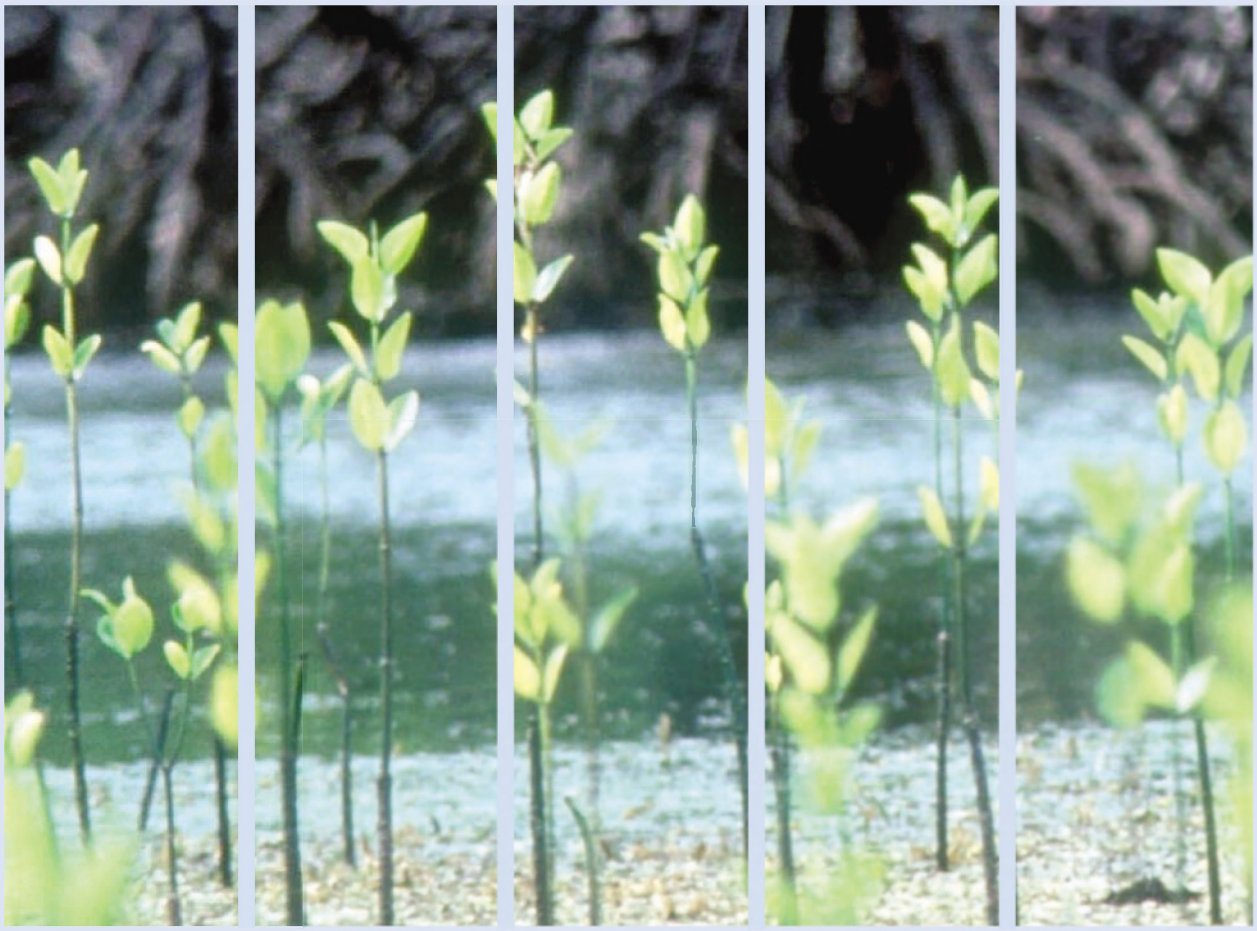
UNEP WCMC GPA

Mangroves



# of East Africa

Michelle Taylor, Corinna Ravilious, Edmund P. Green

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A **Banson** production

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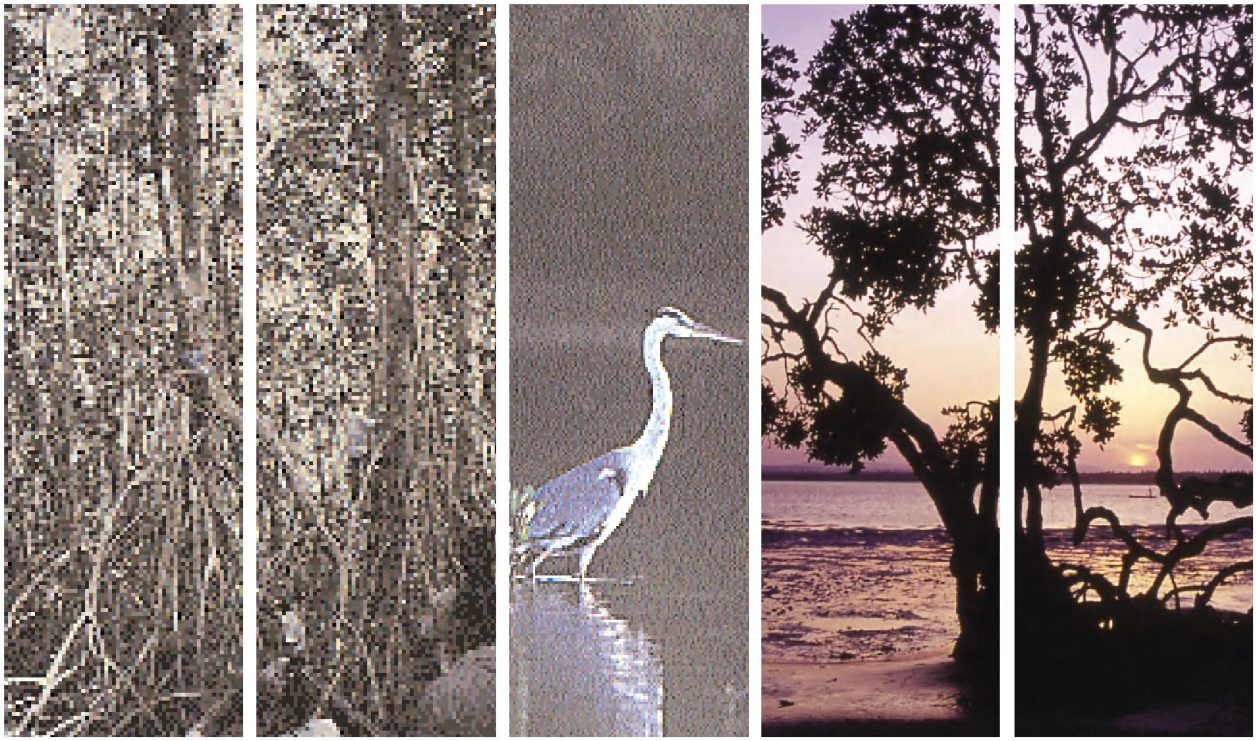
Coastline (km)	Earthtrends, 2001	**Mangrove area on map (km²)**	From GIS data stored and compiled at UNEP-WCMC and stated sources
Population (2000)	Population Division of the Department of Economic and Social Affairs of the United Nations Secretariat, 2002	**Mangrove area (alternative estimate) (km²)**	Relevant country-specific reference
Population density (per km²)	As above	**Number of nationally protected areas containing mangroves**	World Database of Protected Areas, UNEP-WCMC



Photos: SECA/CML (left and centre), Stefano Cannicci (right)

Regional overview

Living in two worlds at once, mangroves protect coastlines from wave energy and protect offshore ecosystems from terrestrial sediments flowing downstream. Throughout the tropics mangroves exist in intertidal areas and are utilized as a habitat by thousands of animal species and as fuel, medicine, food and timber by human coastal populations.

As East African human populations have grown over recent decades, increasing pressure has been placed on mangrove resources. Simultaneously, mangrove research has boomed, unveiling the importance of the ecological, economic and protective role that mangroves fulfil. Governments, non-governmental organizations and local communities have made concerted efforts to protect and regenerate remaining stands. However, overwhelming pressures continue to take their toll.

EAST AFRICAN MANGROVES

Mangrove areas have a high level of productivity as they receive nutrients from both sea and land. Detritus is the primary energy source in tropical estuaries and mangroves are often the producer of this organic litter. Sixty per cent of leaf material in tropical estuaries originates from mangroves. Gross primary production in East African mangroves is seasonally variable but generally comparable to seagrasses and more than coral reefs (see Table 1). Unfortunately little work has centred on energy transfer in mangrove ecosystems and consequently we do not have a complete understanding of trophic relationships and food webs.

In East Africa *Sonneratia alba* is very common, typically occurring in muddy soils where salinity is close to sea water. It is a hardy primary colonizer and resistant to physical disturbance so is often found along outer margins. *Rhizophora mucronata* dominates on muddy soil and is commonly found in large homogeneous stands on upper river banks. *Bruguiera gymnorrhiza* occurs between *Rhizophora mucronata* and *Ceriops tagal* zones, or interspersed throughout them. *Ceriops tagal* has a weaker root system and is less capable of withstanding strong waves and currents; it grows in upper intertidal areas where

Table 1: Mean gross primary production of biotopes in Gazi Bay, Kenya

	Wet season mgC/m³/day	Dry season mgC/m³/day
Mangroves	540.41±222.63	377.67±159.70
Seagrass	552.22±291.36	230.84±84.75
Coral reefs	388.88±247.12	240.27±115.29

Table 2: Mangrove species distribution throughout East Africa

Species	South Africa	Mozambique	Madagascar	Tanzania	Seychelles	Kenya	Somalia
Rhizophora mucronata	✓	✓	✓	✓	✓	✓	✓
Ceriops tagal	✓	✓	✓	✓	✓	✓	✓
Bruguiera gymnorrhiza	✓	✓	✓	✓	✓	✓	✓
Avicennia marina	✓	✓	✓	✓	✓	✓	✓
Sonneratia alba		✓	✓	✓	✓	✓	✓
Heritiera littoralis		✓	✓	✓		✓	
Xylocarpus granatum	✓	✓	✓	✓	✓	✓	
Lumnitzera racemosa	✓	✓	✓	✓	✓	✓	✓
Avicennia officinalis			✓				
Total number of species	**6**	**8**	**9**	**8**	**7**	**8**	**6**

sediments are thicker. *Heritiera littoralis* is found on river banks and in estuary mouths where salinity is low and in inland areas usually flooded only by spring high tides. *Xylocarpus granatum* grows scattered on higher ground in *Avicennia marina* stands where sea water flooding occurs only a few days each month and where freshwater has more influence. *Avicennia marina* is euryhaline and tolerates a variety of flooding regimes and substrates but is most commonly found on firm sandy soils. It is a widely distributed species and often a primary colonizer of exposed seaward areas. *Lumnitzera racemosa* is associated with *B. gymnorrhiza* and *Xylocarpus moluccensis* along river banks. Patterns of zonation can be altered by disturbance because heavily used species may not regenerate first and newly disturbed areas may be colonized by pioneer species.

From 1950 to 2000 265 papers were published focusing on mangrove research in East Africa, 92 per cent of which centred on Kenya. Few were experimental or comparative with 80 per cent descriptive in approach. The mangrove ecosystems of eastern Africa are well studied, but even the baseline information needed for environmental impact assessments and management plans is still not available. A major problem is that available information is often not disseminated. Numerous different national languages further hinder dissemination as findings are often confined to their countries of origin.

The physical three-dimensional complexity of mangrove forests creates a wide diversity of niches suitable for breeding, spawning and hatching of sedentary and migratory species. Mangroves are an important nursery habitat, particularly for fish and crustaceans.

Both terrestrial and aquatic biodiversity within mangroves are high. However, if areas are deforested densities of epifaunal species such as *Littorina scabra*, *Uca* spp., *Sesarma* spp. and *Cerithidea decollata* are greatly reduced. Populations of infaunal species, nematodes, bivalves, copepods and many molluscs are still recorded in similar densities in deforested and natural mangrove areas.

Aquaculture is an expanding industry in the East African region. The consequences of aquaculture projects for mangroves are well documented from Ecuador, Thailand, Indonesia, Malaysia, Vietnam, Bangladesh and India. If this industry develops vigorously in East Africa there is the potential for similar degradation of mangroves. This can be avoided through careful regulation of mangrove felling. Many small-scale, locally managed farms, of low intensity, would be economically and environmentally preferable to a few massive ventures such as the proposed Rufiji prawn project in Tanzania.

Mangrove timber is used locally in construction and for fuel. Mangroves have a range of branch sizes and the varying sizes have different uses and individual names in Swahili:

Fito (2.5-3.5cm): the smallest poles, used to fill walls (usually young *R. mucronata* and *C. tagal*).

Pau (4.0-7.5cm): small poles, used as roof frames (usually young *R. mucronata* and *C. tagal*).

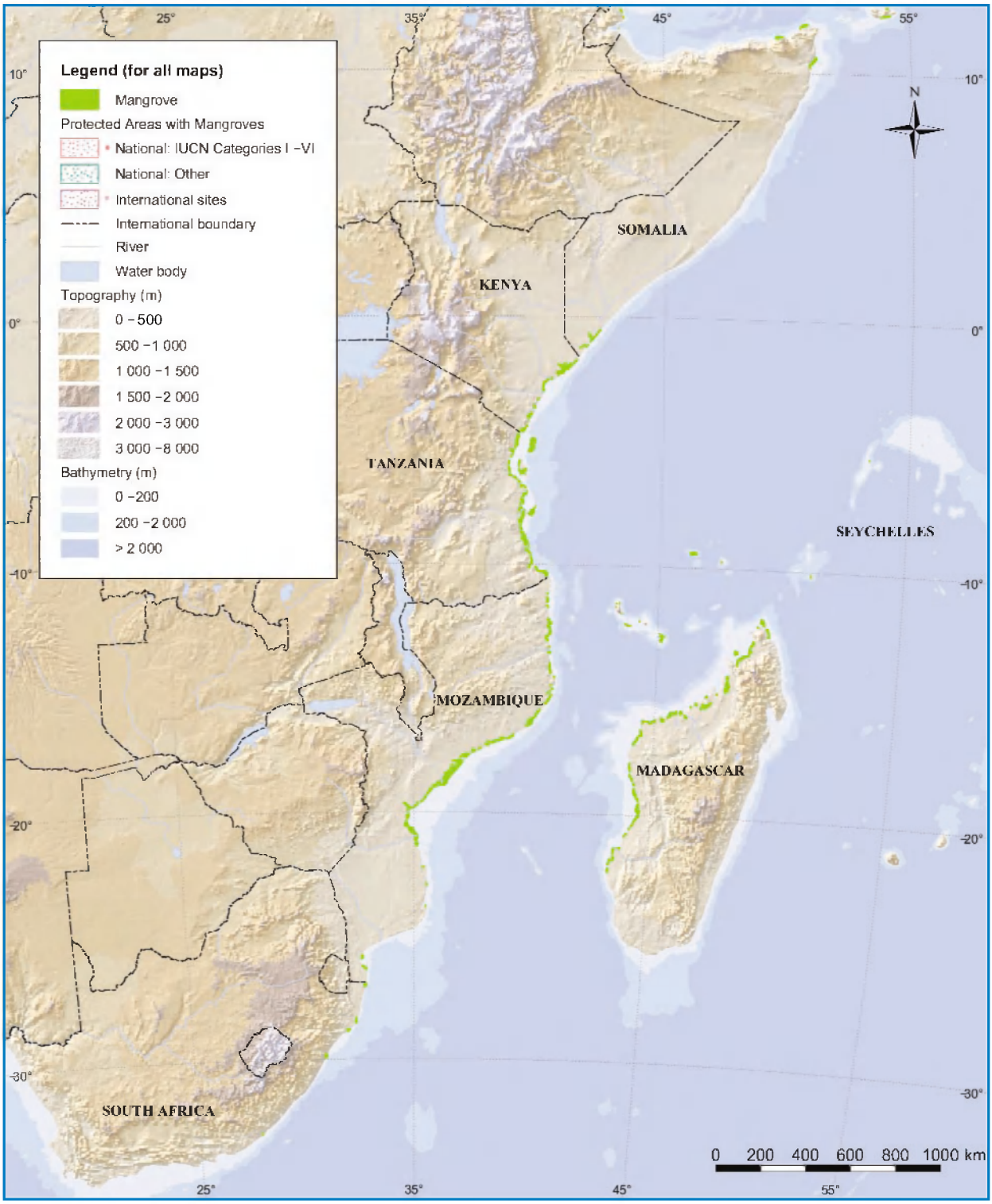
Mazio (7.5-11.5cm): a bit larger, and used to build the main frame of house walls (usually young *R. mucronata* and *C. tagal*), which is then packed with mud.

Boriti (11.5-13.5cm): larger poles, used to build fences, mainly for tourist developments (usually *R. mucronata*).

Nguso (14.0-20.0cm): used at the corner of houses to support the roof (usually mature *R. mucronata* and *B. gymnorrhiza*).

Vigingi (20.5-35.0cm): the largest poles, used to support the main roof of larger tourist hotels (usually *B. gymnorrhiza*).

Local mangrove markets are common as wood is used in so many aspects of everyday life. Fish traps made of mangrove are more robust in salt water than other types of wood. Seaweed farmers use mangrove stakes for the same reason. Boats, such as one-man canoes carved from heavy *Avicennia marina* logs, furniture, drums and serving dishes



East African mangrove distribution

are all made from mangroves. Most villages around mangrove forests construct the majority of buildings from felled mangroves as they are an easily accessible resource.

Mangrove wood is often used as fuel. *Rhizophora* species are especially utilized as they are rich in tannin and burn almost smokelessly, imparting a pleasant taste to cooked food. Green *Avicennia marina* logs, however, are very smoky and slow burning so are often used by honey collectors and fishermen to keep away biting insects at night.

Many villagers produce salt by boiling brackish water in clay bowls over fire. Mangroves are heavily exploited as a fuel source using this technique. With seven tonnes of wood needed to produce one tonne of salt some coastal forests are now bare. On a larger scale salt is harvested from evaporation ponds, shallow brine-filled pits, usually built in cleared mangrove areas.

THREATS

Once common in sheltered bays and estuaries, mangrove forests in some areas of East Africa are now degraded. One of the major factors changing the characteristics of mangroves within the region is inland topsoil erosion, typically from agriculture and grazing land. Natural levels of erosion bring nutrients to coastal areas and build mangrove forests by replacing mud and sand lost by wave action. However, the extreme levels of soil being washed downstream in recent years is burying roots, asphyxiating mangroves.

If mangroves are felled, offshore coastal areas, such as coral reefs, receive even more sedimentation. Already the effects of excessive nutrient loads and sediment discharge can be seen as breaks forming in fringing reefs opposite river mouths. The central Mozambique coast (800km long) is devoid of coral due to discharge from the Lompopo and Zambezi Rivers.

Oil is a major pollution threat in the region as there are tanker routes along the East African coast linking the Gulf to the Atlantic Ocean. Many countries lack even basic facilities for handling bilge in their ports and small oil spills are common. If mangrove lenticels and pneumatophores become covered in oil the tree suffocates. The toxicity of substances within the oil, the age and species composition of mangroves, and sediment type all affect mangrove survival after spills. The effects of oiling can last for many years. For example, reduced mangrove area and epifaunal cover is still recorded in Makupa Creek, Kenya, ten years after spills occurred.

Industry may be developing more slowly in East Africa than elsewhere but rivers, streams and mangroves are used as dumping sites for the textile, chemical, paper, sugar and oil industries within the region. In Kenya, Tanzania and Mozambique agricultural and silvicultural

Photo: GISE Unit/NEMC and TCMP/CRC

Mangrove area converted into coastal salt mining, Mikindani, Mtwara.

effluents enter mangrove areas. In Somalia and Madagascar the concentration is more on livestock industries. However, industrial pollution is not a severe problem in the region as it is still small scale.

Eastern Africa is also undergoing an extraordinary rate of urbanization. The pressure on mangroves from human populations varies immensely across the region. In Madagascar over 90 per cent of households depend on fuelwood and charcoal (including mangroves). By contrast, only 8 per cent of people in the Seychelles depend on fuelwood, even as a supplementary source of energy.

The effects of climate change will be felt across the region as patterns of rainfall, coastal weather, atmospheric pressure and evaporation adjust. Anticipated effects of climate change are increased temperatures, changes in hydrology regimes, a rise in sea level, increased magnitude and frequency of storms and increased carbon dioxide concentration. There will be positive and negative affects on mangroves and it is highly uncertain exactly what the net outcome will be as local variability will be very high and effects site specific.

As temperatures rise mangroves may start to colonize higher latitudinal areas. A warmer climate may result in an increase in frequency and strength of tropical storms and previously sheltered areas, suitable for mangrove growth, may become exposed. Conversely, any reduction in temperature could shrink mangrove range. Any changes in temperature, salinity, storm frequency or precipitation will have effects on flora and fauna composition within mangrove forests.

It is difficult to predict the exact consequences of sea-level rise as many scenarios are dependent on sedimentation fluxes from river catchments and coastal topography or land composition. Generally opinion seems to agree that rising sea levels will lead to mangroves shifting landward, as long as the rate of rise does not exceed mangrove growth and there are no obstructions to inland expansion.

Regenerated mangrove areas, even those that extend beyond original mangrove locations, may not be of

Table 3: Uses of mangroves

Latin species names of mangroves and mangrove associates	Kiswahili/Swahili spoken through eastern Africa and/or Giriama, Kenya	Uses
Avicennia marina (Forskål) Vierhand	Mchu	**Main:** no substantial utilization **Secondary:** high quality charcoal, boat paddles, oars, handcraft handles, axe handles, pounding poles, beehives and traditional drums; the roots provide remedies
Avicennia officinalis Linnaeus		Inferior firewood (only reported from Madagascar)
Bruguiera gymnorrhiza (L.) Lamarck	Mshinzi, Muia, Mkoko wimbi	**Main:** building material, roof supports, high quality firewood **Secondary:** high quality charcoal, boat paddles, oars, handcraft handles, axe handles, pounding poles, beehives and traditional drums; the roots provide remedies
Ceriops tagal (Perr.) C.B. Robinson	Mkandaa mwekundu, Mkoko mtune, Mkoko mwekundu	Building material, paddles, oars, medium quality firewood, charcoal, dyes (incl. tanning compounds), fishing traps
Heritiera littoralis Dryand	Msikundazi, Mkungu	**Main:** charcoal **Secondary:** firewood, building wood, dhow masts
Lumnitzera racemosa Willd.	Kilalamba duma, Kikandaa, Mkaa pwani	**Main:** no substantial utilization **Subsidiary:** building wood, medium quality firewood and charcoal
Pemphis acidula Forst.	Kilalamba kike	**Main:** firewood, charcoal **Subsidiary:** building wood
Rhizophora mucronata Lamarck	Magoni, Mkoko, Mkoko mwenye mwenye	**Main:** building wood, high quality charcoal **Secondary:** high quality firewood, dyes (incl. tanning compounds), medicines, ointments, bow-nets (using roots), fishing traps, weapons
Sonneratia alba Smith	Mlilana, Mpira	**Main:** canoes, boat ribs, paddles, masts, pneumatophores used for floating fishing gears, window and door frames **Secondary:** medium quality firewood and charcoal
Xylocarpus granatum Koenig	Mkomafi	**Main:** canoes, charcoal **Secondary:** firewood **Subsidiary:** the fruits provide remedies for stomach ache
Xylocarpus moluccensis (Lamk.) Roem.	Mkomafi dume	**Main:** high quality timber: bed construction, window and door frames, medium quality charcoal **Secondary:** medium quality firewood

the same quality as virgin stands because species composition, soil type, stocking rates and numbers of animals will have changed. Selective harvesting removes high quality mangroves leaving lower quality species to repopulate the now depleted area. Some human communities, such as those around Chwaka Bay on Zanzibar, do leave "mother" trees to produce seedlings but this is rare and sometimes the mother trees are merely large, mature, lower quality trees. Furthermore, lower quality mangrove wood, smaller trees, or species less used in construction, provide less income. In Chwaka Bay for instance, poles used in construction are of a relatively poor quality and are sold for TSh4 000 to 5 000 (currently US$55 to 75) whereas wood imported from mainland Tanzania can be sold for TSh9 000 to 10 000 (US$125 to 140) as it is of a higher quality.

FAUNA

Crabs are the most conspicuous invertebrates inhabiting mangroves. Upper zones are inhabited by marsh crabs, *Sesarma* spp., and closer to shore fiddler crabs, *Uca* spp., are dominant. Giant mud crabs, *Scylla serrata*, hermit crabs, prawns and shrimp are all mangrove residents. Fiddler crabs in particular play an important role in the cycling of nutrients in mangrove ecosystems as they feed on detritus or micro-organisms living on detritus. Giant mud crabs predate on molluscs and smaller crab species and are harvested for food. Filter feeders such as rock oysters, *Saccostrea cucullata*, and barnacles, *Balanus amphitrite*, secure themselves to lower stems or pneumatophores in lower intertidal areas, enabling them to filter plankton and nutrients from surrounding waters. Mud creepers, *Terebralia palustris*, mud whelk, *Cerithidea decollata*, and *Strombus* spp. are all mangrove molluscs. Some 117 species of molluscs and 163 species of crustaceans have been recorded from mangroves in the East African region.

The most commonly found fish species in mangroves is likely to be mullet. Mullet, for example *Liza macrolepis*, consume large quantities of plant material making them important in nutrient cycling. Other common fish species include Kelee shad, *Hilsa kelee*, milkfish, *Chanos chanos*, anchovy, *Thryssa* spp., striped catfish, *Plotosus lineatus*, gobies, common silver biddy, *Gerres oyena*, and the two-finned round herring, *Spratellomorpha bianalis*. In all, 114 species of fish have been recorded from East African mangroves.

Mangroves are used by migratory bird species such as crab plover, *Dromas ardeola*, African spoonbill, *Platalea alba*, and great white egret, *Egretta alba*.

Larger creatures found in mangrove forests and surrounding waterways include Nile crocodiles, *Crocodylus niloticus*, hippopotamuses, monkeys and dugong, *Dugong dugon* (listed as vulnerable on the IUCN Red List). Zebras, bush pigs, blue duikers, water mongoose and otters are all periodically found in mangrove areas.

Photo: SECA/CML

Migratory crab plover, *Dromas ardeola*, often found in East African mangroves.

LEGISLATION

It is relatively rare for mangroves to be the specific focus of a protected area in the way some marine protected areas focus on habitats such as coral reefs. However, a whole ecosystem approach is needed to ensure the conservation of coastal areas. Many species found within mangroves spend part of their life cycles in seagrass and coral areas so a zone of protection isolating just a reef will not preserve all species at all stages of their life cycles. Current levels of protection need to be improved throughout the region. In the past five years two new nationally designated marine protected areas containing mangroves have been established, both in Tanzania. On an international level, one UNESCO Biosphere Reserve and one World Heritage Site with mangroves have been created since 1996.

FUTURE

A rational use of mangrove forests has to be embarked upon to ensure the long-term survival of the forests and all creatures, human and animal alike, that rely on them. This will mean changes to present approaches in mangrove management. Past problems facing mangrove forests have been the lack of community input into management approaches, high levels of poverty within indigenous coastal communities and a general lack of awareness of the true value of mangroves. These issues and the regeneration of mangrove forests should be included in future mangrove management plans.

Management changes are not the all-encompassing solution as current knowledge of many aspects of mangrove ecosystems needs to be improved. Techniques for natural and artificial regeneration need to be investigated further as do mangrove faunal interactions, mangrove fisheries, hydrology, and growth and development. We would then better understand how felling and other human activities are affecting mangrove ecosystems. Only then will efficient and sustainable management regimes be attainable.

South Africa

Mangroves along South Africa's east coast are more extensive in the north, becoming less frequent in southern estuaries. The largest mangrove areas can be found in the Mhlathuze and St. Lucia estuaries. The Mhlathuze's estuaries and bays actually represent 80 per cent of South Africa's mangroves while the exposed, rocky western coast is devoid of mangroves.

Nahoon River is the southernmost occurrence of mangroves on the East African coast and thus has a slightly different species composition than is typical. The southern extents of tropical species such as *Lumnitzera racemosa*, *Ceriops tagal* and *Xylocarpus granatum* are found in Kosi Bay, northern South Africa. *Avicennia marina*, *Bruguiera gymnorrhiza* and *Rhizophora mucronata* are commonly found in mangrove areas throughout South Africa, with the last not occurring south of the Bulungula River.

South Africa	
Land area (km²)	1 221 040
Coastline (km)	3 751
Population ('000) 2000	43 309
Population density (per km²) 2000	35
Annual population growth rate (%) 2000-2005	0.77
Mangrove area on map (km²)	334
Mangrove area (km²) *Adams et al., submitted*	16.88
Protected areas with mangroves	7

USES

Mangroves in South Africa are, for the most part, valued for their wood resources rather than for associated fisheries as wood poles are widely used in construction. However, mangrove areas are rich fishing grounds for both recreational and subsistence fisheries. Mangroves are also exploited in order to fish as their wood is used to construct fish traps, in particular traps called kraals. Kraals are temporary structures, made largely from mangrove branches, that are used to catch prawns.

THREATS AND LOSSES

In 1988 mangroves occurred in 17 of the 76 estuaries within the Transkei. Now only 14 estuaries boast mangrove habitat. A loss of 6.5 per cent of mangroves per year over 11 years has been recorded. This reduction is indicative of losses occurring in unprotected areas along the entire South African coast. No new mangrove stands have been recorded in the Transkei but mangrove areas in eight original stands have increased (mostly in protected areas). This combination of loss and gain has made net area change over recent decades negligible.

Three estuaries and rivers have suffered complete loss of mangroves, mainly due to an altered hydrological regime. The Mzimvubu River has lost its mangroves to excessive bank scouring linked to flooding events. A drought in the Bulungula estuary closed off the estuary mouth causing freshwater to build up and inundate the mangroves which were then harvested.

The biggest threats currently facing mangroves are harvesting, development around mangrove areas, and reductions of freshwater into estuaries causing river mouths to close and mangroves to flood. In addition, inappropriate agricultural activities, such as cultivation of steep areas, contour furrows and veld management, have led to catchment degradation that ultimately results in increased sedimentation entering mangrove ecosystems.

Being at the southern limits of their extent, mangroves grow at a slower rate than forests further north, which benefit from tropical conditions. Thus, felling South African mangroves is an activity with repercussions over a longer time period than in other countries.

FAUNA

Sesarmid crabs, fiddler crabs, *Uca* spp., giant mud crabs, *Scylla serrata*, mudskippers, *Periophthalmus kalolo*, and many gastropods are all fauna commonly found in mangrove swamps in South Africa. Mangroves provide anchorage for filter-feeding organisms such as Natal rock oysters, *Crassostrea cucullata*, barnacles, such as *Balanus amphitrite*, and numerous mussel species. The nationally endangered mangrove kingfishers, *Halcyon senegaloides*, have their southernmost breeding sites in the Kobonqaba, Ngqusi and Nxaxo rivers. Blue duiker, *Philantomba monticola*, bushbucks, *Tragelaphus scriptus*, and bush pigs, *Potamochoerus porcus*, can regularly be found in the mangroves of South Africa and there is evidence that Cape clawless otters, *Aonyx capensis*, water mongoose, *Atilax paludinosus*, grey duikers, *Sylvicapra grimmia*, and Burchell's zebras, *Equus burchelli*, are also intermittent visitors.

LEGISLATION

South African mangroves tend to be small and found in isolated estuary mouths, making management and policing difficult. And, as elsewhere in East Africa, responsibilities for mangrove management lie with many different government agencies and this has led to fragmented and uncoordinated administration at all three governmental authority levels (central, provincial and local).

In the Transkei only 6 per cent of mangroves are protected yet this area is regarded as having a high level of protection owing to regulations being upheld and efficient policing. Unprotected areas of mangroves in Mdumbi, Mzamba, Koboqaba and Mtamvuma have suffered 50 per cent loss in trees to harvest, whereas protected areas have seen no change in cover, and occasionally an increase.

Photo: Tris Wooldridge

Mngazana estuary in southern Transkei, South Africa.

Photo: SECA/CML

Oysters on stilt roots of *Rhizophora* spp.

Photo: SECA/CML

Coastal villages often use mangrove wood in construction.

In the absence of legally protected areas there are mangrove stands that are protected by local communities. Xora and Nxaxo mangroves are protected in this manner and both areas have seen increased mangrove cover in the past decade. The same could not be said for many, if any, accessible unprotected mangrove areas.

Map source: *Small annotations onto base map based on locations from Hughes and Hughes,1992. Indicative of locations and not regarded as providing accurate areal coverage.*

Mozambique

Mangroves are continuous along the north and central coastlines of Mozambique, becoming less common in southern areas. The most extensive mangrove forests are found in the Zambezi River Delta, where almost 180km of coastline is covered in continuous mangrove forest. This area contains 50 per cent of Mozambique's mangrove area and is also one of the largest mangrove forests in Africa.

There are well-developed areas between the Beira and the Save Rivers in central Mozambique, where mangroves extend 50km inland with canopy heights of up to 30m. And creeks in the north at Lumbo, Mecúfi, Ibo Island and north of Pemba have mangrove areas.

USES

Mangroves are used for construction, firewood, charcoal production, tannins, fruit, fencing, fish traps and medicine in Mozambique. *Rhizophora mucronata* bark is used to dye fishing nets. Dugout canoes and beehives are made from *Avicennia marina* wood. Molluscs and crustaceans, such as mangrove crabs, *Scylla serrata*, mud creepers, *Terebralia palustris*, and shore crabs, *Matuta lunaris*, collected from mangroves represent an important source of protein for human populations in Mozambique, especially on Inhaca Island.

THREATS AND LOSSES

The overall rate of mangrove deforestation in Mozambique is estimated at 18.2km^2/year. However, mangrove forests are still relatively unaffected as there has been a small overall rate, 2.6 per cent, of mangrove cover lost from 1972 to 1990. Some areas, such as Maputo and Beira, do experience heavy utilization and mangroves here are more at risk of severe depletion. Mangrove poles in Benguelene Island are being harvested at a rate of 9 234 tonnes a year.

Mozambique's coastal population was estimated at 6.6 million people (42 per cent of the total) in 1997 and this number is growing. The consequent pressure on coastal resources affects mangroves. Urban areas, such as Maputo and Beira, have experienced much mangrove deforestation for firewood, charcoal, agriculture and salt production. Mossuril has had half of its mangrove forests transformed into salt production areas. During the civil war from 1975 to 1994 Inhaca Island experienced serious overpopulation problems as people sought refuge from the mainland. This had negative impacts on the island's natural resources, including mangroves. As families have returned to their pre-war homes the pressure has eased, and currently Inhaca Island mangroves are managed sustainably. Mangroves and mangrove products still contribute approximately 20 per cent to the average family income on Inhaca Island.

A high volume of crude oil is transported through the Mozambique Channel, around 450 million tonnes annually. There have been 14 minor and two major crude oil spills in Maputo harbour that have affected mangroves. A heavy fuel oil spill in 1992 affected part of the Macaneta peninsula, including mangrove areas. The Cahora-Bassa dam on the Zambezi River has reduced the flow of water, altering water conditions in the mangroves and ultimately causing a shrinking of mangrove area.

Industrial pollution is currently not a significant problem in Mozambique but with the expanding iron smelting and gas/oil drilling activities along the centre of the coast it could be a potential threat to mangroves in future years.

Photo: Tris Wooldridge

Extensive mangrove cutting in the Mebase estuary, northern Mozambique.

Photo: SECA/CML

Prawn ponds are commonly found in mangrove areas.

Photo: SECA/CML

Mangrove wood felled for sale.

MOZAMBIQUE	
Land area (km²)	801 590
Coastline (km)	6 942
Population ('000) 2000	18 292
Population density (per km²) 2000	23
Annual population growth rate (%) 2000-2005	1.76
Mangrove area on map (km²)	5 211
Mangrove area (km²) *Saket and Matusse, 1994*	3 960
Protected areas with mangroves	5

Threats to mangroves could be particularly damaging to Mozambique's economy as the shrimp fisheries of the Sofala Bank are valued as high as US$50 to 60 million per year, 40 per cent of the country's net foreign exchange earnings. Penaeid shrimps, at all stages of development, use mangrove as a preferred nursery habitat.

FAUNA

Barnacles, *Balanus amphitrite*, and rock oysters, *Saccostrea cucullata*, grow on the trunks of mangrove trees. Mud creepers, *Terebralia palustris*, burrowing crabs, *Cardisoma carnifex*, and sand-bubbler crab, *Dotilla fenestrata*, are all common sights within mangrove forests in Mozambique.

LEGISLATION

Conservation and management of mangrove forests fall under the jurisdiction of the National Directorate for Wildlife and Forestry that is also responsible for all terrestrial forests. New land legislation in 1998 provides partial protection to all mangroves as it protects all living resources from the coastline to 100m inland. Projects that could threaten mangrove extent are now subject to environmental impact assessments and mangrove exploitation for commercial purposes can only commence with a licence. A national mangrove management plan is in the early stages of development so that the demands of conservation and sustainable use of mangroves can be met.

Map source: *As in Spalding et al., 1997 and Beifuss, R.D., Moore, D., Dutton, P. and Bento, C., 2001,* Patterns of vegetation change in the Zambezi Delta, Mozambique. Program for the Sustainable Management of Cahora Bassa Dam and the Lower Zambezi Valley. *Working Paper #3. International Crane Foundation, Baraboo, Wisconsin, USA.*

Eastern African Coastal Database and Atlas Project: Tanzania, *2001. Government of Belgium to the Eastern African Trust Fund, UNEP, and the Tanzanian Government. Landsat TM data from 2000, image interpretation by LTRS.*

Guerreiro et al., 1996.

Madagascar

Madagascar is the fourth largest island in the world and has the longest coastline in the region at 9 935km. Nearly all, 98 per cent, of mangroves within Madagascar are found at 29 sites on the west coast, with the remaining 2 per cent located on the east coast. Most west coast stands exceed 500ha in size with Mangoky, Tsiribihina, Ranobe (Besalampy), Betsiboka, Mahajamba and Mahavavy (Baie d'Ambaro) having stands of more than 20 000ha. East coast stands are smaller but more dense.

USES

Seventy per cent of the human population work in agriculture yet the highest revenue earner is the fisheries industry, employing just 14 per cent of workers. Some 60 species of fish were recorded from a mangrove stand in the Tulear Lagoon, 44 of which were commercial species. Mangroves are important nursery areas that support the fisheries industry and local subsistence fisheries. A commonly used trap is a "valakira", a v-shaped dike-like structure made from mangrove wood, usually used to catch prawns. However, the chief use of mangroves occurs when the catch is brought ashore as mangrove wood is used as fuel to boil prawns and to smoke fish. This could prove to be a major threat to mangroves, especially those around villages and towns. In Andavaoanemboka the use is already in excess of sustainable yield.

Globally, Madagascar is a minor tourist destination; however its beautiful coastline ecosystems could be the focus of a thriving ecotourism industry in future years as the government intends to make coastal tourism a key sector for growth. Environmental assessments and careful coastal planning are needed to guarantee coastal ecosystems are not degraded further as hotels and complexes are built.

THREATS AND LOSSES

Coastal sedimentation is a serious problem in Madagascar. Mahajanga port, found at the mouth of the Betsiboka, received 100 million m^3 of sediment from upstream sources rendering it entirely useless. Sedimentation at this scale ultimately suffocates and kills mangrove stands.

Madagascan mangroves are being used proportionately more as time passes, especially around population centres along the coast. This systematic destruction is causing changes in the composition of mangrove forests. Dense mature mangroves are being felled and more tannes (barren saltine areas) are forming as freshwater is channelled away from mangrove areas and into irrigation systems upstream. The reduced flow of water leads to increased siltation of smaller rivers, causing mangrove stands in these river mouths to die.

West coast mangroves could potentially produce 58 000 tonnes of crustaceans a year through aquaculture ventures. However, aquaculture has always been a small-scale industry in Madagascar. The 1990s did see a substantial rise in the number of larger aquaculture farms but the scale is still minor when compared to the extensive operations in many East Asian countries. A medium-sized shrimp farm established in Mahajamba Bay in the early 1990s occupies several square kilometres of salt marsh, tannes and some mangrove areas. From 1972 to 1995, 75km^2 of mangroves were lost from Mahajamba Bay and aquaculture facilities contributed to part of this degradation. With a plentiful workforce, the clay-like tannes which provide ideal conditions for shrimp ponds, and an increased foreign currency flow into the local economy, the

Photo: SECA/CML

Mangrove-wood "valakira" prawn traps across a river.

aquaculture venture in Mahajamba Bay is a great business success despite the environmental consequences. Two more aquaculture facilities have since been established on the west coast, and there are plans for an additional three. The aquaculture industry is growing despite the conversion of sensitive silted areas to tannes, decrease in water quality due to pollution, and other associated environmental degradation.

FAUNA

Among the nine threatened and endemic Madagascan waterbird species, five are recorded from mangrove areas: *Ardea humbloti*, *Anas bernieri*, *Threskiornis bernieri*, *Haliaeetus vociferoides* and *Charadrius thoracicus*. The endangered Madagascar teal, *Anas bernieri*, even nests in holes in mangrove trees.

The Madagascar bat, *Pteropus rufus*, roosts on mangrove trees, and economically important invertebrates such as *Scylla serrata* and two shrimp species, *Penaeus indicus* and *P. monodon*, also occur in mangrove areas.

LEGISLATION

There is no legislation specifically relating to mangroves but mangroves, coral reefs and islands are all classified as "sensitive zones" under environmental impact assessment (EIA) legislation. Consequently EIAs are necessary for projects that could potentially impact these ecosystems.

Legislation pertaining to aquaculture has a fishing focus and does not take into account any environmental degradation factors. Madagascar therefore needs more effective legislation and means of enforcement if sensitive areas, such as mangroves, are to be protected.

Madagascar has just one official nationally designated protected area that covers some mangrove forest, the Mananara Marine National Park on the north-east coast. The Mananara-Nord UNESCO Biosphere Reserve also covers the same area and the Sahamalaza-Iles Radama UNESCO Biosphere Reserve on the northern west coast is another internationally designated protected area with mangrove habitat.

MADAGASCAR	
Land area (km²)	587 040
Coastline (km)	9 935
Population ('000) 2000	15 970
Population density (per km²) 2000	27
Annual population growth rate (%) 2000-2005	2.83
Mangrove area on map (km²)	3 404
Mangrove area (km²) *Ranaivoson, 1998*	3 300
Protected areas with mangroves	1

MASOALA PENINSULA

Drier conditions on the east coast of Madagascar do not naturally predispose the area to mangrove development. Mangroves here may not match the extensive forests that dominate areas of the west coast but they provide key services to local human populations. These mangroves are a nursery for penaeid prawns and other species that make a significant protein contribution to the diets of many communities. Their bark is used to make floor polish and branches are used for construction and charcoal production.

Nearly every patch of mangrove in the Masoala Peninsula is being slowly harvested. Mangroves at Maroantsetra have been almost entirely removed. This is exacerbated by the total clearance of the once dense climax forest that was formerly a backdrop for coastal mangroves, and the high level of rainfall at 4m per year. Increased runoff and sediment loads are inevitable, more so if mangrove and forest losses continue. This will have dire repercussions for wildlife in rivers, mangroves and on coral reefs offshore as water becomes sedimented, turbid and nutrient enriched.

As a rare ecosystem on the eastern coast of Madagascar, these mangroves should receive high conservation priority.

Map source: *Farmalala Miadana Hariosa, 1996.* Carte des Formations Végétales de Madagascar. 1:1 000 000. *3 sheets. I.C.I.V., Toulouse, France.*
With minor corrections from CI/DEF/CNRE/FTM, n.d. Formations Végétales et Momaine Forestier Nationale de Madagascar. 1:1 000 000. *Conservation Internationale/Direction des Eaux et Forêts/Centre National de Recherches sur l'Environnement/ Foiben-Taosarintanin/ Madagasikara.*
Both taken from 1972-1979 Landsat imagery.

United Republic of Tanzania

TANZANIA	
Land area (km²)	945 090
Coastline (km)	3 641
Population ('000) 2000	35 119
Population density (per km²)	37
Annual population growth rate (%) 2000-2005	2.32
Mangrove area on map (km²)	1 272
Mangrove area (km²) *Francis and Bryceson, 2001*	1 335
Protected areas with mangroves	7

Mangroves are the dominant coastal ecosystem in Tanzania where approximately 150 000 people earn their livings from mangrove resources. One Rufiji Delta resident is quoted as saying, "About 75 per cent of our life depends on mangrove. The remaining 25 per cent is divided between fishing and farming."

Mangroves provide ecological services such as nursery areas for fish and prawns, roosting areas for birds and coastal protection. In recognition of their national importance all mangrove areas in Tanzania have been designated as forest reserves since 1928-1932.

The largest mangrove forest in the East African region is the Rufiji Delta and, despite heavy utilization, the majority of mangrove forests there are still intact. With few human communities Kilwa, south of the Rufiji Delta, has also maintained its mangrove areas. Mtwara has extensive mangrove areas, as does Mnazi Bay, and both have suffered minimal felling. In addition, replantation, combined with natural regeneration, has occurred in these areas. An increase in awareness of the value of mangroves and mangrove protection efforts, achievements of the National Mangrove Management Plan, have resulted in little change in mangrove cover in Pangani, Tanga and Muheza districts since the plan was implemented in 1994.

USES

Mangroves are a traded commodity. Mangrove poles are exported and used locally as a building material and to make fish traps. Boat-making is a common use, in particular for the construction of dhow (traditional wooden boat) ribs and rails, and to a lesser extent keels. *Rhizophora mucronata* roots are used to make v-shaped stake traps ("wando") that strand fish as the tide recedes. Mangrove wood is used for fuel to commercially produce salt and lime and process fish. Charcoal-making is widely practised through the Ruvu and Wami Deltas. Mangrove stakes are used by the rapidly growing seaweed farming business on Zanzibar and in the beekeeping industry, as mangroves flower all year round.

THREATS AND LOSS

Overall the actual area of mangroves seems secure in Tanzania as the Mangrove Management Plan has been responsible for replanting initiatives, increased mangrove

protection that has reduced illegal harvesting and increasing people's awareness of mangrove ecosystems. However, threats still exist and many mangrove areas in Tanzania have been heavily exploited in the past.

There is fear that in the future more mangrove areas will be lost to prawn aquaculture (see Rufiji Delta inset). Another reason for mangrove clearance is to construct solar evaporation pans for salt production – there are 30 salt works in Bagamoyo alone. New activities, such as tourism, could lead to destruction as mangrove areas are cleared for hotels and complexes, as has occurred along the beaches of Bagamoyo.

A general problem for coastal ecosystems is the increasing water pollution from upland sources. High levels of zinc, iron and other heavy metals have been recorded in Msimbazi mangroves, located just opposite Dar es Salaam and the opening of the Msimbazi River where many pollutants exit the river system. Mangroves are remarkably tolerant of high metal concentrations. Mangrove wildlife, however, is not as resilient. Heavy metals have been recorded as accumulating in soft body parts and shells of fish and gastropod species and this extra metabolic pressure may affect growth rates and survival. Zinc is particularly toxic to invertebrate and fish larvae.

The clearing of mangrove areas for timber has been rife around the capital city of Dar es Salaam. As urban zones have expanded mangrove areas have been reclaimed for towns, ports, hotels and agriculture. Dar es Salaam is growing at a rate of 6.75 per cent per year so this situation is likely to continue.

The expanding human population has taken its toll on mangrove forests in Zanzibar as well. The Michamvi area had 800ha of mangroves in 1949 and just 43ha in 1989. Maruhubi had 1 040ha and just 76.5ha in 1989. The volume of wood required for house building alone rose tenfold from 1990 to 1992 and is likely to have risen again in line with human populations.

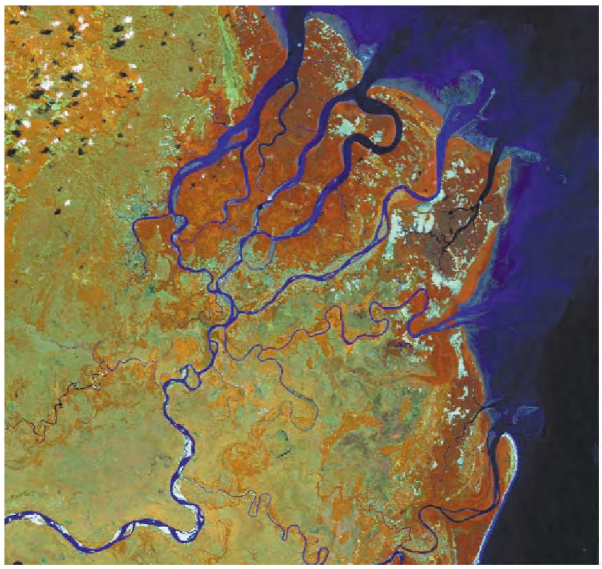


Photo: Landsat images processed by the LTRS at University of Rhode Island

Satellite (Landsat ETM, Imagery of 2000) image of the Rufiji Delta. Mangroves appear red.

Photo: Y.Q. Wang

Mangrove poles to be used for building purposes, Zanzibar.

FAUNA

Mangroves are an important site for migratory wetland birds. Curlew sandpipers, *Calidris ferruginea*, little stint, *Calidris minuta*, crab plover, *Dromas ardeola*, roseate tern, *Sterna dougallii*, and Caspian tern, *Hydroprogne caspia*, can all be found in Tanzania's mangrove forests. Sykes' monkeys, *Cercopithecus albogularis*, hunt for fish and crab on low mangrove branches and hippopotamuses and crocodiles can be found in the murky river waters.

LEGISLATION

Tanzania has a long history of mangrove use and export. Mangrove forests have been legally protected since 1928-1930. Management of mangrove forests initially focused on just wood products and involved a complete ban on felling. As there are many non-commercial uses of mangrove wood local communities were very dissatisfied. At the same time licences were issued to commercial operators who then legally cleared massive areas whilst the villagers could not fell even a modest number of trees.

Management of mangrove forests in the past has been governed by the 1957 Forest Ordinance which was replaced in 1991 by the National Mangrove Management Plan. This plan was implemented in 1994 and takes into account local, small-scale users and incorporates their harvest needs into a sustainable management plan, allowing use and preservation to exist simultaneously. The plan has been successful as mangrove stands in Tanzania have expanded since its initiation. However, there are still

apparent problems at national level as no authority exists to reconcile conflicting interests amongst government institutions.

A good example of a specific conflict is the prawn farming project in Rufiji (see inset). Despite technical advice to the contrary and social protests, the farm was given a permit to operate. This approval violated land policy that stipulates that no large tracts of land are to be used by a single investor. Conflicts such as these undermine the faith people have in the government and could lead to further loss of mangroves if illegal felling activities escalate.

The new forest policy of 1998 considers biodiversity and environmental protection. It seeks ecosystem stability through the conservation of forest biodiversity, water catchments and soil fertility. Local community involvement is encouraged and should be strengthened through joint management ventures with other stakeholders.

Map source: Eastern African Coastal Database and Atlas Project: Tanzania, *2001. Government of Belgium to the Eastern African Trust Fund, UNEP, and the Tanzanian Government. Landsat TM data from 2000, image interpretation by LTRS. Zanzibar, Mafia, Pemba Island data from the Institute of Marine Sciences and* Eastern African Coastal Database and Atlas Project: Tanzania. *Government of Belgium to the Eastern African Trust Fund, UNEP, and the Tanzanian Government.*

RUFIJI DELTA

Nine major tributaries form the Rufiji River basin. This covers 177 000km^2, roughly 20 per cent of Tanzania. The single largest mangrove forest along the East African coast, covering 530km^2, 41 per cent of the East African total, is in the Rufiji Delta.

Some mangrove forests in the Rufiji are intensively used although large portions of the forests are still intact. Considering the long history of mangrove felling for trade and the area's relatively slow human population growth it is unlikely that population pressure is currently the major cause of mangrove loss. However, poor management and unsustainable, illegal harvest has led to the depletion of mangroves in certain areas.

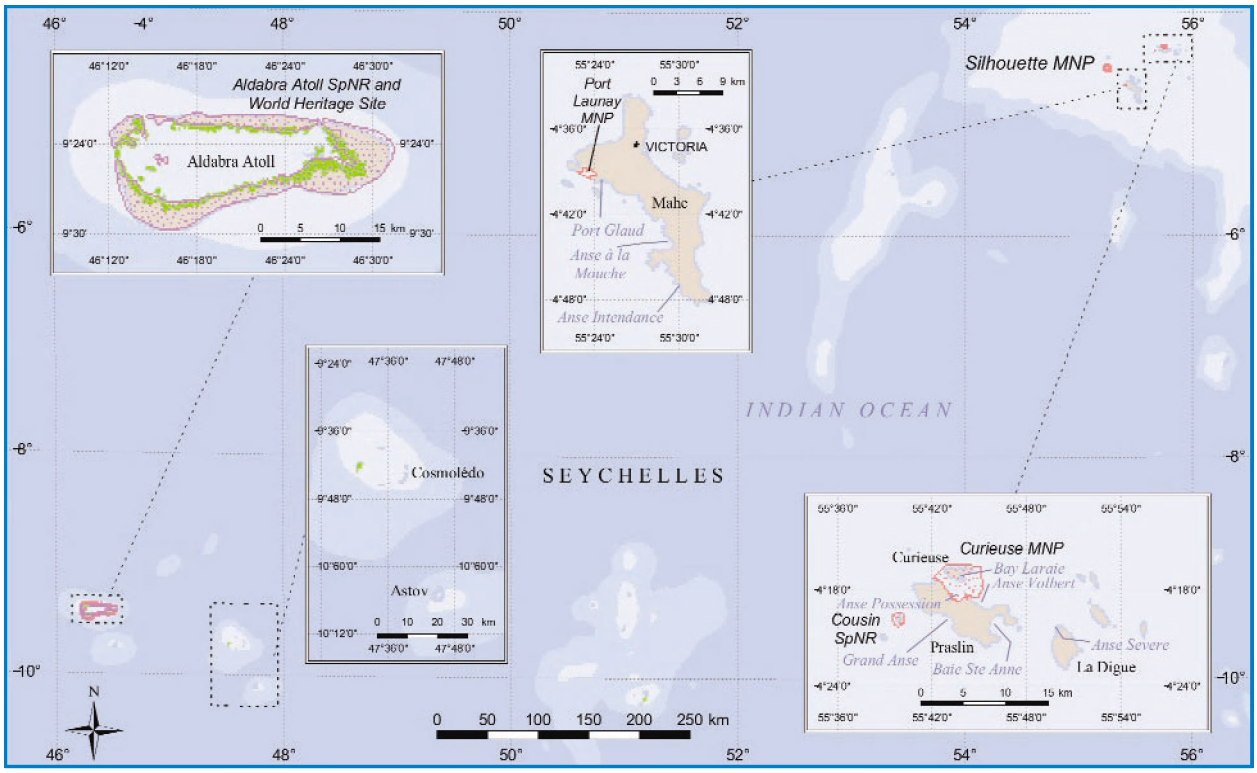
Some mangrove areas have been converted to aquaculture. In particular, a permit to allow a large prawn farm in the area has caused major social unrest and even resulted in several villagers deciding to approach the High Court to sue the government for authorizing the permit. The prawn farm initiative would have meant clearing a huge portion of mangrove forest. It would have increased migration into the area as people searched for employment at the farm and this would have certainly led to mangrove loss as mangroves are needed in many aspects of everyday life. Recently plans for this prawn farm have halted.

Rice cultivation in northern areas of the Rufiji Delta has led to losses of around 1 700ha of mangroves. Seventy per cent of the population consider farming their first priority and rice is important for the survival of people in the area. Communities are constantly trying to expand their lands to grow more rice but in the Rufiji Delta this is illegal as it would involve further mangrove clearance. The government has advised farmers to grow mangroves in their paddy fields with the assurance that rice cultivation could proceed until mangroves develop, at which point the farmers must abandon their fields to allow mangrove growth. This advice was offered in an effort to reduce the amount of land left to waste after rice farmers abandon paddy fields as the water acidifies (typically a few years after initial mangrove clearance). The advice would be ideal if rice fields were used for the typical two or three years, but some paddy fields are used for five to seven years and mangrove growth then means farmers are forced to leave paddy fields unnecessarily early.

Another environmental problem related to rice cultivation has been the use of DDT. Crabs still occur in rice substrates and eat developing rice shoots; DDT is used to kill them. There is a lack of understanding within local communities about the long-term harmful effects of persistent pesticides in the environment and some misunderstanding that the government wants to ban DDT to protect crabs. Open discussion about the rice cultivation situation within the delta is desperately needed.

Poor transport to markets outside the Rufiji area means only modest trade in mangroves and mangrove products is possible. The average income from fishing in the Rufiji Delta is US$160 per year while it is US$300 in Bagamoyo where transport is easier. In Rufiji, more than 70 per cent of villagers complain of low market prices for their wares with high transportation costs, poor transportation and inadequate markets being the main causes. However it is this poor transportation that is protecting Rufiji mangroves from felling and trade.

Seychelles



The Seychelles is a nation of small islands, and mangroves do not exist in the huge forests found elsewhere in East Africa. There are stands on Curieuse at the end of Bay Laraie, in the lagoon of Aldabra and at 12 sites around Mahé. The largest stand on Mahé, around 20ha, is close to Port Glaud/Port Launay in an area called La Plaine Marsh. Other large areas include those at Anse Intendance, 13ha, and Anse à la Mouche, 10ha. There are mangroves at Baie Ste Anne, Anse Volbet, Anse Possession and Grand Anse on Praslin and in Anse Severe on la Digue. However, the largest overall mangrove areas are found on Aldabra, Cosmoledo and Astove.

Of the seven mangrove species found on the 115 islands that make up the Seychelles *Avicennia marina* is found most widely.

USES

Mangroves seem to have no direct uses in the Seychelles such as for fuel, building material, etc.

THREATS AND LOSSES

Historically mangroves have been cleared for roads and housing developments with more recent felling for hotels and proposed golf courses. Wetlands have frequently been considered wastelands in the Seychelles and dumping refuse is a common practice in mangroves there. The main island of Mahé has very steep relief so flat land is at a premium and there is therefore great pressure to clear mangroves. Some mangroves have been drained and reclaimed for aquaculture, agriculture and coastal development.

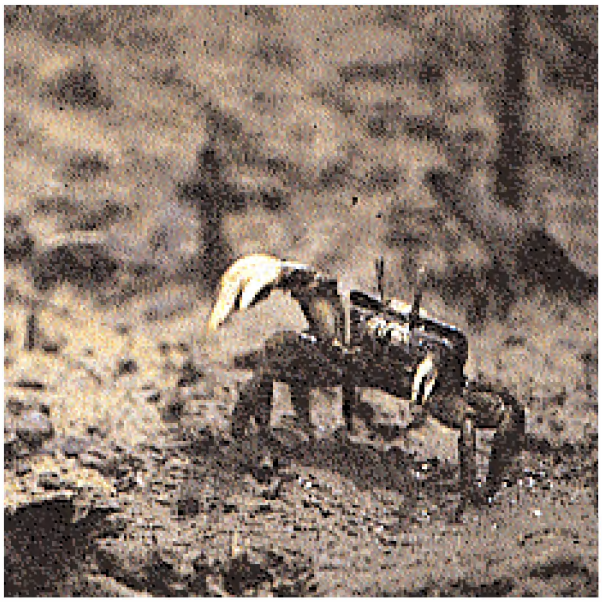
For all these reasons mangroves in the Seychelles have been progressively destroyed. Some areas have recolonized: for instance backwater areas around the land reclaimed between Victoria and the international airport on Mahé. Unfortunately this is a rare example.

Water pollution is increasing in the Seychelles. Only 19 per cent of domestic sewage was treated in 1995. Other main sources of pollution, according to FAO's 1999 report – *Strategic Action Plan for Land-Based Sources and Activities Affecting the Marine, Coastal and Associated Freshwater Environment in the Eastern African Region* – include industrial water pollution from the Seychelles Marketing Board agro-industry (producing dairy products), the Seychelles Marketing Board food-processing plant (processing poultry and other meat products), Seychelles Brewery (producing beer and soft drinks), Indian Ocean Tuna Limited (tuna canning), Penlac Factory (producing paint), Sodepak (manufacturing soap), and cattle and poultry abattoirs. Tourism is another major source of pollution as hotels

Photo: SECA/CML

Mangroves are a natural filter protecting coral reefs.

Photo: SECA/CML



Crabs are conspicuous mangrove inhabitants.

Seychelles	
Land area (km²)	450
Coastline (km)	746
Population ('000) 2002	100
Population density (per km²) 2002	189
Annual population growth rate 2002 estimate (%)	0.47
Mangrove area on map (km²)	29
Protected areas with mangroves	5

utilize many times more water than residential homes, leaving less to filter through mangrove swamps and to the coast. And hotel effluents are often deposited directly into the local marine environment; only eight hotels in the Seychelles had sewage treatment plants in 1997.

Climate change is of particular significance in the Seychelles as a one metre rise in sea level could lead to the submergence of many islands resulting in a 70 per cent loss of land, and as a coastal ecosystem mangroves would be under threat.

FAUNA

In Seychelloise mangroves prawns, crabs, bivalves and snails are all common invertebrates, as are mosquitoes and butterfly beetles. Many terrestrial bird species and monkeys are mangrove residents. Aldabra atoll, one of the largest mangrove areas in the Seychelles, is the only breeding location for the great frigatebird, *Fregata minor*, and lesser frigatebird, *Fregata ariel*.

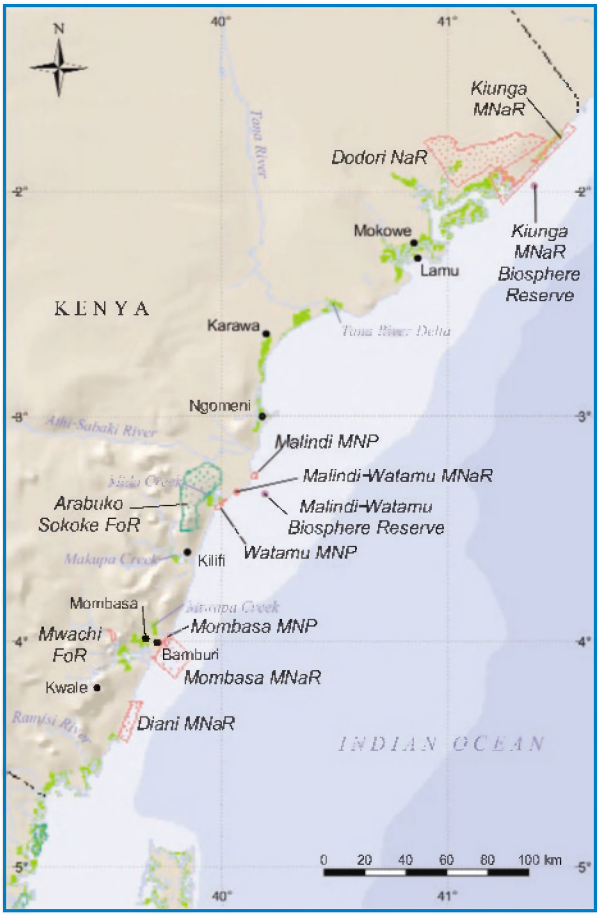
LEGISLATION

The Division of Environment in the Ministry of Foreign Affairs, Planning and Environment is responsible for policy and programme matters on environmental protection, conservation and forestry. The three main implementation arms of the Division are the National Parks and Conservation section, the Forestry section and the Environmental Assessment and Pollution Control section. In 1994 a single piece of legislation, the Environment Protection Act, was enacted that covers the integrated management of the coastal zone and protection of the atmosphere. There is no specific legislation relating to mangroves.

There are five marine protected areas in the Seychelles that contain mangrove areas. Aldabra atoll, which actually makes up a third of the land area of the Seychelles, is a Special Nature Reserve at national level but also acclaimed internationally as a World Heritage site.

Map source: *D.O.S. six-map series, compiled from air photography from 1960. Aldabra maps annotated by R.N. Jenkin.*
D.O.S., 1978. Aldabra Island East. 1:25,000 Series Y852 Department of Overseas Surveys 304P Ed.3.
D.O.S., 1978. Aldabra Island West. 1:25,000 Series Y852 Department of Overseas Surveys 304P Ed.3.
D.O.S., 1978. Farquhar Group. 1:25,000 Series 304P Ed.1 - Department of Overseas Surveys.
D.O.S., 1979. Cosmoledo Group. 1:25,000 Series 304P Ed.1 - Department of Overseas Surveys.
D.O.S., 1993. Providence Group (North). 1:25,000 Series 304P Ed.3 - Department of Overseas Surveys.
D.O.S., 1993. Providence Group (South). 1:25,000 Series 304P Ed.3 - Department of Overseas Surveys.

Kenya



The protective influence of barrier islands off the coast of Lamu and the large estuary has resulted in an abundance of mangroves in the area. In fact, the largest area of mangroves in Kenya is found in the Lamu district where lush forests cover more than 300km^2. The Kwale, Kilifi, Tana River and Mombasa districts all have mangrove areas. The lack of protection along the remaining coast, with the exception of some stands in the far south, leaves few extensive mangroves elsewhere.

Eight species of mangroves are found in Kenya and they follow typical East Africa zonation patterns. *Heritiera littoralis* is a rarer species and its largest concentration in East Africa is found in the Tana River Delta.

USES

Mangroves have traditionally been exploited by Kenyan human populations. Mangrove wood is used primarily as timber, and poles are used to make fences, boats, huts and fish traps. Mangroves are also good sources of fuel, either firewood or charcoal, and some even have medicinal properties, ranging from contraceptive to aphrodisiac. Tannins and dyes are often extracted from mangroves and green *Avicennia marina* logs are burnt and used as insecticide as the smoky fumes repel mosquitoes and other biting bugs. *Avicennia marina* leaves are also often used as fodder for livestock.

THREATS AND LOSSES

Many mangrove areas are being lost to salt production. Just six saltworks between Ngomeni and Karawa have produced 71 400 tonnes of salt. This vast quantity of salt causes underground seepage of saline water from salt pans which kills neighbouring mangroves.

The condition of mangrove forests has declined to the extent that export-quality poles are no longer found in many areas of Kenya. From 1941 to 1956 there was a massive rise of 47 per cent in mangrove exports, with 35 451 scores (20 poles per score) leaving Kenyan forests. Since then deforestation has continued relatively unabated despite an official ban on mangrove exports (see Legislation). In 1992 the Forest Department licensed the removal of 72 100 scores of poles from Lamu for domestic use. These extraction recommendations are based more on national demand than resource availability. Good quality wood is rapidly disappearing and some areas risk mangrove species becoming locally extinct, such as *Xylocarpus granatum* and *Heritiera littoralis* in the Kwale and Tana River districts.

Oil pollution has also plagued Kenya in recent decades. Between 1983 and 1993 Mombasa port and surrounding waters experienced 391 680 tonnes of oil pollution from spills. Mangroves in Makupa Creek have been badly affected as a reservoir of oil has sunk into sediments causing frequent re-oiling.

New threats facing mangroves in Kenya include increasing industrial pollution and prawn farming. There is no history of aquaculture in Kenya so burgeoning projects lack the skills and experience necessary to succeed. In the early 1990s there were proposals to establish prawn aquaculture and rice farming in the Tana River Delta; however, as in the Rufiji Delta in Tanzania, the projects were shelved as a result of public protests.

The number of hotels in Mombasa tripled from eight

KENYA	
Land area (km^2)	580 370
Coastline (km)	1 586
Population ('000) 2000	30 669
Population density (per km^2)	37
Annual population growth rate (%) 2000-2005	1.91
Mangrove area on map (km^2)	610
Mangrove area (km^2) *Ruwa, 1993*	530
Protected areas with mangroves	8

Photo: Riccardo Innocenti

A movable fishing trap, main frame made of mangrove poles, Mida Creek, Kenya.

Photo: James G. Kairo

Clearcut mangrove area in Ngomeni, Kenya.

in 1971 to 25 in 1993. This growing tourism industry could be a potential environmental threat.

Future activities in Kenya which could affect areas of mangroves include damming activities upstream of the Tana River that could reduce downstream water flow and alter the current sediment balance, thus affecting coastal aquaculture and farming activities. Titanium has recently been discovered in the Kilifi District and excavations will result in physical alteration of the area, atmospheric discharges and increased sediment loads. And a new power-generating plant is being built at Kipevu in Mombasa which will likely increase oil waste entering the local marine environment.

FAUNA

Mangrove forests harbour a wealth of animal life, both terrestrial and aquatic. As well as an abundance of bird life there are also numerous reptiles, mammals and insects. At the Tana River Delta and the Ramisi River in particular, numerous animal species can be found including crocodiles, hippopotamuses, buffalo and smaller animals such as baboons, duikers, rodents and fruit bats. The Mida Creek also has a plethora of bird life roosting and feeding in its mangrove forests.

Aquatic species include many prawn and shrimp, crab, mollusc, and oyster species. Common fish species include striped catfish, *Plotosus lineatus*, gobies, common silver biddy, *Gerres oyena*, and the two-finned round herring, *Spratellomorpha bianalis*.

LEGISLATION

A ban on exporting mangroves was implemented in 1978. This ban was lifted in 1981 and reinstated in 1982. In 1996, as Kenyan policies regarding environmental resources were being developed, a proposal to lift the ban arose but as yet the ban remains. Authorization for clearing and any other mangrove exploitation has to be obtained from the Kenya Forestry Department at the Ministry of Environment and Natural Resources. Furthermore, all vehicles carrying mangrove poles must have a transit permit and timber statement. These regulations have made subsistence use of mangroves gradually more difficult. And to further complicate the situation, conflicting issues of indigenous rights and property ownership make felling by local human populations even more problematic.

By-laws used to manage terrestrial forests are not suitable for mangrove areas nor are by-laws relating to water quality and health standards sufficient for the multi-sectoral management needed for mangrove forests. Specific environmental laws are needed to ensure mangrove resources are preserved and utilized sustainably.

Map source: *Kenya Wildlife Service field work July to August, 1992.*
Harrison Onganda, Kenya Marine and Fisheries Research Institute and its programme, the Kenya National Oceanographic Data Center.

Somalia

Somalia's coastline stretches along 3 025km, the longest national coastline on the East African mainland. Somalia's recent past is blighted with war and unrest and, unfortunately, it is this instability that has defined Somalia since central government was overthrown in 1991. After years of warlord control, Somalia's situation now looks closer to resolution since clan elders and other senior figures appointed a new president, Abdulkassim Salat Hassan, in August 2000.

These years of war have left Somalia with the seventh youngest population in the world (as at 2000) and the fourth largest rate of predicted population growth from 2000 to 2005, at 4.21 per cent per year. This is the highest annual growth rate of all countries considered in this publication.

With such a volatile political situation priorities have rightly focused on humanitarian and aid work rather than conservation. For this reason little information about mangrove status is available.

What is known is that mangroves are found in three tidal estuaries between Saada Din Island and Saba Wanak in the extreme south of the country. The Caanoole Estuary and the Bushbush Estuary, which are tidal for approximately 30km inland, have narrow, 20m, mangrove fringes. The Bushbush Estuary runs through the Bushbush Game Reserve, Somalia's only marine protected area with mangroves. Northern areas of Somalia are subtropical and thickets of low, scattered mangroves, usually *Avicennia marina*, exist. However, an upwelling of cold water inhibits abundant mangrove development. Mangroves have also formed in the low wave energy, intertidal zones of channels along the Kisimayo coast. The current status of all these mangrove areas is unknown.

USES

Many mangrove stands have, in the past, been pillaged for firewood and construction purposes. Some areas have been destroyed and clearances have been so extreme that no large vegetation survived leaving barren land. These areas have subsequently been claimed by salt marshes, not by pioneer mangroves species.

THREATS

The overall level of urbanization and industrialization is low in Somalia so industrialized pollution of waterways and mass clearing of mangroves are not current issues faced in this country. Remaining mangrove areas tend to have very low human population levels, two to six inhabitants per km^2, and thus experience a low rate of felling for subsistence purposes.

LEGISLATION

Somalia lacks an organized system of protected areas but in 1990 its coastal habitats were judged to be the most extensive and well preserved in Africa so preservation of these systems may still be possible. The Bushbush Game Reserve was officially designated in 1969 but is probably no longer functional due to the continued political instability. The area from Kisimayo to Ras Chiambone is said to be of a high conservation priority as it includes important coral reef and marine turtle areas and mangrove resources.

Map source: *Base map from R.H. Hughes (based on Hughes and Hughes,1992). Further small areas added by F. Blasco.*

SOMALIA	
Land area (km^2)	637 660
Coastline (km)	3 025
Population ('000) 2000	8 778
Population density (per km^2)	14
Annual population growth rate (%) 2000-2005	4.21
Mangrove area on map (km^2)	906
Mangrove area (km^2) *Choudhury, 1997*	200
Protected areas with mangroves	1

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Mangroves
of East Africa

Mangroves of East Africa contains a series of reports focusing on South Africa, Mozambique, Madagascar, Tanzania, the Seychelles, Kenya and Somalia. It starts with a regional summary of factors and activities that are affecting mangroves across East Africa covering the general topics of mangrove use, species zonation, current status of mangroves, species found in mangroves and threats to mangroves.

Country summaries include details of mangrove-related legislation, industries associated with and involving mangroves, and details of how mangroves are utilized by local human communities. Information on marine protected areas that cover mangroves is also provided. Regional and national scale maps are included.

This publication is designed to provide a concise account of available information and current issues facing mangroves in East African countries.

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