average annual total of less than 1,000 $m^3 s^{-1}$, and show a marked seasonal variability, with high inputs and flash floods during the rainy season and very low flow in the dry season (Ekau and Knoppers, 1996). Rias and dunes, fringing reefs and coastal lagoons dominate coastal features. Small and low patches of fringe mangrove forests dominate estuaries and lagoon margins, along this typical mesotidal coast.

C) - The Northeastern-Eastern humid coast (NEHC), extends from the Itamaracá Estuary (7º30' S) to Guanabara Bay (latitude 22º S). Climate is tropical humid (At-Aw) with annual

precipitation ranging from 1,000 to 1,500 mm. Exceptions are the southernmost end of this sector, an arid sector (< 700 mm of annual rainfall) caused by a coastal upwelling, and some sectors of the eastern coast of Bahia State, where annual rainfall can reach up to 1,800 to 2,400 mm (Nimer, 1972). Extensive quaternary sandy plains characterize this coast, in particular at the southern end along the Espírito Santo and Rio de Janeiro states. Over 60 coastal lagoons occur along this coast, which shifts from mesotidal to micro tidal regime at its mid-sector. Mangroves dominate river mouths and protected shores, whereas coastal dune vegetation dominates open shores. The river discharge is about 7,400 $m^3 s^{-1}$, with the São Francisco River as the main contributor (ANNEL, 1998). In this region, various species of tropical and subtropical affinities, together with many temperate affinities can be found (Yoneshigue-Valentin and Valentin 1992).

Table 1: Summary of the major physiographic and biological characteristics related to mangrove distribution in Brazil. State codes: AP – Amapá, CE – Ceará, PE – Pernambuco, PI – Piauí, RJ – Rio de Janeiro, RN – Rio Grande do Norte, SC – Santa Catarina.

Parameter	North Quaternary Coast (NQC)	Northeast semi-arid coast (NSAC)	Northeast-eastern humid coast (NEHC)	Southern Granite coast (SGC)
Climate	Tropical-humid (Af), 1.200 to 2.800 $mm.yr^{-1}$	Tropical semi-arid (BS), 500 to 800 $mm.yr^{-1}$	Tropical humid (At-Aw), 1,000 to 1,500 $mm.yr^{-1}$	Tropical humid (Af), 1,000 to 1,500 $mm.yr^{-1}$
Location	4º30'N – 3º25'S Oiapoque (AP) to Parnaíba river Estuary (PI)	3º65'S – 6º22'S Camocim (CE) to Potengui River Estuary (RN)	7º30'S – 23º00'S Itamaracá Estuary (PE) to Guanabara Bay (RJ)	23º00'S – 28º53'S Guanabara Bay (RJ) to Praia do Sonho (SC)
Coast length (km)	1,820	1,040	2,360	1,100
River discharge ($m^3.s^{-1}$)	~190,000	<1,000	~7,400	~1,100
Tidal range (m)	>5	2 - 4	2 - 4	<2
Coastal features	Extensive mud flats and mangroves over broad coastal plains, complex estuarine systems	Sand dunes and sandy beaches, small rivers. Mangroves restricted to river mouths	Sandy beaches and coastal cliffs. Lagoons, bays. Mangroves in deltas, protected coastal areas and river mouths	Rocky shores, mangroves restricted to inner portion of bays
Mangrove area (ha)	830,000	34,000	167,000	50,000
True mangrove tree species (number of species)	(7) *Rhizophora mangle, R. harrisonii, R. racemosa, Avicennia germinans, A. schaueriana, Laguncularia racemosa, Conocarpus erectus*	(5) *Rhizophora mangle, Avicennia germinans, A. schaueriana, Laguncularia racemosa, Conocarpus erectus*	(5) *Rhizophora mangle, Avicennia germinans, A. schaueriana, Laguncularia racemosa, Conocarpus erectus*	(3) *Rhizophora mangle, Avicennia schaueriana, Laguncularia racemosa*
Major uses	Extractives of forestry products and artisan fisheries.	Coastal protection, artisan	Artisan fisheries	Artisan fisheries, landscape and

	Ecological services	fisheries		nature protection
Major threats	None	Coastline erosion due to river damming and sea level change, urban expansion, shrimp farms	Urban expansion at metropolitan areas, tourism development	Urban expansion, tourism development, industrial pollution, harbor and navigation

D) - The southern granite coast (SGC) extends from the Guanabara Bay (Lat. 22º S) to Praia do Sonho (28ºS). Climate is tropical humid (Af) with average annual precipitation ranging from 1,000 to 1,500 mm. The coast is characterized by granite outcrops extending from the Serra do Mar Mountains to the ocean, forming an indented littoral with many protected bays dominated by mangrove ecosystems. Dry coastal ecosystems occur on a very narrow sandy quaternary plain. More typically, the tropical mountain rain forest extends to the sea edge (Lacerda et al., 1993). Freshwater input is small and the average is 1,100 m^3 s^{-1} (ANNEL, 1998). The fluvial input is diluted and estuarine plumes disperse over narrow extensions over the continental shelf.

Mangrove ecosystems

Along the coastline of Brazil mangroves cover approximately 1.3 million ha, about 50% of the total mangrove cover in the Americas. Mangrove forests present completely different structural features depending on their location along the coast. At the southern latitudinal limit of the SGC mangroves are defined by the frequency, duration, and intensity of cold winter temperatures, rainfall and/or frost. Mangroves form dense bush-like fringe forests along rivers and at the inner parts of protected shores. At the NSAC mangrove development is limited by low freshwater availability and high salinities. They form high, low density forests along rives and scattered bush-like basin forests behind dunes and in high salinity areas. On the other hand, mangroves at the NQC attain their maximum structural development due to year round high temperature and rainfall, large tidal amplitude and extensive coastal plains. The origin of the MCB mangrove flora is the same as the American mangroves and is believed to have occurred later than other more diversified mangrove forests in the Indo-Pacific (Lacerda, 2002). The genera *Rhizophora* and *Avicennia* are supposed to have evolved earlier and were able to spread into what is presently the Mediterranean and thence to the East coast of the Americas. They may have reached the Caribbean by the early Eocene (some 55-50 million years BP).

Brazil's mangrove forests are very poor in number of tree species, although further systematic investigation is needed due to high population variability among species of a given genus and the extension of the MCB coastline. In fact for various areas of the NQC even superficial biological surveys have yet to be done. MCB mangroves include seven species dominated by the genus *Rhizophora* (Rhizophoraceae) and *Avicennia* (Avicenniaceae) with three and two species each, respectively. Other genera are *Laguncularia* and *Conocarpus* (Combretaceae) with only one species. The genus *Rhizophora* is represented by *R. mangle* L.; *R. harrisonii* Leechman and *R. racemosa* G.F.W. Meyer Saluosa. *R. mangle* is the most widespread species, occurring along the totality of the MCB. *R. racemosa* and *R. harrisonii* are restricted to the NQC. The genus *Avicennia* presents a similar distribution to *Rhizophora* with one species, *A. germinans*, extending from the NQC to the NEHC. The other species, *A. schaueriana*, is endemic to SWAC, spreading along the entire MCB. The family Combretaceae has two widely distributed species:

Laguncularia racemosa and *Conocarpus erectus*. The first has a wide distribution similar to that of *A. schaueriana* and *R. mangle*, *C. erectus* has its Southern limit at the coastal lagoons of Rio de Janeiro State (latitude 22º55'), at the NEHC (Kjerfve and Lacerda, 1993).

Many plant species occur associated with mangrove forests at the MCB. Their diversity reflects general climatic conditions and the proximity of other pristine ecosystems. Higher diversities are found along the NQC where mangroves are seldom submitted to high or even moderate salinities, various typically freshwater macrophytes occur among true mangrove species, such as the Araceae *Montrichardia arborenses* Schott and the Leguminosae *Mora oleifera* (Triana) Duke. Also many palm species e.g. *Euterpe oleraceae* Mart., are typical of these mangrove forests. At the SGC were mangroves occur adjacent to mountain rain forests, a great diversity of epiphytes of the Bromeliaceae and Orchidaceae, "invade" the canopy of mangrove forests in particular *Tillandsia usneoides* L., *T. stricta* Solander and *Vrizia* spp.

It is very difficult to characterize a "true" mangrove fauna, since most of the animals encountered in mangroves are also found elsewhere, in other protected coastal areas, such as mud flats, seagrass beds and salt marshes. The fauna associated with MCB mangroves however is large and diversified. Over 140 species of birds, 220 species of fish and hundreds of species of terrestrial and marine invertebrates species are found creating high faunal diversity environments along otherwise low biodiversity mudflats (Kjerfve and Lacerda, 1993).

Uses and impacts on Brazilian mangroves

Traditional uses

Traditional uses of mangroves in Brazil are relatively small compared to Africa and Asia, since these ecosystems are regarded as permanent preservation areas. Traditional uses are from small communities living in the vicinities of mangroves. The most important uses are shellfish and crustacean gathering particularly clams and crabs. Collecting involves traditional, non-destructive techniques and generally do not have a significant impact on mangroves. For example, the largest fisheries are from crabs, which are collected by hand, and only male crabs are collected. A typical practice in the north coast mangroves is the rearing of teredinid (*Teredo* spp.) by felling mangrove trees, leaving the trunk to rot in the forest and allowing it to be colonized by the bivalve. Shrimp fisheries were once important along the north and northeastern coast, but has recently been replaced by shrimp farms. Apart from traditional fisheries there is still a small use of mangrove wood for boat and fish gear constructions in many areas. Mangrove wood is also used in certain areas to cook pottery.

Aquaculture

Shrimp farming is a recent development in Brazil. Most farms are built adjacent to mangrove forests and a few actually converted mangrove areas into ponds, although this practice may lead to closure of the operation, fines and imprisonment of the owner. The total area of shrimp ponds reaches about 15,000 ha with an average production of 4 ton/ha/cycle, with 2 to 4 cycles per year. A very restricted legislation regarding the installation of shrimp farms was enforced in 2002, preventing new farms to be installed in mangrove-influenced areas.

Oyster farms are also being developed in mangrove creeks and more recently in shrimp farm canals. This practice substitutes the traditional practice of cutting mangrove prop roots to obtain

oysters and gives new job opportunities for fishermen and women. This activity can increase the normal income of a fisher family by up to 25%.

Agriculture and cattle farming are very minor activities in mangrove-influenced areas in Brazil and there is no report of major impacts of such activities on Brazilian mangroves.

Urbanization and industrialization

Urbanization, in particular the growing of metropolitan coastal areas, is the major source of negative impacts on Brazilian mangroves. Large capital cities such as Rio de Janeiro, Salvador, Recife and Fortaleza, are located adjacent to extensive mangroves areas, such as Guanabara Bay in Rio de Janeiro, and Todos os Santos Bay in Salvador. Lack of proper housing and waste treatment causes damage and degradation to mangroves along these coastal areas. Industrialization has also caused impacts on mangroves, mostly associated with harbour facilities and the oil industry, particularly along the southeastern coast. For example, in Guanabara Bay, Rio de Janeiro, where mangroves reached nearly 50 km^2 in the beginning of the century, is presently nearly totally degraded with less than 15 km^2 of pristine forests, mostly due to canalisation of creeks and rivers, oil spills and solid waste dumping.

Global Changes

Although direct human impacts on MCB do present a permanent threat to mangrove ecosystems, the conservation legislation of Brazil has enough instruments for their protection, depending only on proper enforcement. However, global change scenarios may result in serious impacts on the coastal zone, by changing the ecological equilibrium of the coastal zone and by maximizing human impacts.

Global change scenarios are variable and mostly contradictory. However, all models point to an increase of global temperatures during the past century with two distinct periods of warming, one between 1910 and 1975, and another from 1976 onwards. The rate of warming after 1976 has been much higher than during the first period and therefore higher than any warming rate recorded during the past 1,000 years (Climate Change, 2001).

Downscaling to the regional level, climate changes are quite variable and heterogeneous, being neutralized or maximized by regional features, such as geological setting, including tectonics, microclimatology, and most significantly the presence of human activities. Whereas certain regions of the world have maintained relatively stable parameters such as annual rainfall, others may have witnessed a decrease of over 10% per decade of annual rainfall since 1960 (Walther et al., 2002). Another important aspect of the regional level of climate change deals with the biology and ecology of organisms. Organisms, populations and ecosystems will respond to regional changes rather than to average global changes. Changes in phenology and physiology, range and distribution of species, composition and interactions within communities and the structure and dynamics of ecosystems can thus, to a certain extent, be used as proxies to regional climate change (McCarthy, 2001). For example many plant species have delayed their flowering period for about 1-2 days per decade along the past century as a response to increase in light hours (Walther et al., 2002). Benthic fauna of mangroves, in particular burrowing crabs, increase their time of permanence in burrows

as a response to increasing temperatures at the mud surface (Field et al., 1994). Fish communities change according to changes in the salinity regime of estuaries caused by salt intrusion due to decrease in freshwater flux and mangrove forests migrate along estuarine gradients reflecting changes in the salinity regime (Lacerda and Marins, 2002). These impacts may be maximized by anthropogenic activities occurring on river basins.

At the Eastern Ceará coastline, NE Brazil, and at the Jaguaribe River estuary in particular, the water-withdrawn resulting from river damming and irrigated agriculture will probably maximize the effects of sea level change. If available estimates are used, mangroves require sedimentation rates of about 1 mm yr^{-1} to keep pace with general sea level rise (Lacerda et al., 2002) and thus avoiding erosion. Along many of the Ceará rivers estuaries, and a large stretch of the NSAC, the supply of sediments to the coast is much less than that, resulting in severe erosion and death of mangrove trees. Erosion of mangrove mud substrate results in high suspended matter load into the incoming tide, bringing mud inland, further increasing the erosive force of tides and making possible the deposition of marine sands brought along the coast by prevailing trade winds. This accelerates mangrove tree destruction by high sedimentation with marine sands.

The high tidal amplitude and the low gradient of rivers in the Brazilian NE makes their estuaries very sensitive to sea level changes and changes in freshwater flux, generally extending the saline water intrusion inland. Mangrove invasion on herbaceous vegetation topographically high upriver has been taking place at the Jaguaribe Basin and monitored since the 1980's. In certain areas stretches of riverbanks covered by pastures and even agricultural lands have been lost to mangroves. Saplings of *Laguncularia racemosa* are colonizing riverbanks and beaches up to 30-40 km inland from the coast. This process seems to be facilitated by the deposition of fine sediments on river sand and gravel beaches. This fine sediment is probably derived from erosion and transport through tides of mangrove sediments at the mouth of the Jaguaribe River. This creates a feedback mechanism accelerating erosion of the coastline by trapping the brought in sediments upriver by the newly established mangroves.

Rehabilitation and restoring of Brazilian mangroves

Among environmental oriented government actions is the restoring of mangroves surrounding metropolitan areas, where mangroves have been most badly affected. This has resulted in extensive replanting and rehabilitation programs in many areas along the coast, involving about 10,000 ha currently, mainly in the SGC and the NSAC. For example, in surrounding landfill sites these programs have proved a large success. Mangroves drastically reduce the non-aesthetic impact of solid waste disposal sites, attracting a large number of animals, in particular birds, which also help to control rats and insect populations abundant in these areas. Mangroves have also proven to be efficient biogeochemical barriers to the transfer of pollutants, generated by landfills, to adjacent coastal areas. Research carried out in Brazil (Machado et al. 2002) is demonstrating this unsuspected benefit from mangroves, which will be a strong argument in favour of their conservation and restoration, especially at the periphery of urban areas.

The Gramacho Metropolitan Landfill in Rio de Janeiro, Brazil, which receives about 7,000 tons of solid waste per day, is leaching high concentrations of heavy metals to Guanabara

Bay. Mangroves around the landfill have been subjected to an intensive restoration program by the landfill administration, and restoration is in full progress. Bare sediment cores show lower heavy metal concentrations and a distribution profile suggesting remobilisation and export. Under mangroves, much higher heavy metal concentrations are found around the rhizosphere depth, hampering their migration and eventual export to Guanabara Bay, as seem from the sharp decrease in heavy metal concentrations above this depth. Speciation studies (Machado et al., 2002) showed that at this depth heavy metals occur as refractory chemical species, unable to be absorbed by plant roots, which impede the intoxication of the mangroves. Thus minimization of pollution by heavy metals should also be considered when evaluating the amenities provided by mangrove ecosystems all over the world.

Institutional and legislation framework

Mangroves in Brazil are subject to strict conservation legislation. The Forestry Law of 1965 defines mangroves as a permanent preservation area and restricts any activity leading to their conversion and any non-traditional uses. More recently activities such as tourism development and shrimp culture have been the subject of specific legislation, not only protecting mangroves but suggesting rehabilitation measurements and conservation practices. Also many conservation units include mangrove ecosystems and are ruled by their specific legislation. Federal, State and Municipal departments and agencies act on mangroves together with universities and NGOs. Many examples of this cooperation to preserve and manage traditional mangrove uses exists in the country, to an extent that, although permanently under pressure, mangrove extension in Brazil has been relatively preserved when compared to most other Latin American countries.

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WORKSHOP DISCUSSIONS

Workshop Day 1: Monday 17th March

Session I, II & III: Discussion of the Conceptual Framework for a Code of Conduct for Mangroves, plus the draft Preface and Introduction.

Conceptual Framework

In discussing the appropriateness of the FAO Code of Conduct for Responsible Fisheries (1995) as a working model of the mangrove Code, it was noted by the participants that the FAO Code is also published in Spanish as "Codigo de Conducta para la pesca responsible". Thus it is a well known document in South America.

Draft Preface

The definition of mangrove in Brazil also includes salgados and similar areas which occur above the intertidal zone where mangroves have become isolated from the tidal regime. It was also pointed out that the Amazon Delta actually has very little mangrove (too much freshwater outflow). The mangroves of the Amazon are mainly along the open coastline of Maranhao. This point was edited into the Preface (by replacing the Amazon Delta with the Orinoco Delta as an example of a major mangrove-fringed delta).

Draft Introduction

The participants provided their expert views on the threats to Central and South America mangroves in order to complete Table 0.1 of the draft Introduction ("Summary matrix of main threats to mangroves, by region"). It was further recommended that Table 0.1 should include a trend descriptor for each threat, i.e. to show whether each threat is increasing, decreasing or stable. The table was then edited as a group task based on this recommendation.

Nature and Scope of the Code

It was noted that Brazil has a complete ban on cutting mangroves and any trade in mangrove wood products is also illegal. Thus some of the articles of the Code on mangrove forest use would not be relevant to Brazil. However, collecting and other uses of mangrove aquatic products, e.g. mangrove oysters are permitted. Traditional fishers in Brazil, including local people who collect mangrove crabs and molluscs, are known as " Marisqueiras".

It was agreed that the Code for mangroves can help stimulate thinking into needs for other codes, either those more specific by area (for local area management), or by topic (e.g. for shrimp farming or tourism involving mangrove ecosystems).

Workshop Day 2: Tuesday 18th March

Session IV: Articles 1 and 2

There is a recent Law in Brazil (2002) specific for shrimp farming in the environment, including monitoring guidelines. It was agreed to use this as an example and add it to the Brazilian case study (the legal document is in Portuguese but a summary in English will be extracted for this purpose). Examples of degraded or converted mangrove areas in South America are documented by Lacerda and Kjerfve (1999). These will be added to Article 9.

Ecuador is actively supporting co-management involving local communities, the private sector and the State government. The government sets the level of exploitation permitted, but the local community and the private sector agree the nature of resource sharing.

Examples of community management in Colombia were discussed and photographs provided by Ricardo Alvarez-Leon were gratefully accepted for scanning to use as illustrations in the Code, together with a description for each selected photograph.

A site in Esmaraldas, Ecuador gives a good example of ecotourism in a mangrove forest; the site includes 65m high trees, which are 100-150 years old. A maximum of 12 tourist guides are permitted to offer paid guiding services, organised by Ministry of Environment, which trained the 12 people proposed by the community as guides.

Session V to VII: Articles 3 to 10

In order to facilitate the on-going discussion process, the participants divided into smaller groups and continued their discussions in their preferred languages of Spanish or Portuguese, with interpretation into English for the benefit of the consultants.

In Spanish:

Much of the afternoon session was devoted to discussion of Article 2, especially Table 1, which lists management priorities for different categories of mangrove. It was noted that Ecuador and Colombia follow the recognised international biophysical classification from Odum et al as modified by Lugo and Snedaker (1974) which identifies six categories (1) overwash mangroves: (2) fringe forest, (3) riverine forest; (4) basin forest; (5) hammock forest and (6) scrub forest.

It was agreed to contribute an additional table giving the biophysical classification for Ecuador as the working example. This differs from the existing example in Table 1 (based on the Philippines) which describes different mangrove categories in terms of their geography and resource values.

There was discussion about the term "traditional" in the context of mangrove resource users, which implies sustainable users, but this is not necessarily the case. For example, some traditional mangrove dwellers practice destructive fishing methods. Thus it was agreed that, in the context of Article 7, terminology should be used which refers to both traditional and non-traditional activities that are also sustainable.

Two additional points were discussed and noted in relation to mangrove management in Colombia and Ecuador:

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

2) Colombia and Ecuador operate on the basis that polluters pay penalties for their actions.

In Portuguese:

The Brazilian participants discussed separately the legal framework, implementation and use of mangrove inventory and monitoring as supporting actions for management. A written summary of their conclusions was provided for editing into the draft Code of Conduct.

Workshop Day 3: Wednesday 19th March 2003

Field trip to Jaguaribe Estuary

An all-day field trip was made by the workshop participants to the Jaguaribe River estuary and the adjacent coastal area in the eastern part of Ceara State. The Jaguaribe River-estuary has many features of mangrove ecology and management interest, including riverbank erosion and die-off of mangroves; large old mangrove trees of the dominant species found in Brazil (*Rhizophora mangle*, *Avicennia germinas*, *A. shaweriana, Concarpus erectus* and *Laguncularia racemosa*); natural regeneration and colonisation of mangroves, particularly by *Laguncularia*; and artisanal fisheries - especially collection of the edible mangrove crab *Ucides cordatus*. There is also a spectacular sand dune system extending between the river estuary and the Atlantic coast. In some places wind-blown sand is being deposited over the mangroves. A boat trip was made to the mouth of the estuary, then upriver, followed by a visit on foot into the mangroves and the sand dunes between the mangrove forest and the Atlantic.

A large semi-intensive shrimp farm producing *Penaeus vannamei* was also visited. This farm is located behind the mangrove zone in a former salt production area. It was noted that mangroves, especially *Laguncularia* have rapidly colonised suitable habitats such as canals used for shrimp water exchange at the farm.

At the Jaguribe River estuary, about 30 women (wives of local fishermen) are engaged in a project to rear mangrove oysters (*Crassostraea rhizophorae*) using non destructive methods. Instead of collecting wild oysters by cutting them off mangrove roots (the traditional practice), the women now use artificial oyster collectors made from plastic water bottles to obtain spat. The oysters are then transferred to rearing in trays suspended from a fixed frame made from pvc pipe and concrete. Oysters with a meat weight of 1-2g are reared in this way until they can be harvested and sold with a meat weight of 5-7g. The oyster project has been funded by Ceará State Science foundation (FUNCAP) and supported with applied research from the Federal University of Ceará. As well as receiving technical and financial assistance, the women's group has representation in the local municipal administration. Currently, the women can produce 100 dozen oysters weekly, which is sufficient to supplement their basic subsistence income by about 25%. In addition to plans to expand production, the group need help to market the oysters more profitably.

Workshop Day 4: Thursday 20th March

Brazilian participants suggested that it is possible for the aquaculture sector to promote an expansion in the area of mangroves and to assist the local communities to benefit from artisanal aquaculture via the positive environmental benefits more mangroves could provide; e.g. oyster rearing by wives of local fishermen (see field trip notes from 19th March).

In Brazil if shrimp farm owners are caught cutting mangroves the following is the possible sequence of penalties they can face:

1) The farm will be closed
2) The violators will be prosecuted by the local community
3) They will have to pay a fine
4) They may be sentenced to prison

In Brazil it is possible to go to prison for collecting biological samples without the proper permits from the government under the environmental crime act (1998).

Governments should provide good maps that are updated regularly to help with management of coastal areas.

Discussions on making green seals for mangrove products (shrimp, oysters, tourism). Need an independent institution/auditor as cannot be the government to provide a service for the buyer. There is an opportunity to develop specific green guidelines and promote awareness of sustainable products.

The impact of climate change on mangrove ecosystems was discussed as one of the needs in mangrove research which the Code should list.

Need to improve research on well known species but also unknown commercial species to date e.g. in Labomar "Prospective of local biological research".

There is regional cooperation among Central America and Caribbean on mangroves e.g. Honduras, Nicaragua and El Salvador. However, there is no regional cooperation in South America but this is thought not necessary.

The best mechanisms to translate information to local people in Brazil is through TV as it has the most widespread audience and the highest impact. Can increase awareness of mangroves to a wide audience.

Downstream activities:

It was agreed that one of the most valuable follow up activities after the Code is published would be to prepare more specific and simpler versions of the Code for different stakeholders. In Brazil, a simplified version for school children and teachers is the highest priority. The children's version of the Code could be tested out immediately using the existing educational facilities at Labomar which have strong links also to the municipal authority and the mangrove wetland park in Fortaleza. The children's version of the Code would be prepared in Portuguese and it could also be prepared in Spanish for use in the

neighbouring countries of Colombia, Ecuador and Venezuela. Also be adapted for artisanal fishermen, tourists and shrimp farmers.

It was further agreed that the State of Ceara represented an excellent potential location for field testing of the main Code, including its practical use to help local mangrove communities to benefit from more sustainable resource use. In particular the state has well designed shrimp farms behind the mangrove zone with strong interest among the shrimp farmers to take positive measures to improve the environment around the farms, e.g. by planting mangrove or promoting natural regeneration of mangrove along the banks. There are already community based projects to help local fisherfolk to rehabilitate mangroves and to develop new livelihood opportunities e.g. oyster culture (as described in the field trip). Educational activities involving mangroves are also well established, in the form of the "Parque Projeto" a mangrove wetland park in Fortaleza (see below).

Friday 21st March

Projeto Parque Vivo

A mangrove wetland park features prominently in the city of Fortaleza, Ceara State, Brazil and provides important environmental protection, educational and recreational functions for the city. The park extends along both sides of the Coco River, from right in the city centre to the coast where the river enters the sea. It drains an area of over 500 square kilometres and includes 375 Ha of mature mangrove forest with many tall *Avicennia, Laguncularia* and *Rhizophora* trees. The park is managed as a collaborative project ("Projeto Parque Vivo") between the Municipal Authority of Fortaleza and the Federal University of Ceara. Since the park opened in 1993, it has received more than 40,000 visitors, many of whom have been children on organised educational visits from their schools. The park staff come from both the municipal authority and the university. They take the children on guided tours through the park and arrange many other activities for them, such as waste recycling workshops. The park features a well constructed walkway to enable visitors to view the mangroves easily, good posters and brochures explaining the environmental importance of the project and illustrating some of the mangrove animals and plants found in the park. There is also a website: www.parquevivo.ufc.br. University staff are engaged in research projects in the park, including studies on pollution and the impact of land-fill activities.

REFERENCES

The following references were consulted for additional information to support the draft Code.

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Plataforma Technologica do Camarao Marinho Cultivado, Ministerio da Agricultura, Pecuaria e Abastecimento

APPENDIX 1: PRE-PROJECT PROPOSAL

"Code of Conduct for Sustainable Management of Mangrove Forest Ecosystems for Africa, South and Southeast Asia and South America":

A Simplified and Friendly Version for Children

1. Relevance of the project

1.1 To provide an appropriate and effective simplified version of the Code of the Conduct, addressed to students of all levels and general public.

1.2 To help promoting public awareness raising and education through it.

1.3 To encourage youths to support and develop a new posture towards fragile environments/ecosystems, specifically mangroves.

1.4 To help encourage information-sharing between different countries and localities where mangroves are located.

1.5 To assist as an accesible tool in the education about protection of mangroves.

1.6 To help the divulgation of the Code.

2. Project objectives

2.1 Summarize and adapt the complex text of the final version of the Code of the Conduct, making it appropriate to children of all ages and general public.

2.2 Make a friendly publication, by adding illustrations to it, to attract the necessary attention to encourage the preservation awareness.

3. Project Strategies

3.1 Form an interdisciplinary group to hold the following responsabilities:

3.1.1 Translate from/to English/Portuguese/Spanish;

3.1.2 Adapt language to the aimed level;

3.1.3 Consult about relevant/parallel subjects;

3.1.4 Research specific issues/themes involved.

3.2 Establish the better format and size of the publication.

3.3 Elaborate three versions of the publication, in each of the three idioms.

3.4 Edit the publication in Page Maker program making it ready to go into printing process.

4. Indicative budget

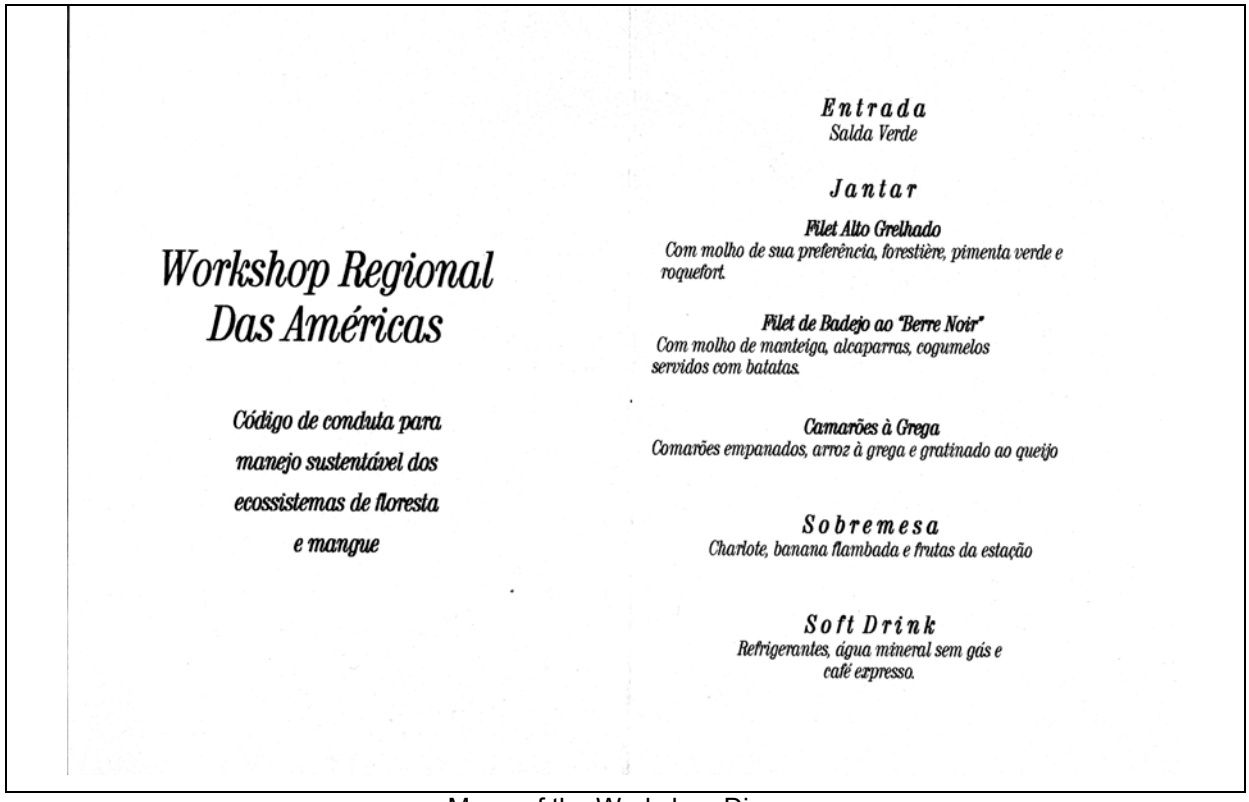
Project personnel = US$ 10,000

Media support and upgrade = US$ 10,000

Consumable items = US$ 7,000

Total budget = US$ 27,000

APPENDIX 2: WORKSHOP DINNER



Workshop Regional Das Américas

Código de conduta para manejo sustentável dos ecossistemas de floresta e mangue

Entrada
Salda Verde

Jantar

Filet Alto Grelhado
Com molho de sua preferência, forestière, pimenta verde e roquefort.

Filet de Badejo ao "Berre Noir"
Com molho de manteiga, alcaparras, cogumelos servidos com batatas.

Camarões à Grega
Comarões empanados, arroz à grega e gratinado ao queijo

Sobremesa
Charlote, banana flambada e frutas da estação

Soft Drink
Refrigerantes, água mineral sem gás e café expresso.

Menu of the Workshop Dinner

Workshop participants signed the workshop dinner menu

Participants in the Workshop Dinner (Left – Right): Liz Ashton, Don Macintosh, Roberto Retamales, Ricardo Alvarez-Leon, Luiz Drude de Lacerda, Rozane Valente Marins, Carlos Artur Sobreira Rocha and Alejandro Bodero.