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Minireview

Status and distribution of mangroves in Mozambique

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The status of mangrove forests in Mozambique is presented. Mangroves in Mozambique cover an area of approximately 396 080 hectares and occur mostly in sheltered shorelines and river estuaries. The highest concentrations of mangroves occur in central Mozambique, in the deltas and estuaries of large rivers. There are nine mangrove species in Mozambique. The major use is in building and as firewood. Major threats to mangroves include over exploitation for firewood and clearing of mangroves for solar salt production. Potential threats are oil pollution, uncontrolled coastal migration and industrial development along the coast. The rate of mangrove deforestation is estimated as 1 821 hectares year^{-1}, and is highest in Maputo and Beira. Conservation and management of mangroves in Mozambique falls under the Forests and Land Legislation Act, which envisages community participation in the protection of natural resources. Proposals are still under way for a national mangrove management plan.

Introduction

Mangroves are defined as characteristic littoral plant formation of tropical and subtropical sheltered coastlines (Hughes and Hughes 1992). They have been described as 'coastal woodlands', 'tidal forests' and 'mangrove forests' (Berjak *et al.* 1982, Saenger *et al.* 1983). In Mozambique mangroves occur in protected shorelines, deltas and estuaries distributed all along the coastline. They are important coastal ecosystems providing ecological, economical and environmental benefits to the people oif Mozambique.

Current studies on Mozambican mangroves can be divided into two major groups. Studies investigatinf the biological and physical aspects and studies concerning socio-economics. Research on biological and physical aspects include: Taxonomy, distribution, fauna and flora associations and biophysical requirements (e.g. Cuambe 2000, Vilanculos and Marquez 2000, Kalk 1995, Saket and Matusse 1994, Hatton and Couto 1992, Hughes and Hughes 1992). Socio-economic studies cover demographic profiles as well as source and destination of mangrove products, mainly firewood and building poles (Chande 2000, Hatton and Massinga 1994, Sitoe *et al.* 1994).

The objective of this paper is to outline the current knowledge on the mangroves of Mozambique, in terms of distribution, uses and threats.

Study area

Mozambique is located on the eastern coast of Africa between latitudes 10°20'S and 26°50'S. The climate is essentially tropical, with a rather sub-tropical climate in the south. Two main seasons can be distinguished: A warm rainy season from October to March and a cooler dry season from April to October. The average annual rainfall in the coastal areas is around 1 173mm — data provided by the National Institute for Meteorology (1998–2000). The 2 770km Mozambican coastline can be divided into three main regions; the sandy coastline in the south, estuarine in the central region, and coraline with coral limestone in the northern region of the country. Mangroves occur mostly in the central estuarine region. In this study, the main areas visited were Maputo Bay and Inhaca Island in the southern region; Beira, Zambezi Delta and Quelimane in the central region and Lumbo, Mussoril, Nacala, Pemba, Ibo and Mecufí in the northern region.

Material and Methods

This paper is chiefly a review work on the distribution, uses and threats on mangroves, and is based on published and technical reports produced in Mozambique. Data concerning species diversity and identification of plants were obtained largely from the herbarium voucher specimens at Eduardo Mondlane University and the Herbarium of the National

Institute for Agronomic Research. The species diversity and comparison between regions was based largely on site observation and literature. Site observation were conducted during several visits to the study sites, carried out during the past eight years.

Results

Mangrove habitats and distribution

Mangroves occur along most of the Mozambican coast (Figure 1). A total of 396 080ha of mangroves occur in the country (Saket and Matusse 1994). The northern region, located between the River Ruvuma (10°30'S, 40°7'30"E) and Angoche (16°12'36"S, 39°54'E), has numerous islands (mainly Quirimbas archipelago) that provide protection to mangroves and coral reefs. Here, the topography is highly indented, the coastal plain is narrow, the rivers are non-tidal and the mangrove forests are mostly confined to the vicinities of the river mouths (Hughes and Hughes 1992). Rivers such as Megaruma and Montepuez are seasonal. The northern coast has well developed creek mangroves in Lumbo, Mecúfi, Ibo Island and the mainland areas north of Pemba City (Whittington *et al.* 1997, Saket and Matusse 1994, Hughes and Hughes 1992).

The central region, located between Angoche (16°12'36"S, 39°54'E) and the Save River (20°52'12"S, 35°30E) has extensive and well established mangroves. This is because of the alluvium and freshwater discharge that is received from 18 rivers flowing to the Indian Ocean. The estuaries of the big rivers such as the Zambezi, Púnguè, Buzi and Save are all in this central region. The mangrove of the Zambezi delta extends inland approximately 50km. This mangrove is continuous from areas in the south to Quelimane (17°46'48"S, 36°54'E) covering almost 180km of coastline. This mangrove is one of the single-largest mangrove forests in Africa and represents close to 50% (185 757ha) of Mozambican mangrove.

The southern region, from the Save River (20°52'12"S, 35°30'E) southward to Ponta de Ouro (26°30'S, 32°24'36"E) on the Mozambique/South Africa border, has extensive mangroves in the Morrumbene Estuary, Inhambane bay, Maputo bay and Inhaca Island. Maputo bay with its four main rivers flowing into the bay, is one of the major mangrove areas in southern Mozambique. At Inhaca, mangrove covers approximately 50% of the entire island coastline constituting one of the largest vegetation types.

Diversity

There are nine species of mangrove trees in Mozambique. The dominant species are *Avicennia marina* (Forssk.) Vierh., *Bruguiera gymnorrhiza* (L.) Lam., *Ceriops tagal* (Per.) C.B. Robinson, *Rhizophora mucronata* Lam. and *Sonneratia alba* Smith. Others are *Heritiera littoralis* Aiton, *Lumnitzera racemosa* Willd., *Xylocarpus granatum* Koenig and *Pemphis acidula* Forst The fern mangrove, *Acrostichum aureum* L., is also common. Other plant associates found close to the mangrove areas include *Barringtonia racemosa* (L.) Roxb., *Hibiscus tiliaceus* L., *Phoenix reclinata* Jacq., *Thespesia populnea* (L.) Soland. ex Correa. The transition zone (between the mangroves and the terrestrial vegetation) is occupied by grasses and herbs such as *Chenolea diffusa* Thunb., *Salicornia perrieri* A. Chev., *Suaeda maritima* Dumont, *Paspalum distichum* L., *Sporobolus virginicus* (L.) Kunth, *Arthrocnemum* sp. The herb *Sesuvium portulacastrum* L occurs in saline areas (salt deserts) and is occasionally harvested as a vegetable.

Pemphis acidula was only found in northern Mozambique (e.g. Mecúfi). This species occurs close to the terrestrial vegetation in areas subjected to extreme high tides. *Sonneratia alba* was only recorded from Incomati River (25°40'48"S, 32°39'36"E) northwards. This is a very common species in northern Mozambique where it thrives together with seagrass species in upper coraline intertidal areas. All nine mangrove species occur in parts of northern Mozambique. Figure 2 shows a schematic diagram of mangrove zonation in central Mozambique. The seaward side is occupied by *Sonneratia alba*. This is followed by tall *Avicennia* then *Ceriops–Rhizophora–Bruguera* communities. *Avicennia* exhibit double zonation, growing as tall trees on the seaward side and as scrub vegetation on the landward side. The diversity of mangroves decreases southward. Semesi (1998) pointed out that *Heritiera littoralis*, *Luminitzera racemosa* and *Xylocarpus granatum* decline in abundance in the vicinity of Inhambane Province.

Mangrove uses

Mangroves are utilised by the people of Mozambique for building materials, firewood, fencing, fish traps and for medicinal purposes (Table 1). Ecologically mangroves play an important role as nursery and feeding grounds for many important commercial fish and crustacean species. Mangrove deforestation is a serious problem in urban centres such as Maputo and Beira. In Incomati Benguelene Island mangrove poles are harvested at an annual rate of 9 234 metric tones/year (Sitoe *et al.* 1991).

Threats to mangroves in Mozambique

Major threats to the mangroves in Mozambique include: (i) uncontrolled exploitation for firewood, charcoal and poles; (ii) clearance of mangroves for agriculture (mainly for rice fields) and salt production; (iii) pollution and (iv) decreased flow of freshwater to mangroves caused by construction of dams (Saket and Matusse 1994, Doddema 1997, Doddema and Manjate 2000). In addition, the uncontrolled influx of people from the interior regions to the coast has resulted in increased exploitation of mangroves (Saket and Matusse 1994). Change in mangrove area per province between 1972 and 1990 in shown is Table 2.

Crude oil and heavy metals have also affected mangroves. FAO/UNEP(1982) mentioned a total of 14 minor and two major crude oil spills in the Maputo harbour which affected mangroves. In 1992, a heavy fuel oil spill apparently affected part of the Macaneta peninsula including mangroves (northern Maputo).

Transformation of mangrove areas into salt pans is common in the coastal regions of Mozambique. In Mossuril

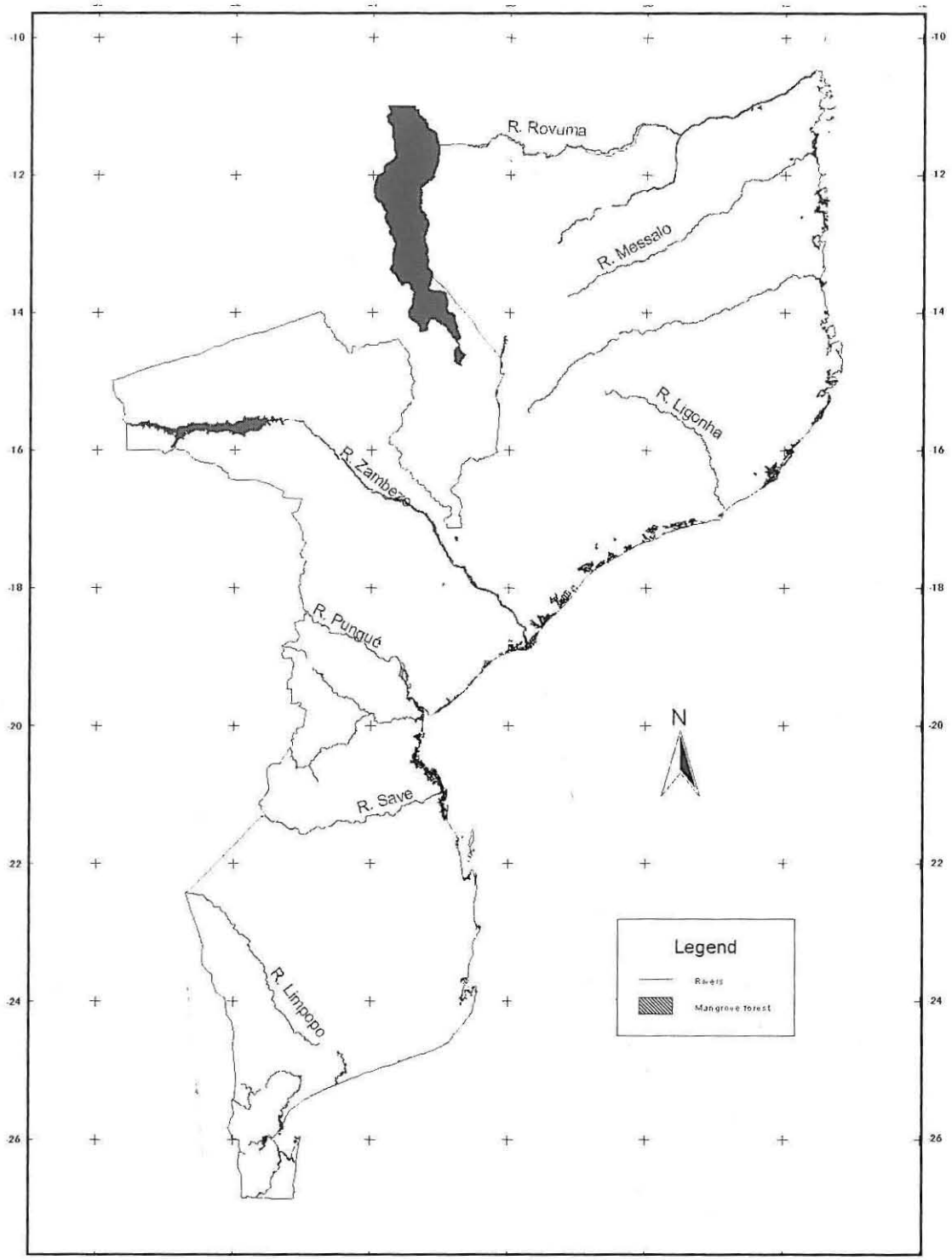

Figure 1: Distribution of mangroves in Mozambique

(northern Mozambique), 50% of the mangroves have been transformed into salt production areas.

The construction of the Cahora-Bassa dam on the Zambezi River has resulted in a reduced flow of freshwater. This has altered water conditions causing the shrinking of mangrove areas and accelerated bank erosion. The salt water in the Zambezi delta apparently presently ascends 80km upstream (Doddema 1997).

Tourism can potentially affect mangrove vegetation, especially when it takes place without sound planning. Sustainable tourism will have to tackle mangrove conservation wherever mangroves occur.

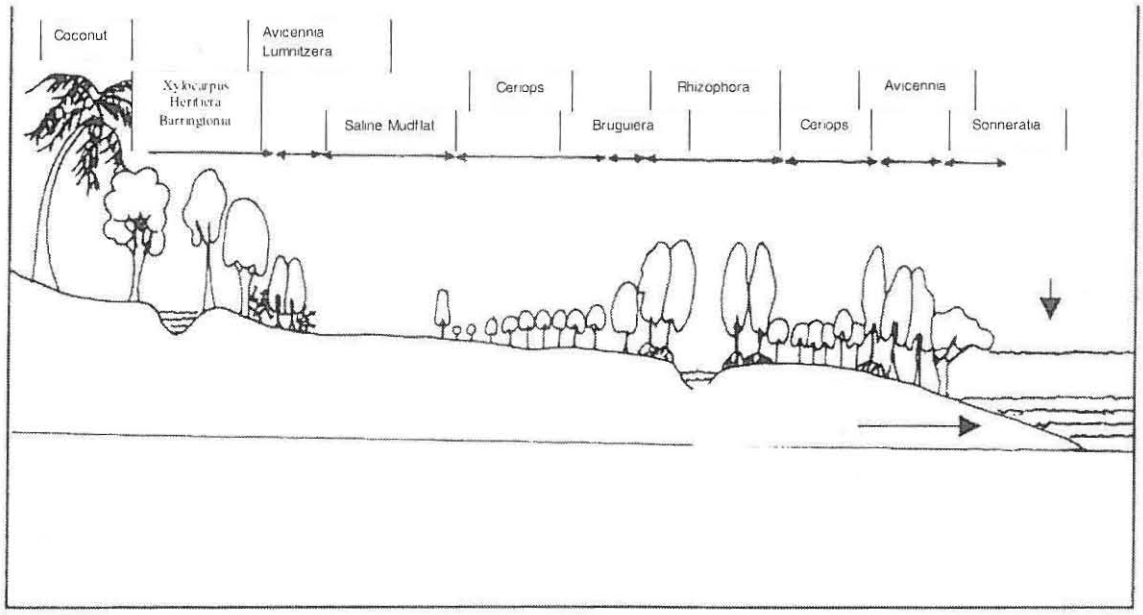

Figure 2: Mangrove transect at Zambezi delta (after Sweco 1982)

Erosion, which can be caused by wave action, storms or winds, can affect mangroves. Some areas of the coastline, e.g. Portuguese Island in the south and Dondo region in central Mozambique, show natural mangrove die-back and drying up, due to sand accretion and to watercourse diversion respectively (Hatton and Couto 1992, Doddema and Manjate 2000). The diversion of the watercourse in the Portuguese Island mangrove channel was a result of sand accretion (Hatton and Couto 1992). Sand accretion promotes mangrove recolonisation as observed in areas such as Portuguese Island and northern Inhaca Island.

Present industrial development along the Mozambican coast is a threat to mangroves. Projects for iron smelter and gas/oil drilling in central Mozambique are potential threats to mangrove stands. The proposed construction of a new dam on the Zambezi River will exacerbate reduced water flux downstream thereby affecting mangrove forests and their associated fauna.

Table 1: Uses of mangrove species in Mozambique (after Barbosa 1995, De Boer 2000, Doddema 2000)

Botanical name	Mozambican names	Uses
Avicennia marina	Musso, N'tsowozi, Txomahati, Invede, Mpedge, Mangal branco	Firewood, fishing poles, dugout canoes, animal fodder, materials used in the construction of beehives
Bruguiera gymnorhiza	Ikapa, Nkandala, M'Piria, N'kandaia, M'fumansi, Setaka or Xitaka, M´finse	Good firewood, fishing stakes, materials used in the construction of houses
Ceriops tagal	Ikapa, Nsangi, Nkandala, Mucandala, Nhakandala, Hlohlotxwani, Hlohlodjani, Mangal indiano	Good firewood, charcoal, fishing stakes, poles used in house construction, timber for boat building
Heritiera littoralis	Mucolongo, Necolongo, Mangal-Moçambique	
Lumnitzera racemosa	Piripito, Mpiripito, Mangal preto	Good firewood, poles for building
Pemphis acidula	Mavuvuta, M'zama	
Rhizophora mucronata	Nhantanzira, Mtanganda, Sinkaha, Ikapa Mangal vermelho	Good firewood, fishing stakes, fish traps, poles used in house construction, bark used for dying nets
Soneratia alba	Mpiria, Tjindiri, Mangal maça	Poles, firewood
Xylocarpus granatum	Murrubo, Marrubo, Nseti, Shukuliha Mangal bola-de-canhão	Good firewood, fish smoking, materials for boat building, medicine for stomach ache
Thespesia populnea	Mulola	Rope is made from the bark at young plants
Hibiscus tiliaceus	Lilolo, Nolo, Swombe, Muloladenbe	Bark used in the making of straps and belts
Phoenix reclinata	Kindzu, Tchindo, Muchindo	Edible fruits, sap used for making alcoholic beverage, brooms
Sesuvium portulacastrum	Secilii, Serisiri	Green vegetable

Table 2: Changes in mangrove cover (hectares) in Mozambique between 1972–1990 (Saket and Matusse 1994)

Provinces	Year 1972	Year 1990	Area depleted	New area of mangroves	Deforestation rate (%)
Maputo	14 605	12 599	2 217	211	15.2
Gaza	387	387	0	0	0
Inhambane	20 094	19 848	246	0	1.2
Sofala	129 997	125 317	6 334	1 654	4.9
Zambezia	159 417	155 757	3 766	106	2.4
Nampula	55 849	54 336	2 006	493	3.6
Cabo Delg	27 730	27 836	0	106	0
Total	408 079	396 080	14 569	2 570	

Mangroves conservation and legislation

The conservation of mangroves in Mozambique falls under the general legislation for terrestrial forests (controlled by the National Directorate for Wildlife and Forestry). The Bazaruto Archipelago National Park and the Inhaca and Portuguese Islands reserves are currently the only existing marine protected areas with mangrove forests. The Pomene, Marromeu and Maputo special reserves also contain mangroves. There are proposals to protect mangrove forests in the Primeiras and Segundas archipelago, the Quirimbas archipelago, the Nacala-Mossuril region, the Bartolomeu Dias area, parts of Pemba bay, the Save River mouth and the San Sebastian peninsula (Gove 1995, Kelleher *et al.* 1995)

A new land legislation was approved in 1998. In article 5 of the new legislation, all mangroves are subject to partial protection together with other living resource occurring within areas from the coastline to 100 metres inland of the coastline. This land legislation envisages community participation in the protection of natural resources (including mangroves) and in conflict resolution. Development projects with potential impacts on mangroves are subject to environmental impact assessments. Under this legislation, mangrove exploitation for commercial purposes must be licensed.

A pilot study aimed at providing baseline data for a national mangrove management plan has been conducted in central Mozambique. This management plan envisages aspects such as (i) classification and mapping of mangrove areas, according to the biological diversity, ecological and economic functions; (ii) planning and zonation of land use; (iii) reforestation or rehabilitation of mangrove areas; (iv) control of mangrove resources exploitation; (v) the creation of alternative sources of income besides mangroves; (vi) creating a national mangroves management committee. This pilot project has defined intact and degraded mangrove areas and urban and rural mangrove communities. Different applications can be derived from mangrove vegetation including: Exploitation of the fauna (e.g. fish, crabs), utilisation of mangrove trees (e.g. firewood, building material, ropes) and conversion of mangroves into development areas (e.g. urban expansion, salt-extraction plants, aquaculture). Mozambique will need to find a compromise between development and conservation. Mangrove areas with the highest species diversity and productivity of overall habitat and mangrove areas adjoining major river mounts are recommended as priority areas for conservation. Urban areas with high rates of mangrove deforestation (e.g. Maputo, Beira, Nacala-a-Velha) are priority areas for mangrove reforestation.

Discussion

Uses of mangrove resources in Mozambique are similar to those observed in other African countries (e.g. Semesi 1998, Salm 1995). The pressure inflicted by the growing population and the economic development of the coastal region seem to be the main factors causing mangrove depletion. Contrary to the negative effect of aquaculture development in places such as the Philippines (Christensen 2000) such activity is still new and is mostly performed in former salt-extraction areas in Mozambique. The development of large scale aquaculture in Mozambique will result in negative impacts such as: Further depletion of mangrove regions, pollution of mangrove habitats through aquaculture chemicals, depletion of faunal resources traditionally used in small scale fisheries, resulting in reduced livelihoods for the local people.

A general decrease in mangrove coverage was observed for Mozambique (Table 2). However, a localised increase in coverage seems to be mainly due to regeneration. As stated, in the previous section, sand accretion seems to be the main reason for the increase obseved in mangrove regeneration. Limited accessibility to remote regions has assisted in the preservation of the mangroves in the central (Doddema 2000) and northern areas of Mozambique.

The distribution of different species of mangroves and their abundance should be related to different factors such as air and water temperature, salinity versus freshwater and sediment (e.g. Ellison and Farnsworth 1996). The successful implementation of the national mangrove management plan will require further research on management and conservation issues. Specific research should also consider the possible relationship between mangrove abundance/distribution and river floods. Research on infestations by boring caterpillars (Semesi 1998) has not been quantified for Mozambique. The effects of caterpillar on mangroves has been observed around Inhaca Island and northern Beira.

To conclude, mangroves in Mozambique, are an important asset, providing direct, and indirect benefits. Law inforcement is required in order to enforce conservation practices and the sustainable use of mangroves. Such enforcement is to be considered within the national mangrove management plan.

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