Monitoring of Mangroves in Somalia (Puntland, Somaliland and South Central Somalia)

Technical Report No. L-19
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1 Introduction

1.1 General

Monitoring is the repeated observation of a system in order to detect signs of change. Monitoring can be used to quantify change, identify the causes of change and determine acceptable levels of change. Socioeconomic monitoring allows us to understand what kind of human induced factors affect the mangrove, whether people are benefiting from the current levels of management and how they perceive the ecosystem in question. Ecological monitoring allows us to form a picture of how the ecosystem is doing.

In order to carry out monitoring, we first need to establish a baseline (the situation, or point in time, from which we are measuring change.

Small areas of mangrove forests exist in the estuary of the Juba River and on the coast between the Juba River and the Kenyan border. Some mangroves are also found in the coastal areas of Somaliland and Puntland, near Zeylac and East of Bossasso, respectively. Here, trees such as *Avicennia marina*, *Rhizophora mucronata*, *Ceriops somalensis*, *Bruguiera gymnorrhiza*, *Sonneratia alba* and *Xylocarpus obovatus* (see appendix 7) reach a height of 10 to 15 m in thick clumps. North of Mogadishu, only dispersed mangroves are found with trees 5 to 6 m high. The patches of mangroves in Somalia play a vital role in reducing shoreline erosion. These mangroves are also habitats to fish and are critical for conservation of biological diversity.

Since 1991, Somalia has been subjected to extreme environmental degradation, natural and man-made associated with the current war and lawlessness. Consequently, the mangroves of Somalia now remain degraded and so urgent solutions have to be sought.

1.2 What is mangrove?

Mangroves refer to the plants of certain families of angiosperms, e.g. Rhizophoraceae, Sonneratiaceae, Verbenaceae and Arecaceae which grow in thick clusters along the estuaries, salt marshes, swamps and coasts in tropical countries. They have characteristic prop roots by which they anchor even on the open coast facing the sea and stabilize the land to harbor many animals. They are very hardy, gregarious and can withstand strong waves as the numerous

prop roots prevent them from uprooting. Amongst them the most important genera are *Rhizophora*, *Bruguiera*, *Avicennia*, *Ceriops*, *Sonneratia*, *Lumnitzera.* In this scenario, the plantation, propagation and protection of the mangroves may help to minimize the effect of a tsunami. Figure 1 shows a typical mangrove environment.

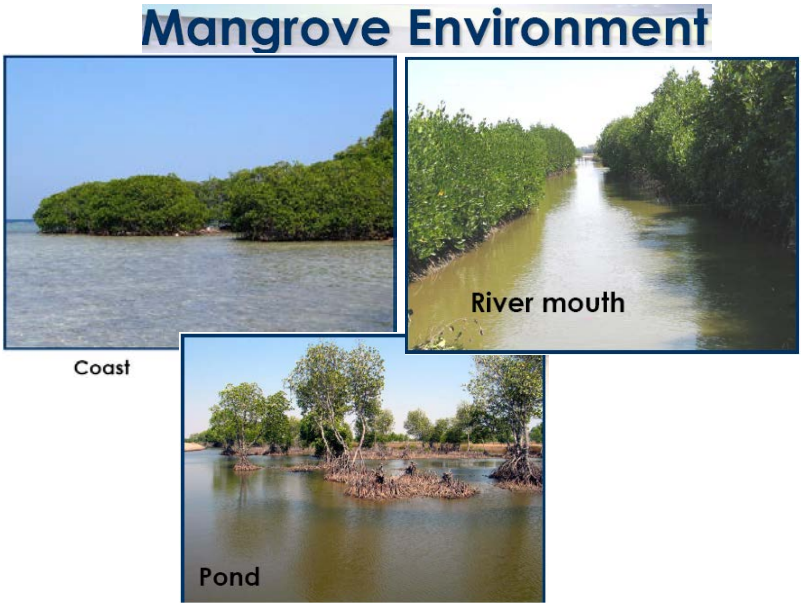


Figure 1: Typical mangrove environment

Somalia mangroves belong to the East African coast. The East African mangroves are an eco-region consisting of mangrove swamps along the Indian Ocean coast of East Africa in southern Mozambique, Tanzania, Kenya and southern Somalia (from Wikipedia Encyclopedia).

1.3 Issues related to the mangrove ecosystem in Somalia

The loss of biodiversity, habitat degradation and the modification of mangrove and coral reef ecosystems along the coastline are among the main environmental concerns in the Horn of Africa Region especially Somalia. Destructive human-related pressures come from over-fishing, charcoal production, agriculture, grazing, urbanization, and industry. Other threatening concerns are dumping of hazardous wastes on Somalia's coastal waters (UNEP 2005a) and climate changes, contributing to the rapid coral bleaching and sea-level rising. The shores facing the Indian Ocean were shocked by the catastrophic tsunami in December 2004, and about 300 people were reported to have died in Somalia (UNEP 2005a).

In Somalia, mangroves are sheltered in some inlets on the Red Sea and Indian Ocean shoreline to the south of Kismayio Town in the Southern part of Somalia. The coral reefs, combined with the mangroves and sea-grass beds of the Somali Current LME (NOAA 2000) forms a diverse but very productive ecosystem of greater ecological and socioeconomic importance along the coast; these mangroves also provide a potential sanctuary to a wide variety of terrestrial fauna and flora (UNEP/GPA and WIOMSA 2005).

The loss of biodiversity and the degradation of mangrove habitats in Somalia are apparent and quite visible environmental consequences. These are the consequences of climate change causing rising sea level and high sea temperatures leading to coral bleaching combined with the direct human pressures on the coastal and marine environment coming from increasing coastal populations, pollution and human mismanagement.

Several Marine Protected Area treaties - MPAs have been declared and proposed along the Red Sea and the Indian Ocean such as the Dahlak Archipelago marine park (2 000 km²) in Eritrea. However, most of these treaties were not implemented effectively due to the lack of central government in Somalia and ineffective management plans and missing law enforcements in most of the countries in the region (UNEP 2006) except the Watamu and Kisite marine national parks in Kenya, which are well established and generally well managed (IUCN and others 2004, Obura and others 2004).

Another key concern is the lack of public and government awareness on hot issues of use of the Somali shores and coastal waters as dumping grounds for hazardous wastes from some industrial countries (UNEP 2005a).

In Somalia and Kenya, there has been over-harvesting of the mangroves to meet an increased demand for construction timber, as well as mangrove clearance from the expansion of agriculture and solar salt pans (UNEP/GPA and WIOMSA 2004).

Coral reefs occur extensively along Africa's east coast
In southern Somalia coral reefs form a barrier along the coast.

Source: NASA 2001

1.4 Problem Statement

Thousands of people depend on reefs for food and livelihood along the Somalia coastline. Reefs also create sheltered lagoons and protect coastlines and mangroves against wave damage. Mangroves in turn protect reefs from sedimentation and eutrophication.

This SWALIM MANGROVE project aimed to set and develop a monitoring strategy and methodologies for watching and scrutinizing the status of mangrove resources in Somalia. The project study and observation focuses mainly on stretches of land covered by mangroves along the coasts of Puntland, Somaliland and South Central Somalia regions. These sites have been selected as representatives of the mangrove areas characterized by inconsistent resource management and conflicting interests in terms of governance and use of mangrove resources that have led to significant decline in mangrove extents which has raised considerable environmental concerns.

2 Objectives

The overall objective of the project was to generate baseline data for monitoring of mangroves in the three regions of Somalia, Puntland, Somaliland and South Central Somalia.

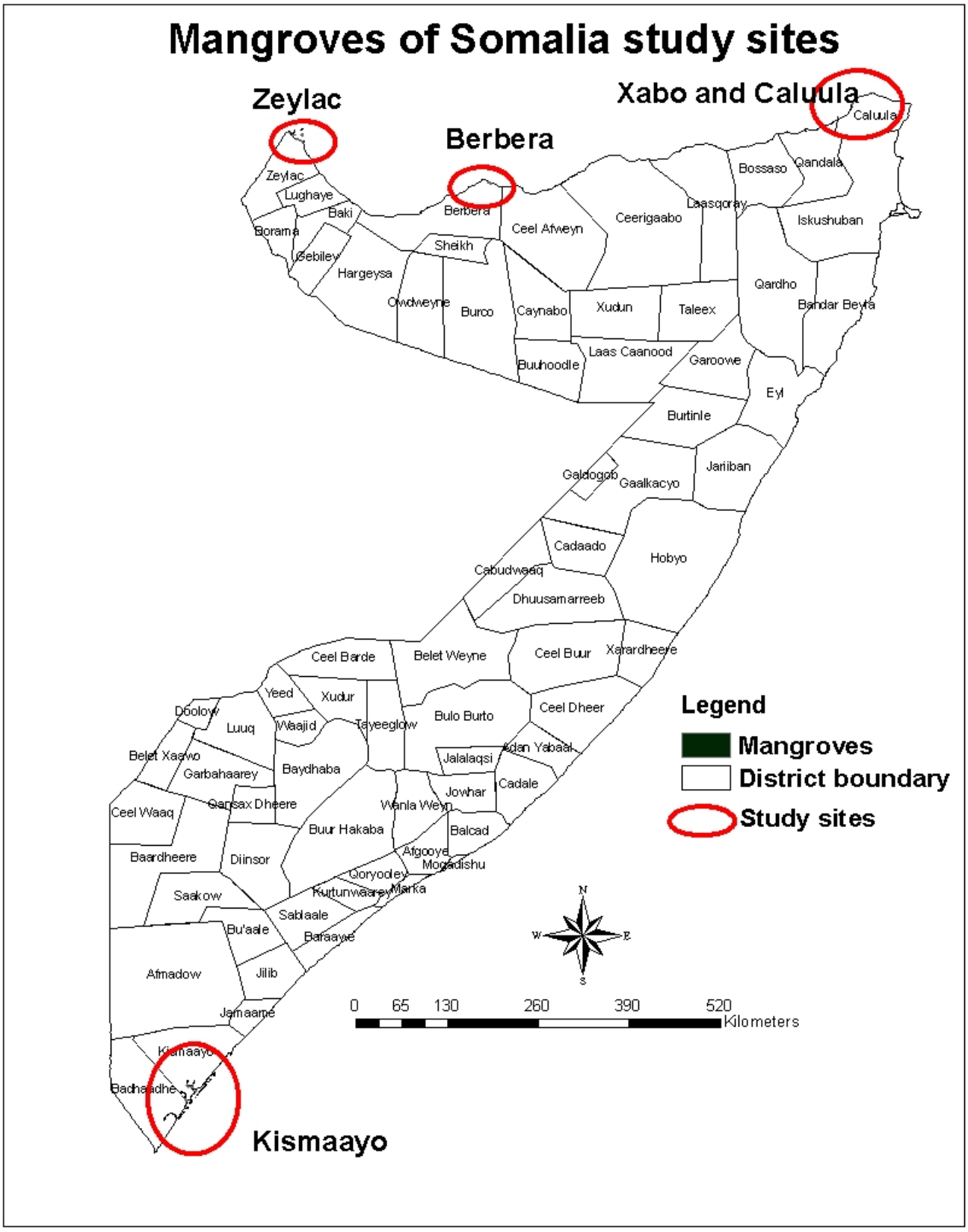
Specific objectives were to:

1) generate baseline data on vegetation (species composition, frequency, density and cover) of the mangrove
2) produce a cover map of the mangroves of Somalia
3) outline the activities related to resource use and management in the mangrove ecosystem.
4) Establish monitoring sites within the mangroves

3 Study Area

The study area in this activity comprises of the mangroves of Zeylac, Berbera, Xabo, Caluula and Kismaayo (see figure 2). More details about Somalia are given in Project Report No L-12 of August 2007 by FAO SWALIM and can be accessed using the link, **http://www.faoswalim.org ,**

Figure 2: The study sites in the context of Somalia



4 Methods and Materials

The proposed methodology for monitoring mangroves under the outlined monitoring strategy will comprise of the following:

1. Interpretation of satellite Images
2. Ground field observations to collect ecological vegetation data
3. Interviews with the local people on use and management of mangroves

4.1 Interpretation of satellite Images

In this pilot project mangrove forests along the Somalia coastal areas, in Puntland and Somaliland, were mapped using high resolution images from Google Maps (see figure 3). Google Earth version 5.0.11733.9347 with a Build date of May, 2009 was used. The image dates varied from 2003 to 2006 based on image date information.

The methodology involved identification of known locations of mangrove forests along Somalia with the help of local knowledge and the available literature. With this in mind, a virtual tour of the coastal areas was taken in Google Earth and all present mangrove forests mapped as individual polygons using the polygon digitizing tools within the Google Earth User Interface. Sites for field surveys were then selected from the digitized maps.

Figure 3: Google Earth image showing location of Mangrove forest in Caluula district.

Google Earth user interface allows for data capture in a Keyhole Mark-up Language (KML) data exchange format that can be exported and used in different applications. The ability to take a virtual walk on Google Earth with a seamless image cover provides an opportunity to identify different features on the Earth's surface. Application of Google Earth for mapping in Somalia was also made possible by the fact that there is a countrywide coverage by cloud-free images of high resolution. The interpretation of Google Earth images for mapping followed a known principle that mangrove forests are usually found along the northern coastal areas and at the estuaries of major rivers in Somalia. Mangrove forests exit as a cluster of trees together which can easily be discriminated by visual eye inspection, on the images, along the coastal areas.

The end result was a KML file layer of mangroves along the coast of Somalia. These files were then converted to shape files to conform to other data format using XTools Pro Tool extension in ArcGIS 9x GIS software.

Figure 4 shows a schematic presentation of the procedure that was carried out to generate the visually interpreted and classified maps.

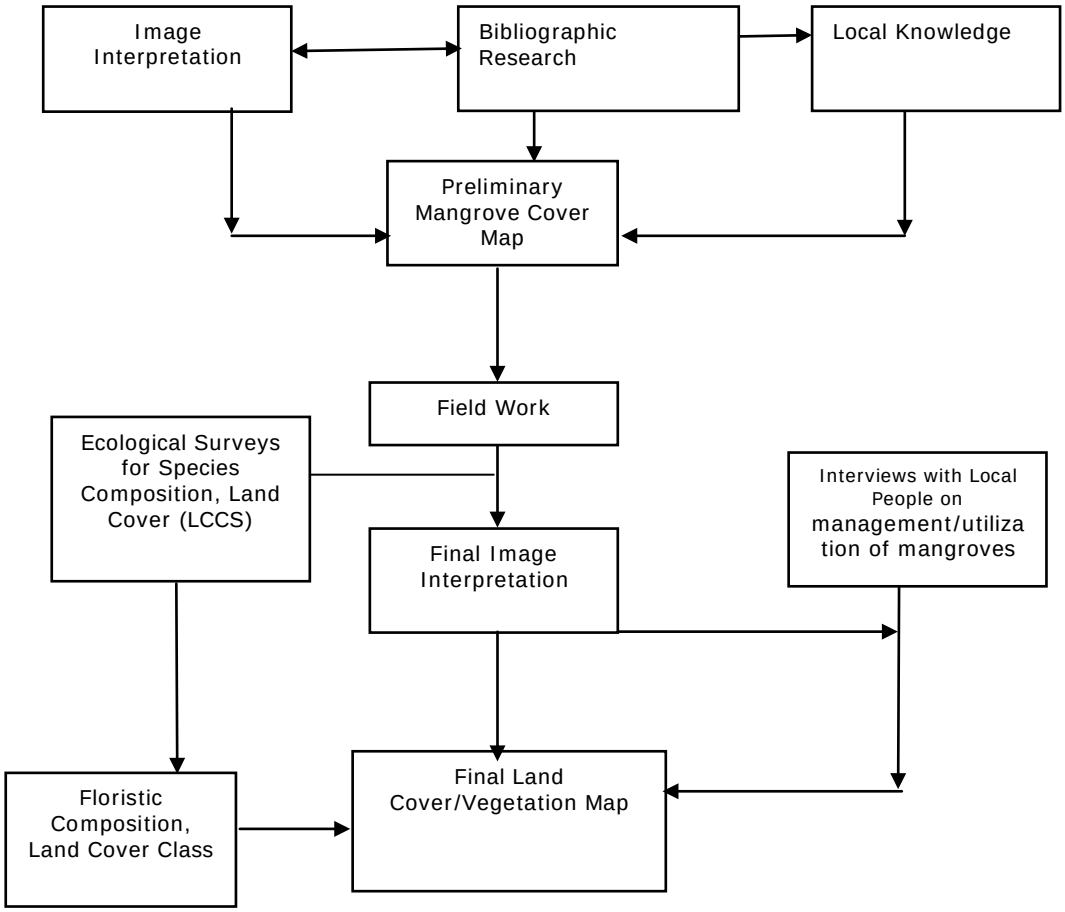


Figure 4: Mangrove mapping procedures

4.2 Ground field observations (sampling) for mapping mangroves in Somalia

Vegetation sampling and data collection was done using the line transects method as described by McIntyre (1953), Johnston (1957), Crocket (1963), Heady (1983), Westman (1984) and. A line transect measuring 100m in length was laid within the sample points.

Sampling of vegetation was done by dropping vertical points at every 1 m interval along the line transect. The species hit by the vertical point were recorded and in the absence of a species at the vertical point, the nearest plant to the hit was recorded. The records also indicated if the hit was mineral soil, litter or base of a plant. Plant base was used to denote the presence of woody vegetation species within the sample point.

The trees were sampled along the transect lines (perpendicular to the shoreline) and the woody crown interceptions were recorded. The following woody vegetation attributes were determined: species name, frequency, crown cover and height class. Figure 5 shows the procedure followed during the vegetation sampling exercise.

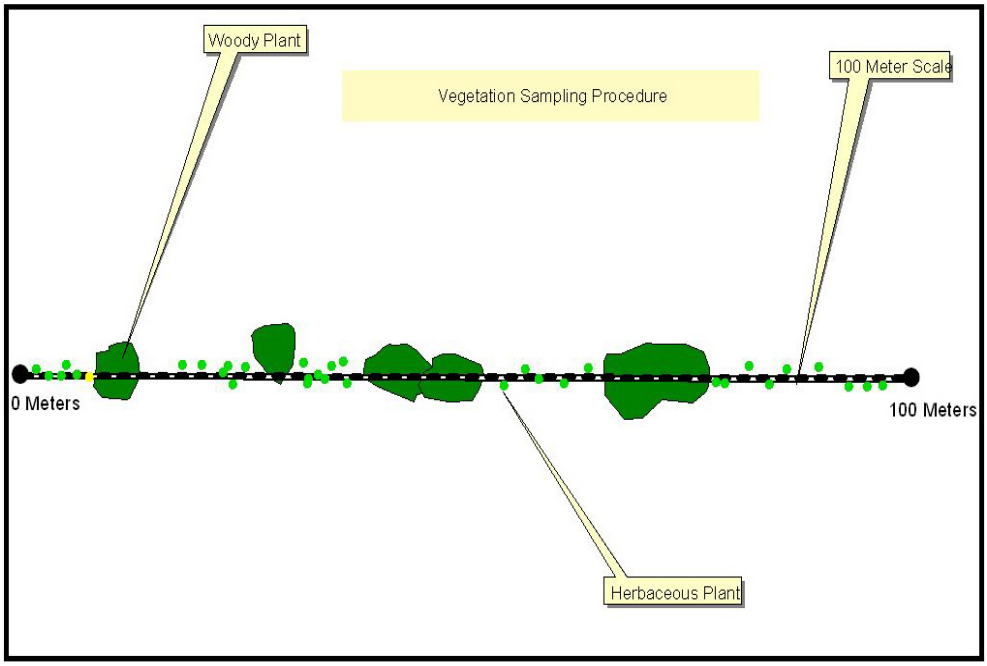


Figure 5: Vegetation sampling technique along a transect line

A 10 meter by 10 meter quardrat was also used to generate data on the tree densities. Within each plot, tree counts were made by species and height class.

Appendix 2 and 4 give the data forms used to collect data on vegetation. Classification of land cover was done following the FAO LCCS (FAO Land Cover Classification System) and using the data form given in Appendix 3.

4.3 Interviews with the local people

The interviews were conducted using a semi-structured questionnaire (see Appendix 1). The questionnaire was administered to individuals and groups of people in every village that was visited. These groups of the local people were mobilized with the help of village elders.

5 Results

The results in this study are listed by mangrove community of the different areas and are outlined in the following chapters:

5.1 Mangroves of Zeylac (44ha)

These mangroves of Zeylac region in Somaliland cover an area of approximately 44ha and are spread along the coast between Zeylac and Lowya Cadde. Some of these mangroves are also found around the Sadadin Island (see figure 8). These mangroves are dominated by two mangrove species, *Avicennia marina* and *Rhizophora mucronata* figure 9 and 18, respectively.

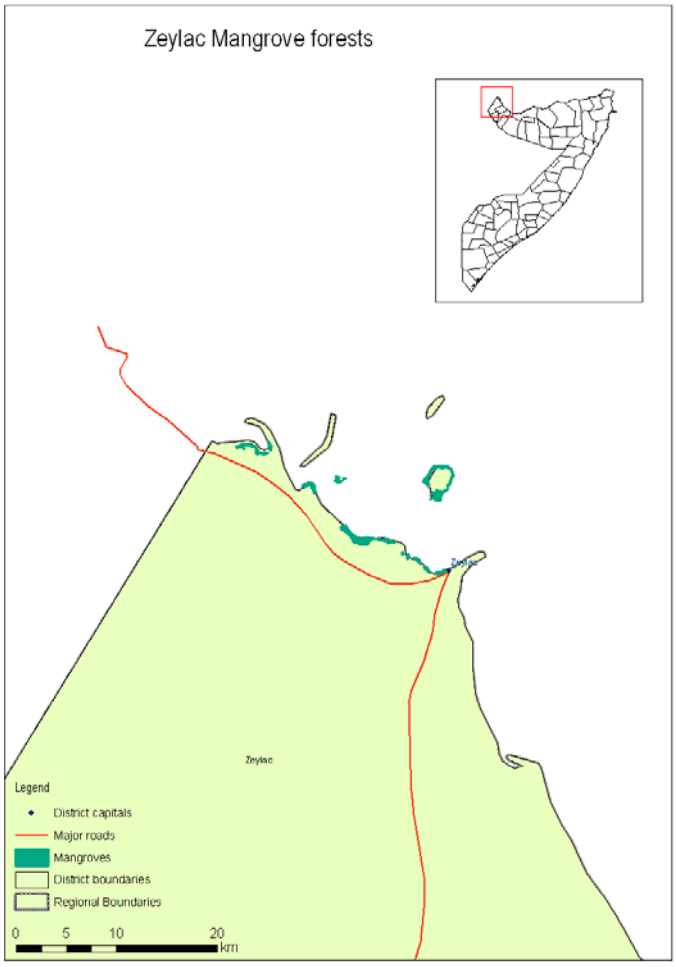


Figure 8: The mangroves of Zeylac region

5.1.1 Plant density and Percent cover

Table 1: Density of mangrove trees in Zeylac

ID	Area Name	Coordinates		Species Name	Counts (10*10m Quadrat)	Density (ha)
		x	y			
MS 2	Geed-Xuurah	032288	1260008	-	22	2200
MS 4	Geed-Xuurah	0323063	1259919	Avicennia marina	9	900
					21	2100
MS 5	Raas-Toqushi	0327430	1258526	Avicennia marina	17	1700
					7	700
MS 6	Toqushi	0327029	129010	-	-	-
MS 7	Milixda Toqushi	0326045	1258747	-	-	-
MS 8	Milixda Toqushi	0325542	125890	-	-	-
MS 9	Milixda Toqushi	0325190	1258315	Avicennia marina	13	1300
					3	300
MS 10	Milixda Toqushi	0325331	1258982	-	-	-
MS 11	Buqdhada (c)	0324040	1258578	Avicennia marina	28	2800
MS 12	Buqdhada (c)	0324468	1258395	Avicennia marina	26	2600
					2	200
MS 13	Buqdhada (c)	0323978	1258523	Avicennia marina	22	2200
					13	1300
MS 14	Laheeloow Toqushi	0323782	1258939	Avicennia marina	26	2600
					9	900

MS 15	Afka-Buqdhada	0324260	1258476	Avicennia marina	60	6000
MS 16	Cagta -Buqdhada	0324776	1258339	Avicennia marina	-	-
MS 17	Toqushi	0324479	1259010	-	-	-
MS 18	Laheloow Toqushi	0323888	1258748	Avicennia marina	-	-
MS 20	Buqdhada Toqushi	032440	1258395	Avicennia marina	-	-
MS 21	Toqushi	0324810	1258925	-	-	-
MS 22	Buqqacan Toqushi	0324486	1258388	-	-	-
MS 24	Milixda Toqushi	0326308	1258796	Avicennia marina	8	800
					14	1400
MS 25	Qudhaan Jaale	0332267	126834	-	-	-
MS 26	Upper part of Qudhaan Jaale	0332042	1256316	Rhizophora	29	2900
MS 27	Cubeeda Adah Channel	0330933	1264594	Avicennia marina	3	300
				Rhizophora	14	1400
MS 29	Zaylae -Zaylae port	0333087	1255744	-	-	-
MS 30	Zaylae Cashuural R aasiga	0327174	125876	Avicennia marina	22	2200

Table 1 shows the density of trees in the mangrove ecosystem in Zeylac. The dominant tree species is *Avicennia marina* with the tree density, in some areas, rising to as high as 6000 trees per hectare.

Table 2: Mangrove species composition and percent canopy cover by sample site in Zeylac

ID	Area Name	Coordinates		Species Name	Height Class (m)				Total meter interceptions (m)	%
		x	y		<1	1-7	7-14	>14		
MS 2	Geed-Xuurah	032288	1260008	-	√				92.15	92
MS 4	Geed-Xuurah	0323063	1259919	Avicennia marina	√	√			95.99	96
MS 5	Raas-Toqushi	0327430	1258526	Avicennia marina	√	√			39.1	39
MS 6	Toqushi	0327029	129010	-					-	-
MS 7	Milixda Toqushi	0326045	1258747	-					-	-
MS 8	Milixda Toqushi	0325542	125890	-					-	-
MS 9	Milixda Toqushi	0325190	1258315	Avicennia marina		√			24	24
					√				32	32
MS 10	Milixda Toqushi	0325331	1258982	-					-	-
MS 11	Buqdhada (c)	0324040	1258578	Avicennia marina		√			52	52
MS 12	Buqdhada (c)	0324468	1258395	Avicennia marina		√			88	88
					√				2	2
MS 13	Buqdhada (c)	0323978	1258523	Avicennia marina			√		80	80
						√			18	18
MS 14	Laheeloow Toqushi	0323782	1258939	Avicennia marina			√		30	30
						√			65	65
MS 15	Afka-Buqdhada	0324260	1258476	Avicennia marina		√			54.7	55
MS 16	Cagta -Buqdhada	0324776	1258339	Avicennia marina		√			100	100
MS 17	Toqushi	0324479	1259010	-					-	-
MS 18	Laheloow Toqushi	0323888	1258748	Avicennia marina					-	-
MS 20	Buqdhada Toqushi	032440	1258395	Avicennia marina		√			99	99
MS 21	Toqushi	0324810	1258925	-					-	-
MS 22	Buqqacan Toqushi	0324486	1258388	-					-	-

MS 24	Milixda Toqushi	0326308	1258796	Avicennia marina		√			7	7
					√				41	41
MS 25	Qudhaan Jaale	0332267	126834	-					-	-
MS 26	Upper part of Qudhaan Jaale	0332042	1256316	Rhizophora		√			70	70
							√		5	5
MS 27	Cubeeda Adah Channel	0330933	1264594	Avicennia marina		√			2	2
				Rhizophora		√			68.7	68
MS 29	Zaylae - Zaylae port	0333087	1255744	-					-	-
MS 30	Zaylae Cashuural R aasiga	0327174	125876	Avicennia marina		√			61.4	61

Table 2 shows results from the line transect tree crown intercept observations. Note that some of the sites had closed canopy cover giving closed mangrove forest. Majority of the trees are between 1 and 7 meters in height. Few trees were above 7 meters in height.

Figure 9: *Avicennia marina* (Notice the Breathing roots (pneumatophores) of *Avicennia marina* obtain oxygen directly from the air)

5.1.2 Sources of livelihood

Table 3 and figure 11 show the main sources of livelihood in the mangrove area of Zeylac. Salt extraction (figure 12, 13 and 14) from the pans is a common feature in this area, with about 30% of those interviewed indicating that it was an important source of livelihood in the area. Other sources of livelihood, according to the respondents, included fishing, pastoralism and other businesses. The percentage response is given against each item.

Table 3: Sources of livelihood

Pastoralism	Fishing	Salt	Restaurant	Other
14	29	29	14	14

Figure 10: Ecological studies in Zeylac mangroves by SWALIM, August 2010

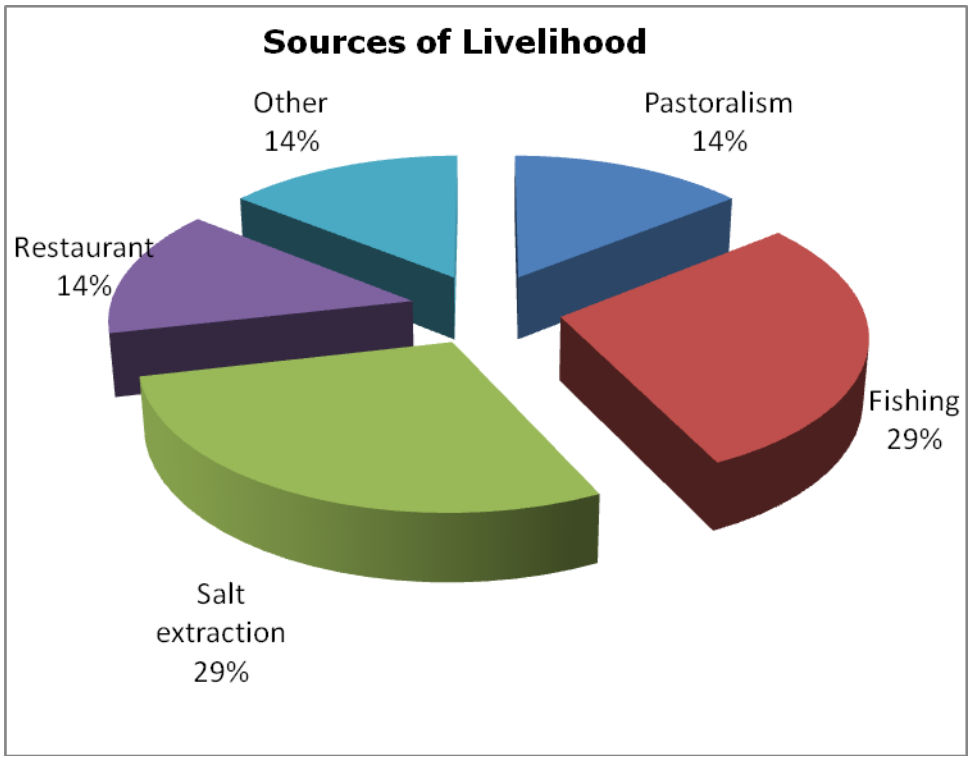


Figure 11: Sources of livelihood

Other activities in the area also include tree nurseries for generation of mangrove seedlings. These seedlings are then planted in areas that once had mangrove trees and are now denuded.

Figure 12: Freshly prepared Salt pan in Zeylac, August 2010

Figure 13: Salt pan in Zeylac – harvested salt, August 2010

Figure 14: Salt pan in Zeylac - crystallization, August 2010

Figure 15: Birds (cranes) in the mangroves of Zeylac, August 2010

5.1.3 Environmental degradation problems

About 42 % of those interviewed indicated that the main land degradation problem was Tree cutting for fodder and timber for construction. Other land degradation problems included Sand dunes (25%), Over-fishing (17%), Oil spillage from the vessels and garbage dumping by the communities in Zeylac, with their percentages. The mangroves are a source of fodder for the camels (figure 16).

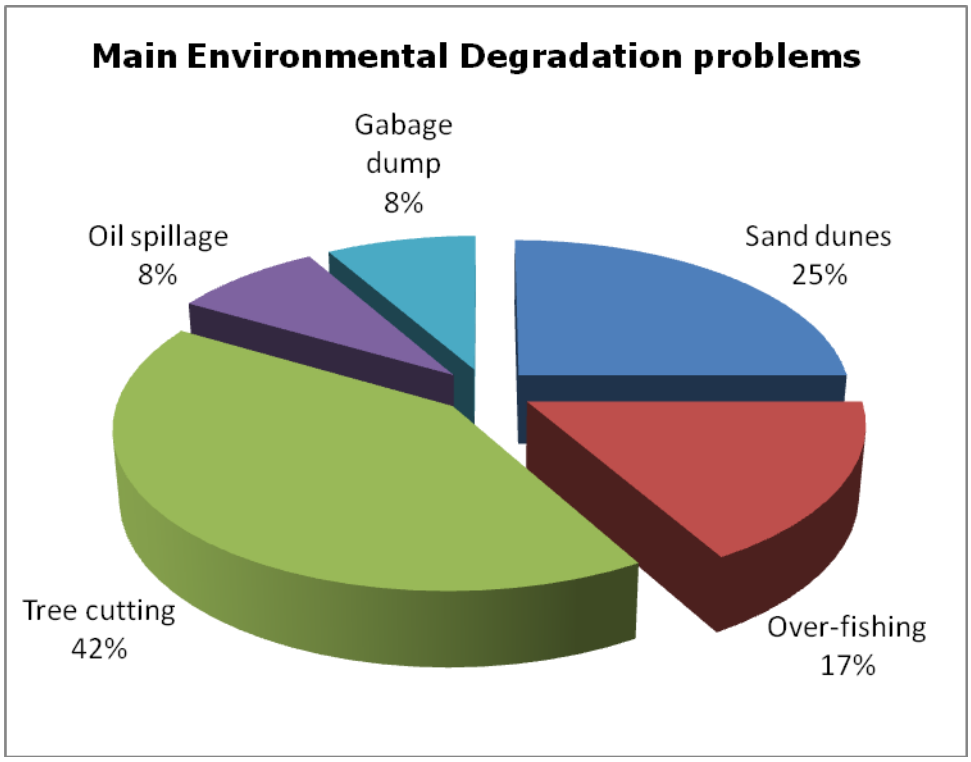


Figure 16: Main Environmental Degradation problems

Two mangrove species were found to dominate in the mangroves of Zeylac, *Rhizophora mucronata* and *Avicennia marina*. The main services offered by the mangroves included wind break, fire wood, construction poles, shade and recreation. The mangroves are a good habitat for the bird life.

5.1.4 Goods and services provided by the Mangroves of Zeylac

Figure 17 shows the goods and services obtained from the Zeylac mangroves. Extraction for construction poles and fire wood ranked highest, and stood at about 60% according to those interviewed. Other services included feed for the camels and shade. The percentage response against each of these goods and services is given in the figure 17.

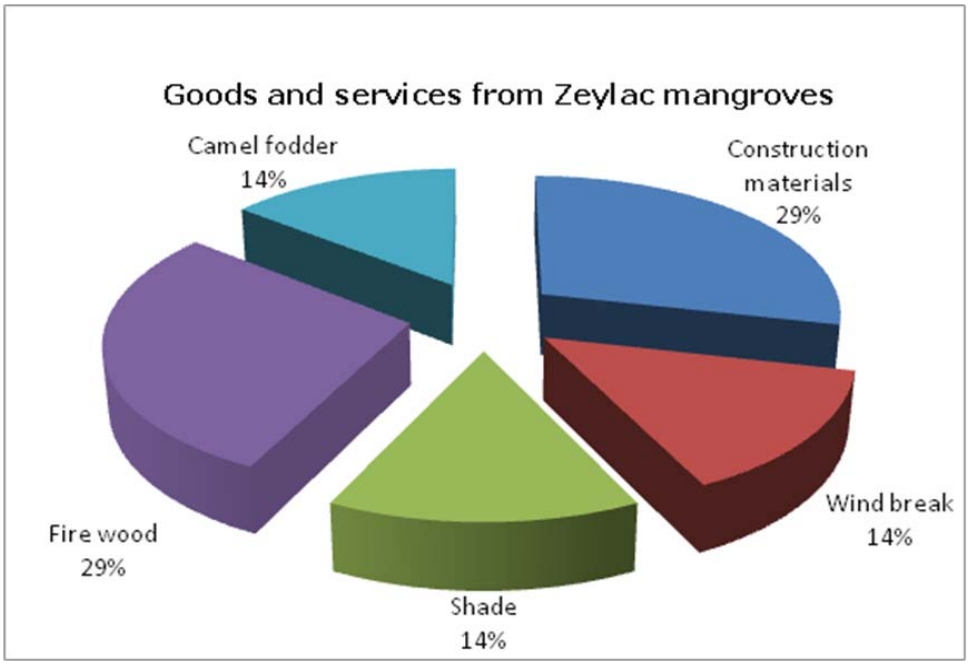


Figure 17: Goods and services from the Zeylac mangroves

Figure 18: *Rhizophora mucronata* in the mangroves of Zeylac, August 2010

Figure 19: Young planted mangrove trees near Zeylac, August 2010

5.1.5 Importance of mangroves to other animals

About 50 percent of those interviewed indicated that the mangroves of Zeylac were important breeding ground for birds and fish species. In addition, about 30% of those interviewed indicated that the mangroves of Zeylac were also important habitat for the birds. Other importance and the percentage reponse from those interviewed are shown in the figure 20.

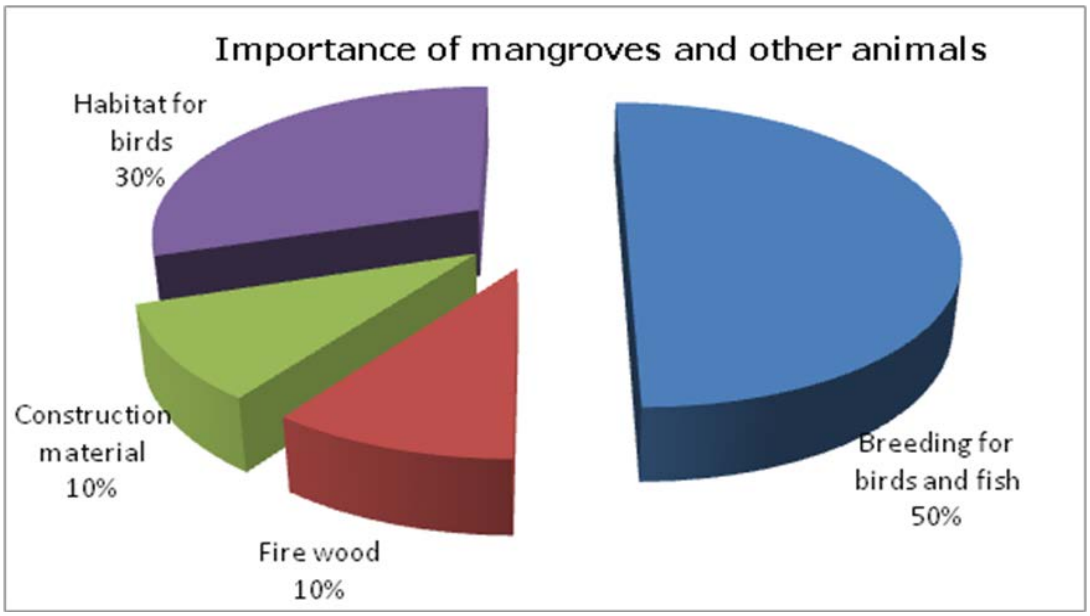


Figure 20: Importance of mangroves and other animals

5.1.6 Importance of mangroves in Zeylac

As regards the importance of the mangroves, 45 % of those interviewed indicated that the mangroves offer as important wave breaks. About 33% of those interviewed indicated that the mangroves offer as very important wind breaks while about 22% indicated that the mangroves are important recreation facilities. These results are shown in figure 21.

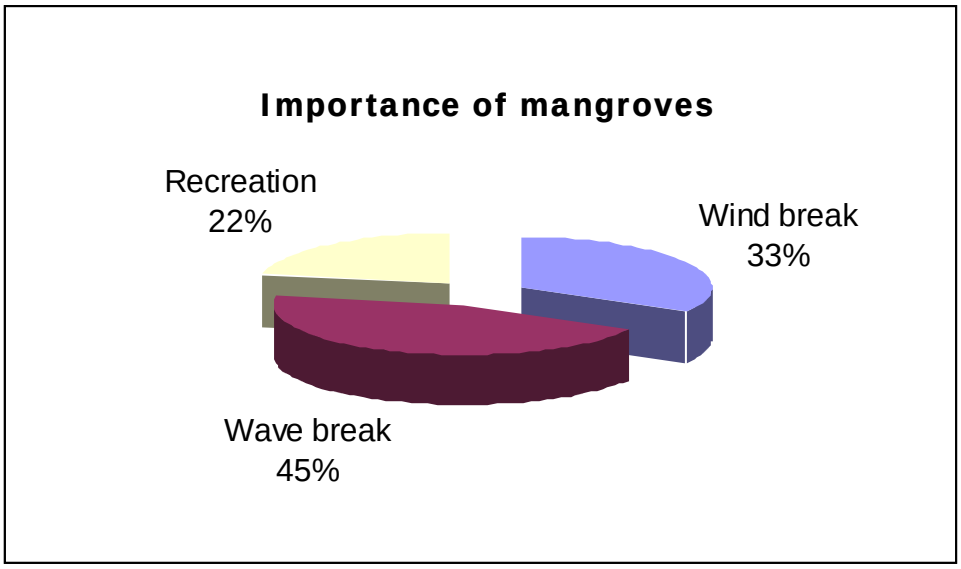


Figure 21: Importance of mangroves

5.1.7 Training on the environment of Zeylac mangroves

Out of all those interviewed, all of them indicated that they did not receive any form of training related to the environmental (figure 22).

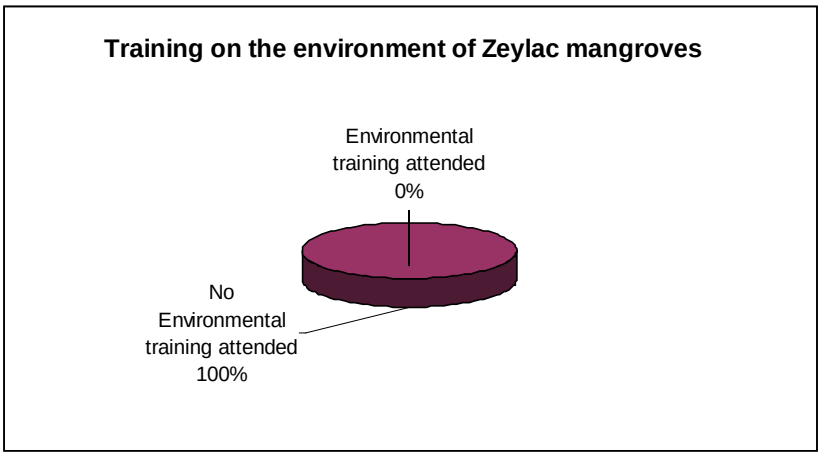


Figure 22: Training on the environment of Zeylac mangroves

However, they all felt that the mangroves were in very good shape as there was good regeneration of the mangroves.

5.1.8 Threats to the Mangroves of Zeylac

The highest threat to the Zeylac mangroves is tree cutting as indicated by about 50% of those interviewed (figure 23). Other serious threats to these mangroves included waste disposal and browse by the camels. About 25% of those interviewed felt that the mangroves of Zeylac faced no threat at all.

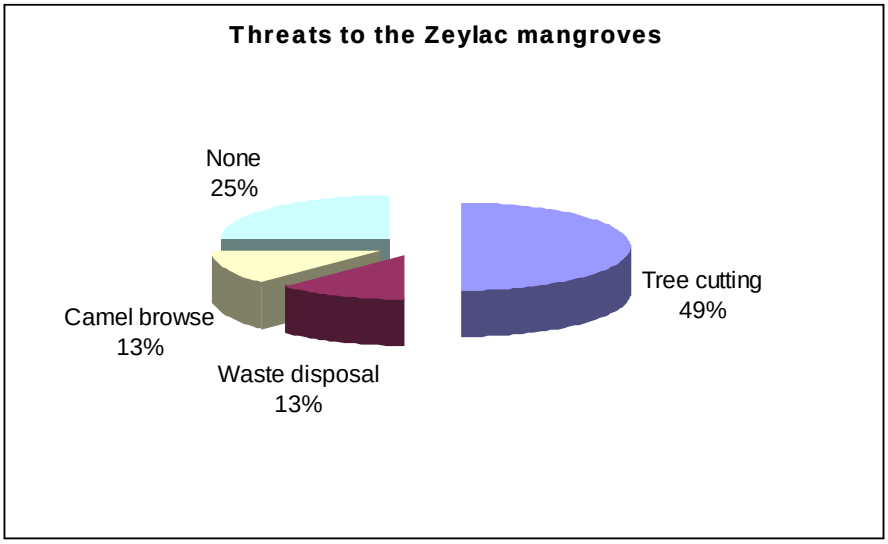


Figure 23: Threats to the mangroves of Zeylac

Figure 24: Construction by mangrove tree poles in Zeylac, August 2010

Figure 25: Camel browsing on *Rhizophora mucronata*

5.1.9 Beneficiaries of the Zeylac mangroves

Of all those people that were interviewed, about 40% indicated that the pastoralists benefited more than others. Other beneficiaries of these mangroves included restaurant owners, fishermen and urban dwellers. Figure 26 shows these beneficiaries and the percentages as indicated by those interviewed.

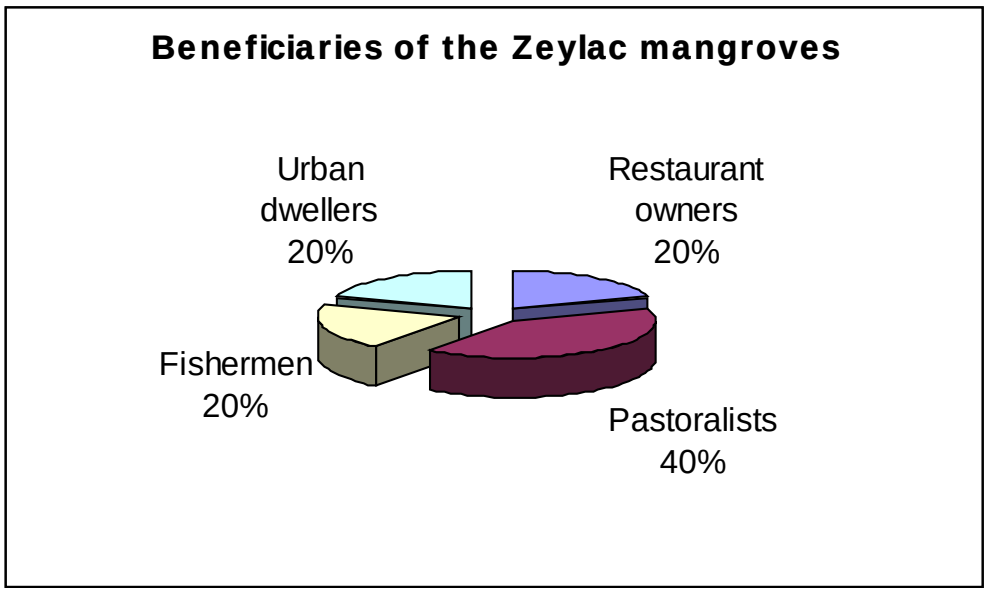


Figure 26: Beneficiaries of the mangroves of Zeylac

5.1.10 Mangrove products extraction trend in Zeylac

Over 50% of those interviewed indicated that the trend in extracting products from the mangroves of Zeylac has been increasing (figure 27). More and more people are extracting products from the mangroves.

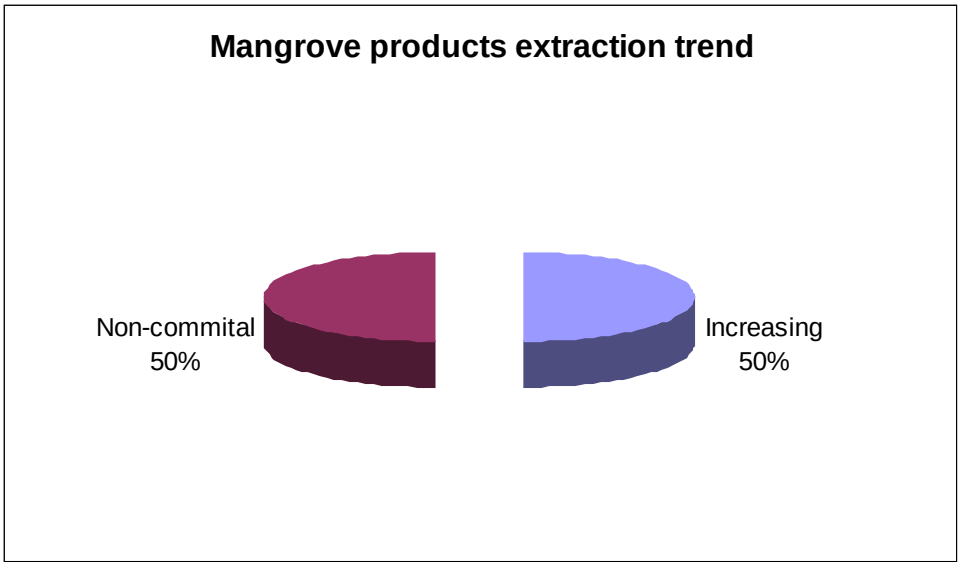


Figure 27: Mangrove products extraction trend

5.1.11 Destination of Zeylac mangrove products

Figure 28 shows that most of the mangrove products have the local urban centers as their destination. The percentages as indicated by those interviewed are shown in figure 28.

Figure 28: Destination of the Zeylac mangrove products

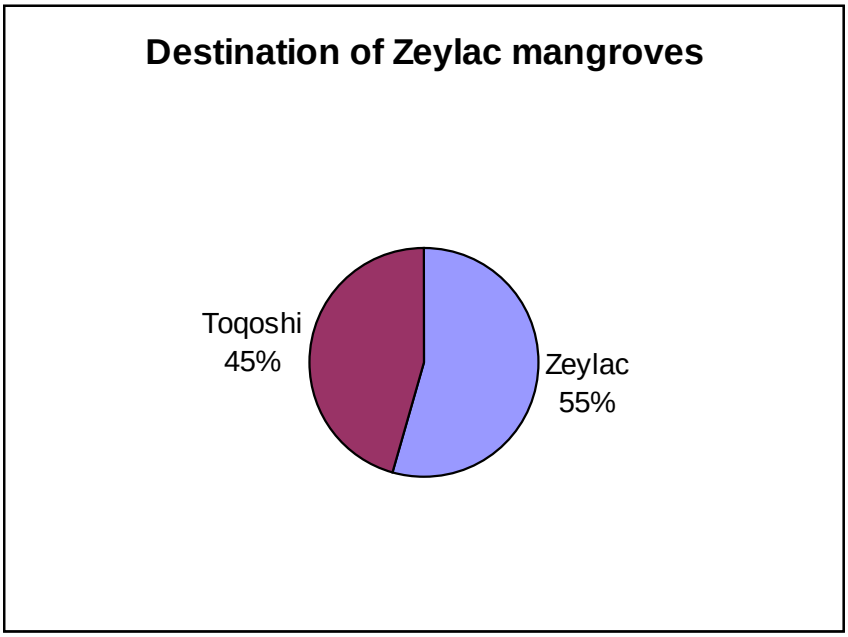


Figure 28: Destination of the Zeylac mangrove products

5.2 Mangroves of Berbera (39ha)

The mangroves of Berbera (figure 29) cover an area of approximately 40 hectares. There was no field assessment carried out on these mangroves of Berbera. There are, therefore, neither photos nor field data presented on these mangroves.

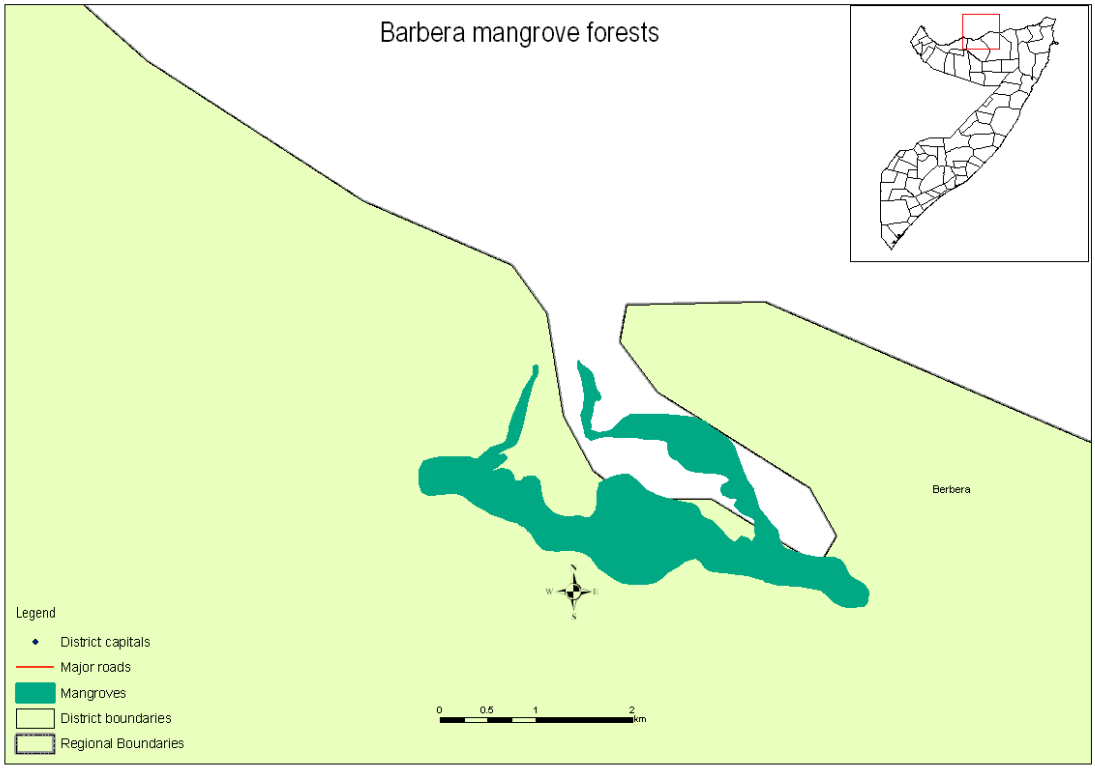


Figure 29: Mangroves of Berbera

5.3 Mangroves of Caluula and Xabo (60ha)

These mangroves are found within Caluula district and are close to the urban centers of Xabo and Caluula as seen in figure 30. The information here will be presented separately for the two mangrove areas of Xabo and Caluula.

ID	Area Name	Coordinates		Species Name	Height Class (m)				%
		x	y		<1	1-7	7-14	>14	
01	Alula	1322891	0473927	Avicennia marina		√			
02	Alula	1323141	0474208	Avicennia marina		√			99
03	Alula	1323003	0474513	Avicennia marina	√				11.1
04	Alula	1323268	0474411	Avicennia marina		√			98
05	Alula	1323662	0474756	Avicennia marina		√			99
06	Alula	1323534	0475084	Avicennia marina		√			90
07	Alula	1323700	0475322	Avicennia marina		√			85
08	Alula	1324009	0475308	Avicennia marina		√			99
09	Alula	1323773	0475626	Avicennia marina		√			75
10	Alula	1324313	0475499	Avicennia marina		√			99
11	Alula	1324330	0475789	Avicennia marina		√			50
12	Alula	1324614	0475896	Avicennia marina		√			50
13	Alula	1324555	0476067	Avicennia marina		√			45
14	Alula	1324675	0476414	Avicennia marina		√			99
15	Alula	1324914	0476488	Avicennia marina		√			80
16	Alula	1324843	0476931	Avicennia marina		√			75
17	Alula	1324462	0476890	Avicennia marina		√			90
				Avicennia marina		√			5
18	Alula	1324179	0477263	Avicennia marina		√			75
19	Alula	1324191	0477504	Avicennia marina		√			99
20	Alula	1324517	0477420	Avicennia marina		√			80
21	Alula	1324684	0477239	Avicennia marina		√			40
				Avicennia marina		√			50
22	Alula	1324800	0477499	Avicennia marina		-	-	-	-
23	Alula	1324642	0477596	Avicennia marina		√			98
24	Alula	1324662	0477903	Avicennia marina		√			50

				Avicennia marina		√			35
25	Alula	1324638	0478287	Avicennia marina		√			90
26	Alula	1324219	0478560	Avicennia marina		√			80
27	Alula	1324158	0478986	Avicennia marina		√			50
28	Alula	1305264	0449124	Avicennia marina		√			
29	Alula	1306054	0449372	Avicennia marina		-	-	-	-
30	Alula	1306902	0449456	Avicennia marina		-	-	-	-
31	Alula	1303134	0449734	Avicennia marina		-	-	-	-
32	Alula	1309115	0450085	Avicennia marina		-	-	-	-
33	Alula	1310593	0450398	Avicennia marina		√			99
34	Alula	1311366	0450824	Avicennia marina		-	-	-	-
35	Alula	1312066	0451380	Avicennia marina		-	-	-	-
37	Alula	1313058	0451813	Avicennia marina		-	-	-	-
36	Alula	1312802	04701703	Avicennia marina		-	-	-	-

Table 4: mangrove species composition and percent canopy cover by sample site

Table 4 shows the sample sites and the data obtained. The results in table 4 indicate that *Avicennia marina* is the dominant mangrove species in Calula.

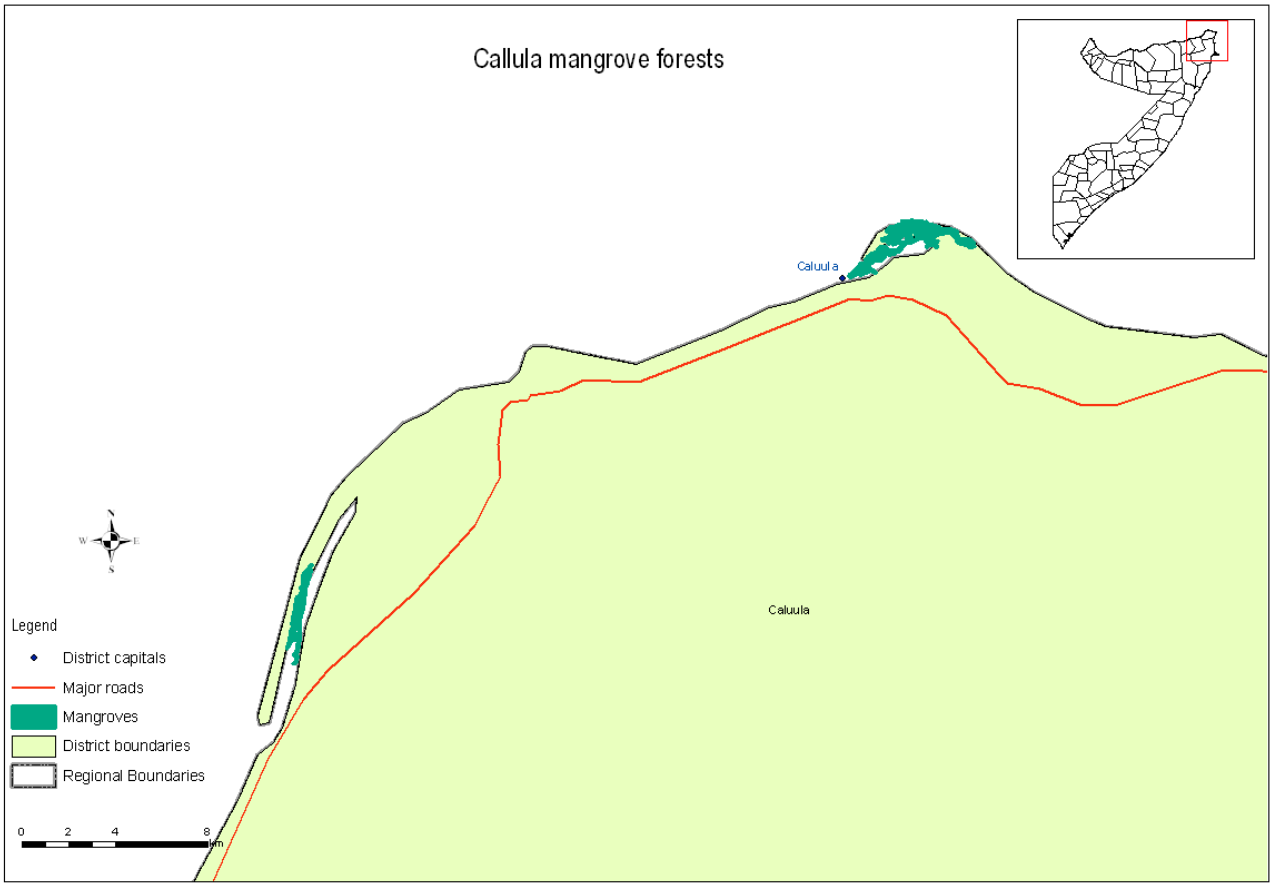


Figure 30: Mangroves of Xabo and Caluula

5.3.1 The mangroves of Xabo area

These mangroves covered an area of about 36ha. They are found spread along the lagoon of Xabo area. The mangroves form forests with trees of up to 5 meters tall. The dominant plant species here is *Rhizophora mucronata* (figure 31) and *Avicennia marina* (figure 9).

Figure 31: *Rhizophora mucronata* in the mangroves of Xaabo, August 2010

Figure 32: Stressed mangroves in Xaabo, August 2010

The following is information generated from the questionnaire data by interviews conducted in the field with the local people in Xabo settlement.

5.3.2 Sources of livelihood in Xabo region

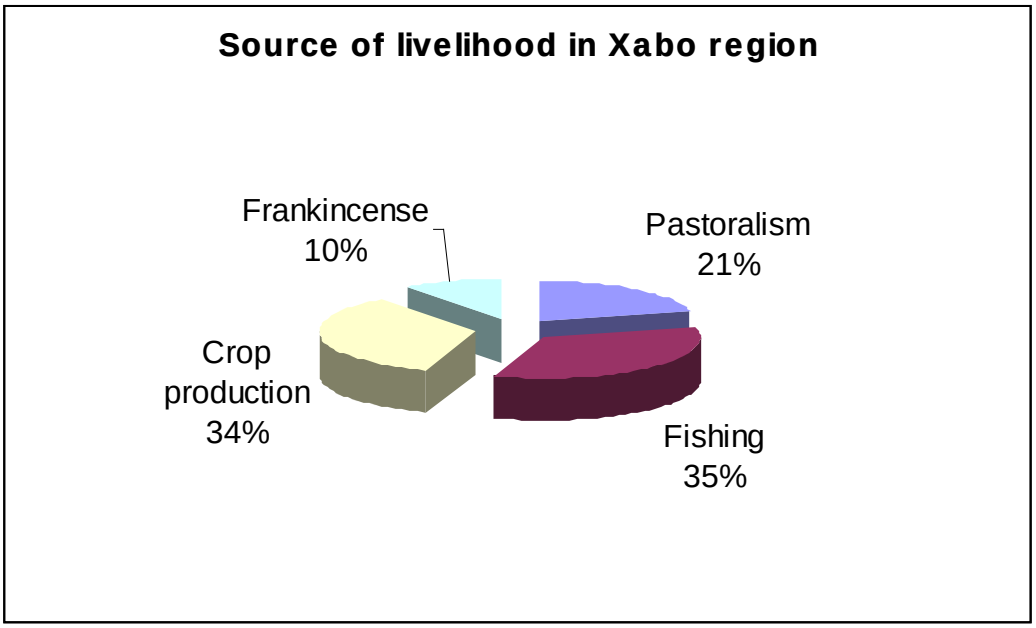


Figure 33: Source of livelihood in Xabo region

Figure 33 shows the sources of livelihood in Xabo area as shown by the percentage response from the interviews with the local people. Fishing and crop production by irrigation from springs and well form the main sources of livelihood. The crop production (also popularly known as Oasis farming) here is mainly date palm.

5.3.3 Environmental degradation problems in Xabo area

About 50% of those interviewed in Xabo indicated that floods were causing soil erosion in the area (figure 34). Over browsing of the mangroves by camels and overgrazing by livestock were also indicated as major environmental degradation problems in the area. Sand dune encroachment into the grazing lands was also shown as an environmental concern in the area.

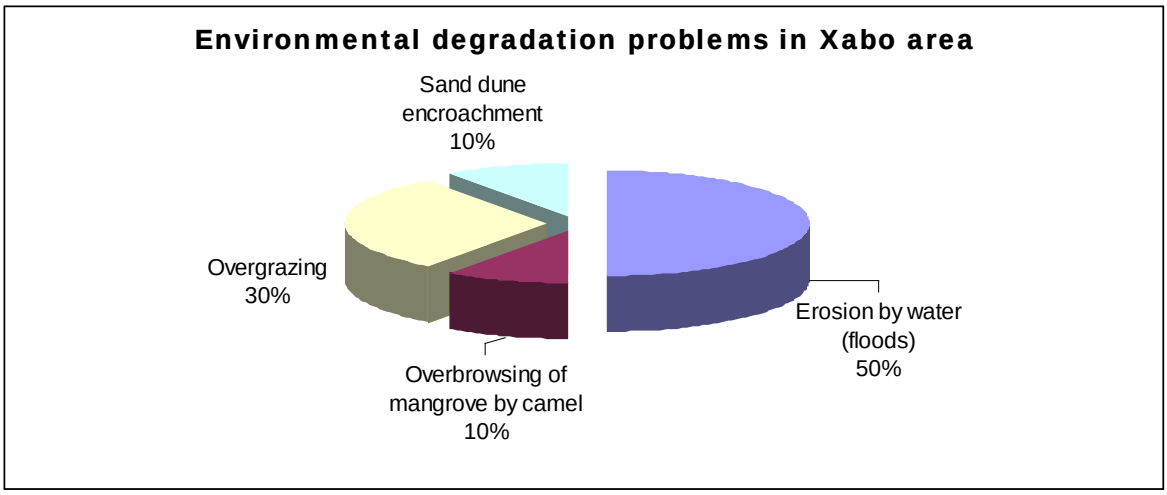


Figure 34: Environmental degradation problems

5.3.4 Goods and services provided by the Mangroves of Xabo

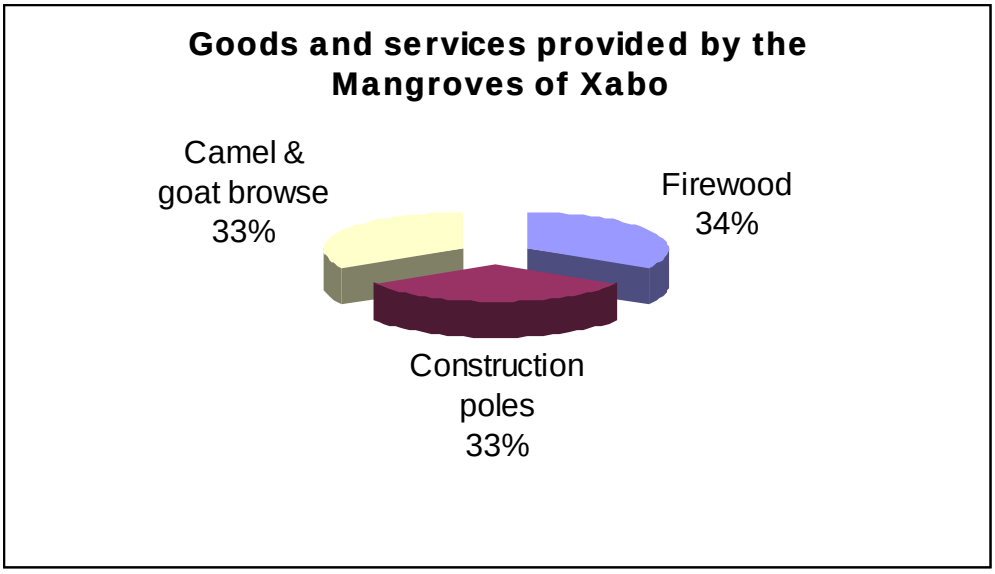


Figure 35: Goods and services from mangroves of Xabo

Figure 35 shows the goods and services provided by the mangroves of Xabo. Tree cutting for construction poles was indicated as a major activity in Xabo. Firewood is also collected from the mangrove forest by the local people. Camel browse of the mangroves is a major activity too. The percentage response from the interviewee is shown in figure 35.

5.3.5 Importance of mangroves of Xabo area

The mangroves of Xabo are very important sources of firewood as indicated by the respondents during the interviews (figure 36). About 30% of those interviewed indicated that they collected firewood from the mangrove forest. The mangroves are also important wind breaks besides providing protection against the destructive effects of tsunamis. The mangroves are also important sources of construction material.

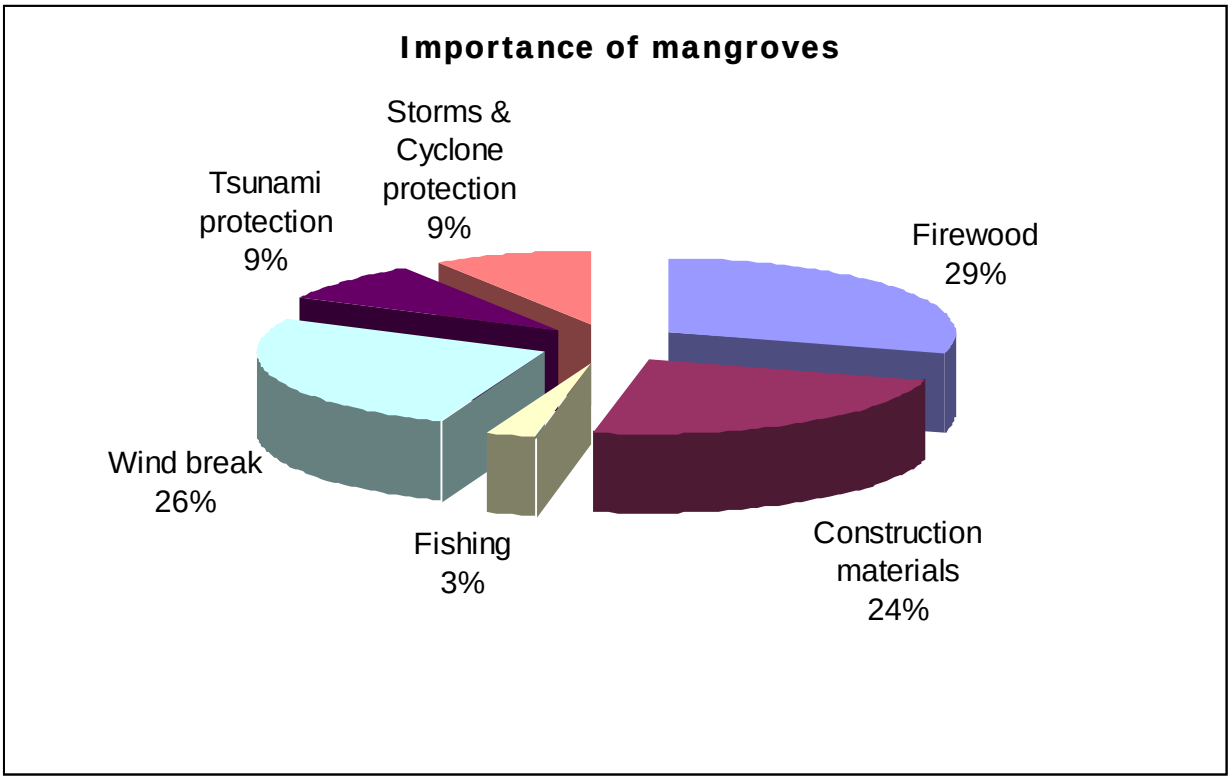


Figure 36: Importance of mangroves of Xabo

5.3.6 Importance of Xabo mangroves to other animals

Figure 37 shows the importance of the mangroves of Xabo area to other animals. About 30 percent of those interviewed indicated that the mangroves of Xabo are important breeding grounds for the birds besides offering food and home to these birds. The mangroves are also breeding ground for the fish as indicated by about 30% of those interviewed.

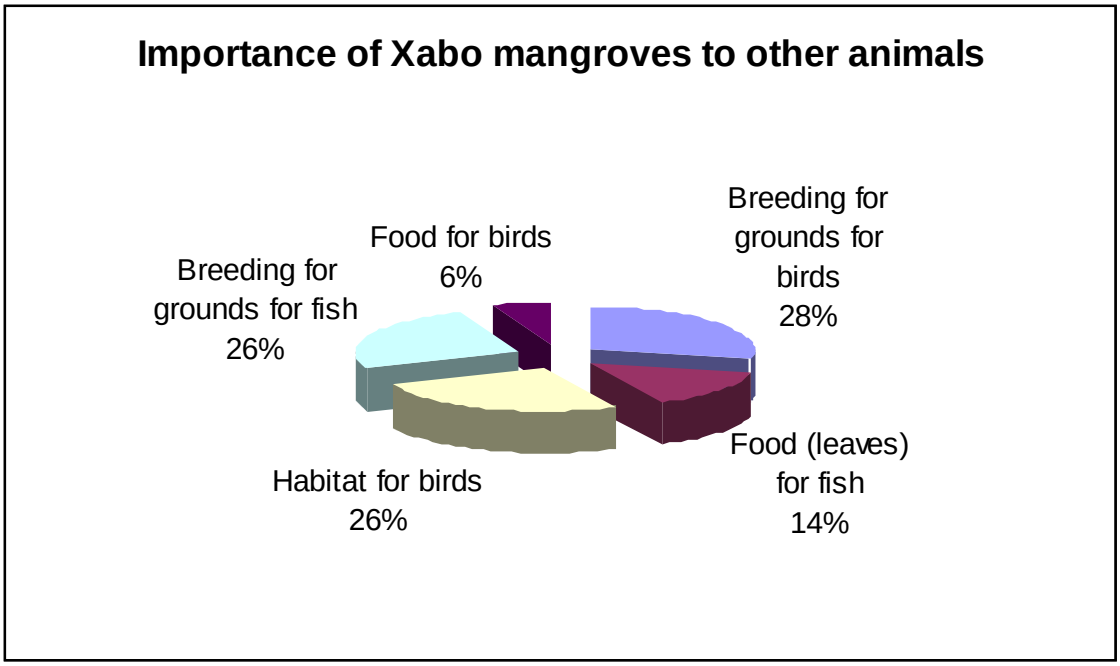


Figure 37: Importance of mangroves of Xabo to other animals

5.3.7 Training on the environment of Xabo mangroves

All those interviewed indicated that they had received training on matters related to mangrove management and restoration (tree nursery preparation and management). The NGO called RMCO was indicated as having provided, in this area, training to the local people.

All those interviewed also indicated that they had become more knowledgeable about the mangroves (utilization and management) than before.

5.3.8 Threats to the Mangroves of Xabo

Figure 38: Threats to the mangroves of Xabo

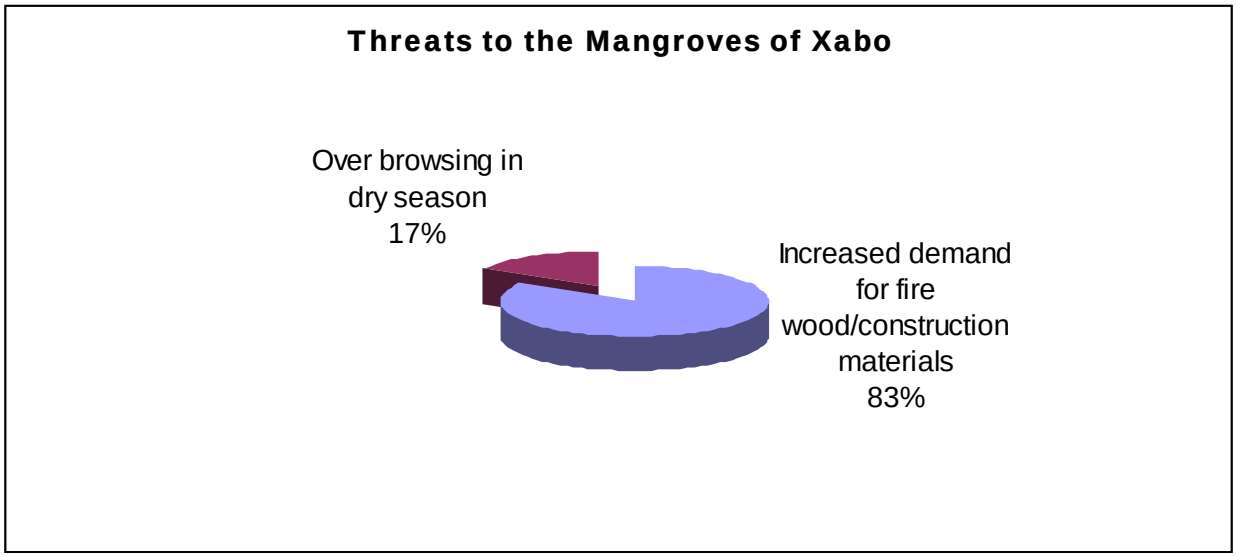


Figure 38: Threats to the mangroves of Xabo

Figure 38 is a presentation of the threats to the mangroves of Xabo as indicated by the respondents during the interviews. Over 80% of those interviewed indicated that the mangroves were threatened by the increase in magnitude of tree cutting for construction poles. In addition, about 20% of those interviewed indicated that the mangroves were receiving increased pressure from dry season browse by animals. The respondents also indicated that the threats are increasing with increase in population.

However, all those interviewed indicated that the community owns the mangrove forest of Xabo. The community elders of Xabo try to enforce laws that protect the mangroves but the demand is overwhelming as there is a continuous influx of IDPs besides the general population increase.

5.3.9 Beneficiaries of the Xabo mangroves

Figure 39 shows that about 90 % of those interviewed indicated that the beneficiaries of the mangrove resources included the local inhabitants of Xabo and surrounding settlements, besides the pastoralists and fishermen. About 10% of those interviewed also indicated that the beneficiary list of the Xabo mangroves included the IDPs.

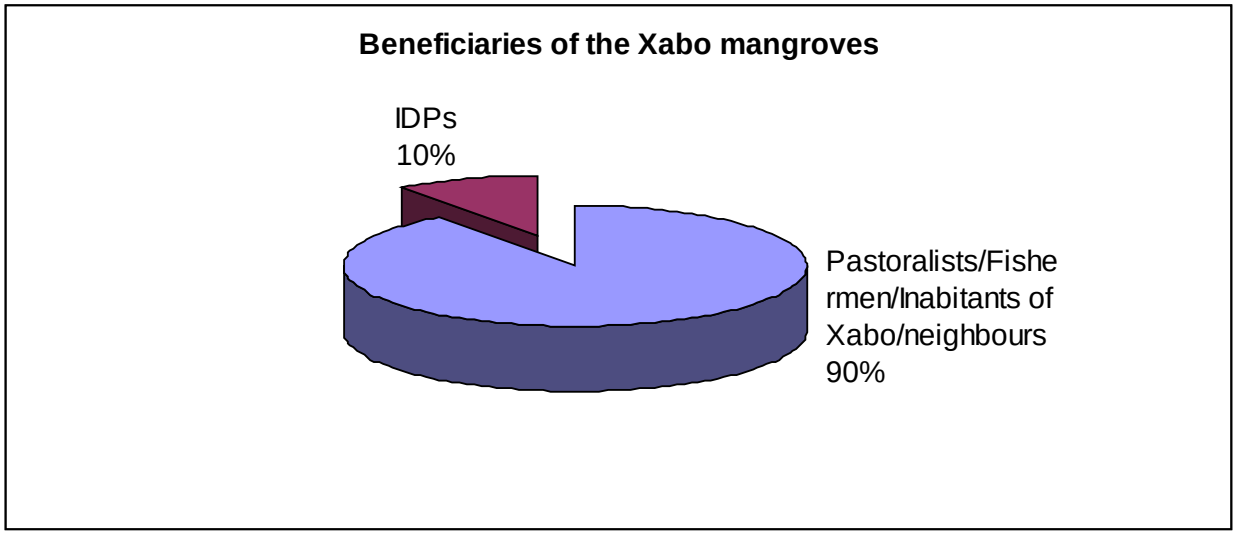


Figure 39: Beneficiaries of the Xabo mangroves

5.3.10 Destination of Xabo mangrove products

All those interviewed indicated that the destination of the products included Xabo and the surrounding settlements.

5.3.11 The mangroves of Caluula area

These mangroves covered an area of about 24ha. The are found in several fragments of forests with two main tree species, *Rhizophora mucronata* (figure 31) and *Avicennia marina* (figure 9).

5.3.12 Sources of livelihood in Caluula region

According to the response from those interviewed, fishing ranks as highest source of livelihood, with about 33% of those interviewed indicating that they depended on fishing (see figure 40). Other sources of livelihood in the Caluula mangrove ecosystem included pastoralism, crop production/date palms, frankincense, mangrove tree cutting and other tree cutting activities. The percent response from those interviewed against each of the sources of livelihood is shown in figure 40.

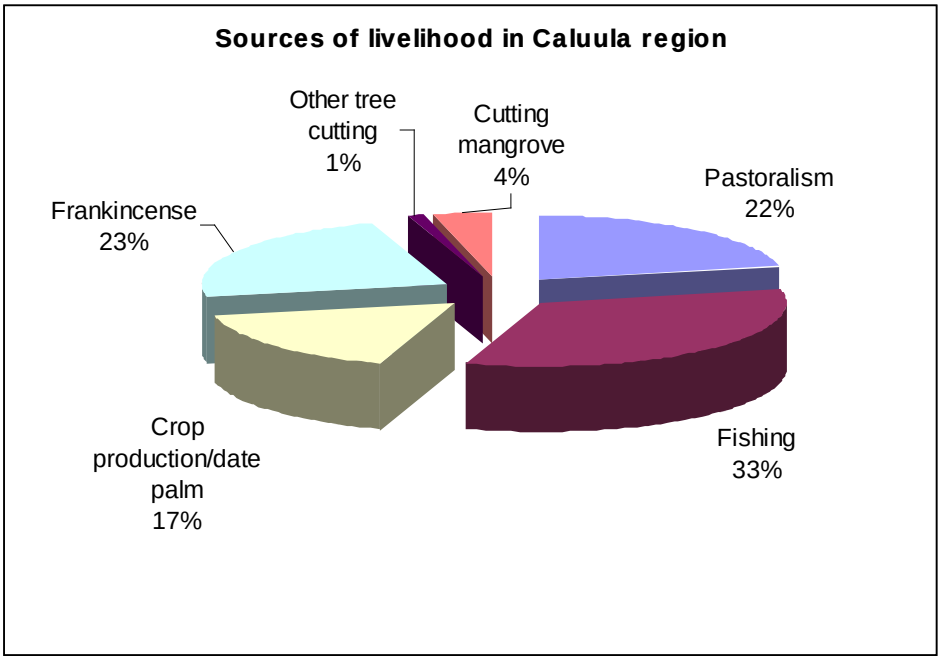


Figure 40: Sources of livelihood in Caluula region

5.3.13 Environmental degradation problems in Caluula

Figure 41 shows the response from those interviewed in Caluula regarding issues of environmental degradation. Mangrove tree cutting ranked highest with about 30% of those interviewed indicating that it was indeed a serious problem. Other environmental degradation problems as indicated by those interviewed and the percentage responses are shown in figure 41. Overgrazing and floods are some of the reported environmental degradation problems reported during the interviews. Marine degradation in Caluula was also a concern.

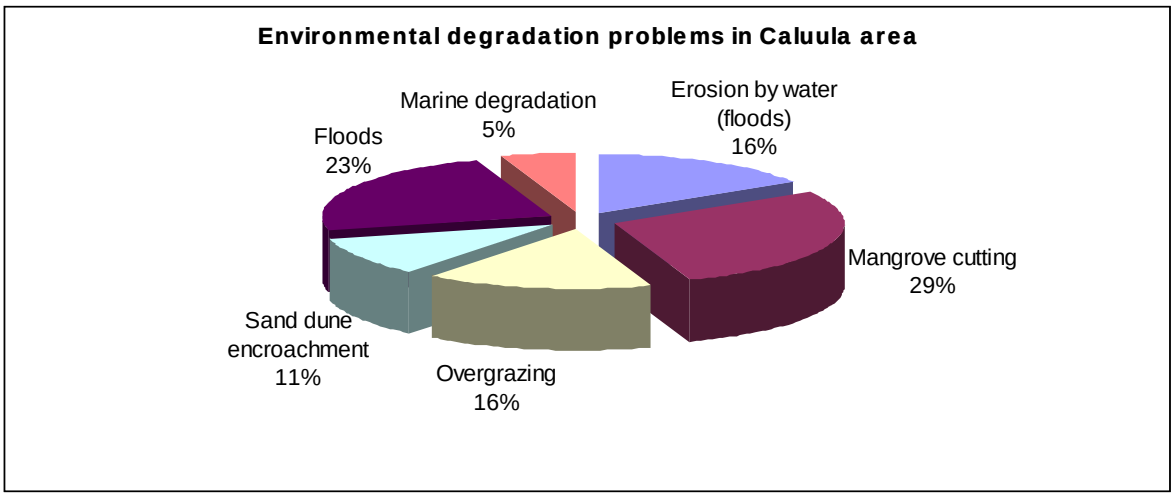


Figure 41: Environmental degradation in Caluula region

5.3.14 Goods and services provided by the Mangroves of Caluula

Figure 42 shows the goods and services provided by the mangroves of Caluula as indicated by those local people that were interviewed. About 40% of those interviewed indicated that the mangroves provided construction poles and timber. Other goods and services provided by the mangrove ecosystem are shown in figure 42 with the corresponding percent response from those interviewed.

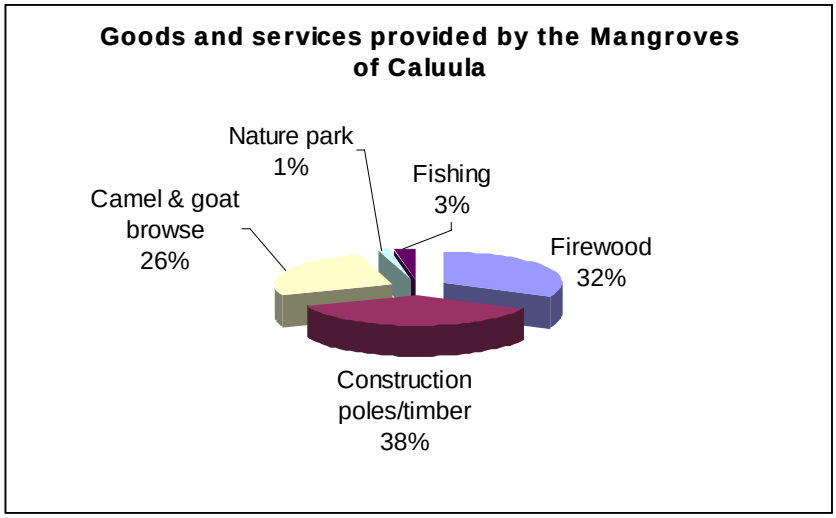


Figure 42: Goods and services provided by the Mangroves of Caluula

5.3.15 Importance of mangroves of Caluula area

Figure 43 gives the results of the interviews with regard to the importance of the mangroves of Caluula. About 40% of those interviewed indicated that the mangroves provided construction materials in Caluula. Other important attributes of the mangroves in Caluula and the percent response from those interviewed are also shown in the figure 43.

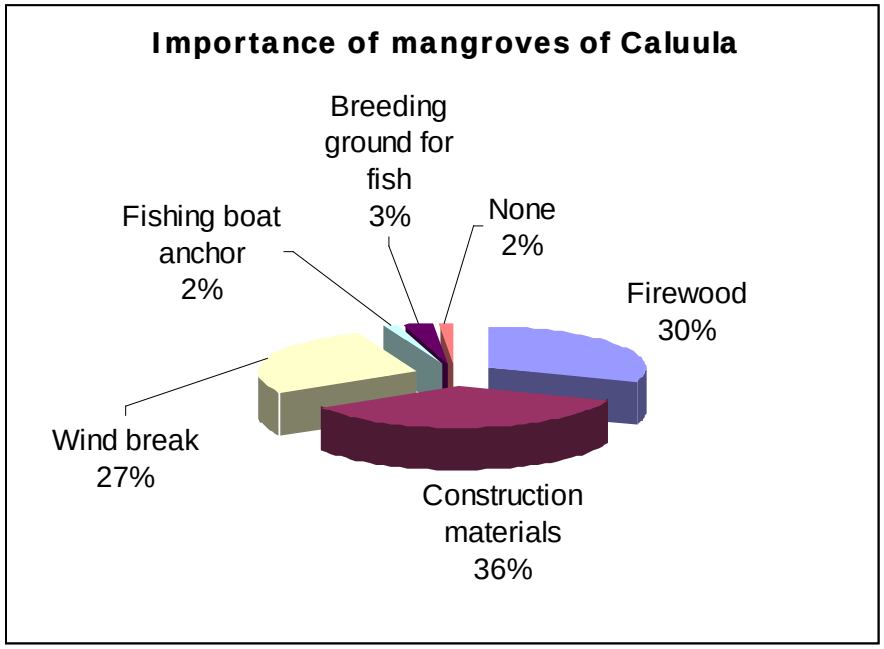


Figure 43: Importance of mangroves of Caluula area

5.3.16 Importance of Caluula mangroves to other animals

Figure 44 shows the importance of the mangroves of Xaluula to other animals (birds and fishes). About 20% of those interviewed indicated that the mangroves of Caluula were important habitat for birds. These mangroves were also important breeding grounds for both fishes and birds. The fishermen also find this mangrove area important for boar anchor. The percentage response against each of this attribute by those interviewed is shown in figure 44.

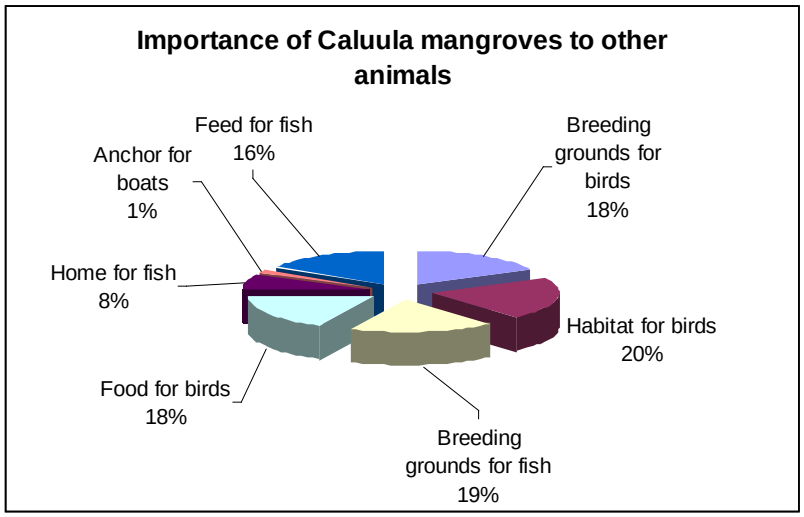


Figure 44: Importance of Caluula mangroves to other animals

5.3.17 Training on the environment of Caluula mangroves

From the interviews on training obtained on the environment of the Caluula mangroves, over 90% of the respondents indicated that they had received no training related to the environment of the mangrove ecosystem (see figure 45). Only about 10% of those interviewed indicated that they had received any environment related training, with the NGO RMCO being cited as the champion in environmental training initiatives.

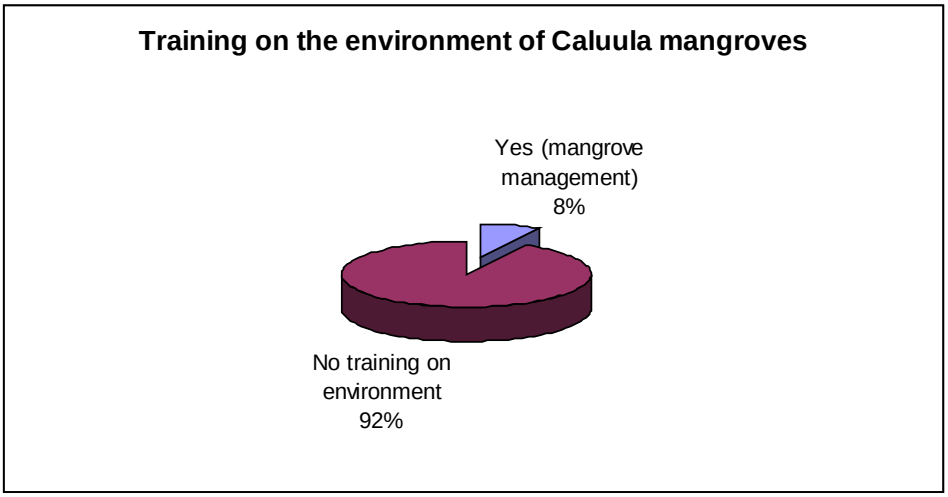


Figure 45: Training on the environment of Caluula mangroves

On a similar note there were more respondents indicating that their knowledge on the Caluula mangrove ecosystem had not improved over time (92% respondents), with only about 10% of those interviewed indivating that had had their knowledge on the Caluula mangroves improved (see figure 46).

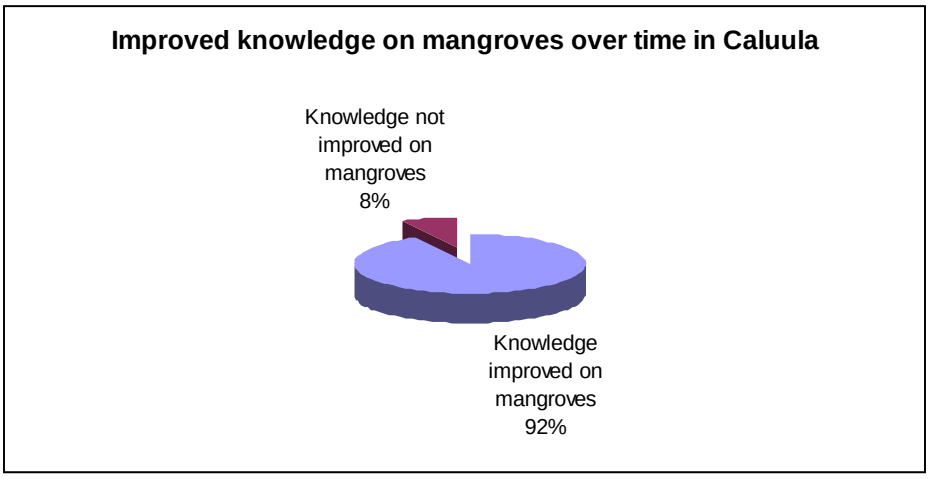


Figure 46: Improved knowledge on mangroves of Caluula over time

About 90% of those interviewed indicated that the mangrove of Caluula were in good shape while only about 10% felt that these mangroves were in bad shape.

5.3.18 Threats to the Mangroves of Caluula

Out of those interviewed, about 80% and 4% of them felt that the mangroves of Caluula were threatened by increased tree cutting and over browsing, respectively while about 18% did not know about any threats to the mangroves (see figure 47).

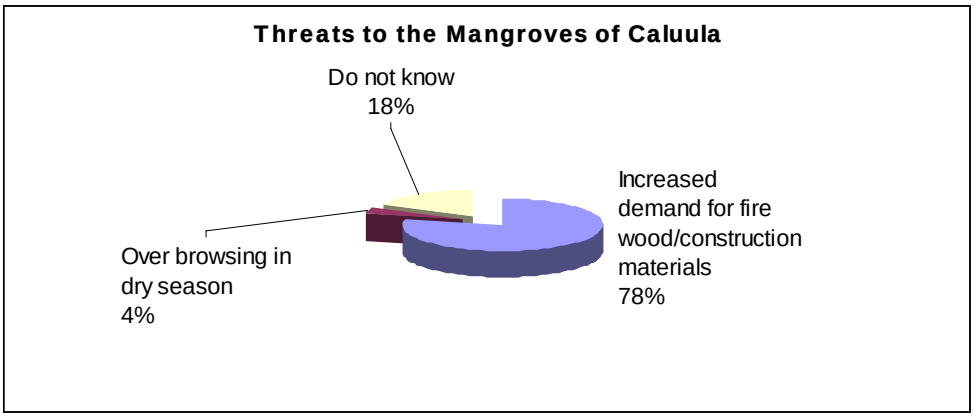


Figure 47: Threats to the Mangroves of Caluula

These threats to the mangroves of Caluula were on the increase due to increased pressure from the ever-increasing population and subsequent increase in community needs.

5.3.19 Ownership of the Caluula mangroves

As in Xabo all those interviewed indicated that the community owns the mangrove forest of Caluula. The community elders of Caluula try to enforce laws that protect the mangroves but the demand is overwhelming as there is a continuous influx of IDPs besides the general population increase.

5.3.20 Resource extraction from Caluula mangroves

According to those interviewed, fire wood collection and tree cutting for construction material form the bulk of the resources extracted from the Caluula mangroves, with over 80% of those interviewed indicating that fire wood was collected as trees were felled for building materials. Some of those interviewed indicated that the mangroves also formed browse for the animals while some indicated they did not extract any resource from the mangroves (figure 49).

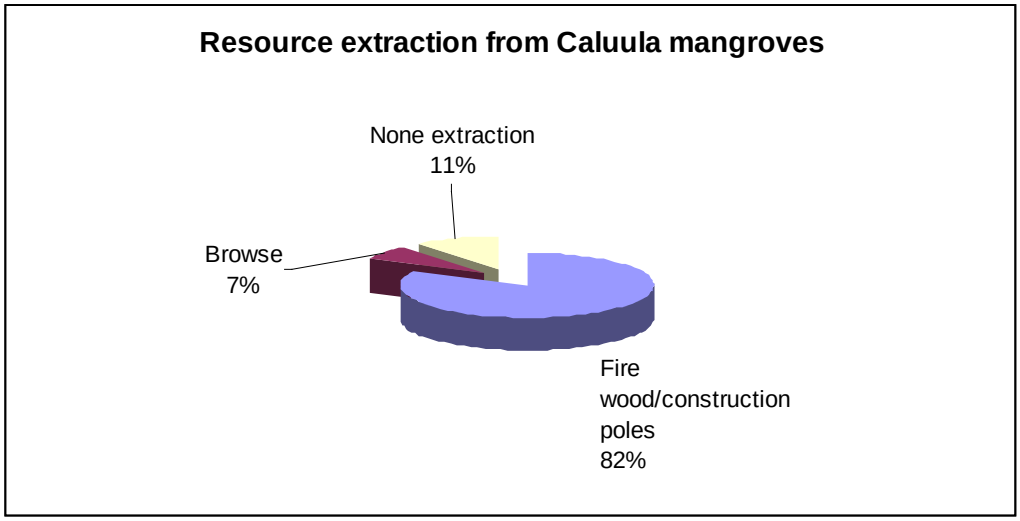


Figure 49: Resource extraction from Caluula mangroves

5.3.21 Beneficiaries of the Caluula mangrove products

Figure 50 shows that above 80% of those interviewed indicated that the beneficiaries of the mangrove resources included the local inhabitants of Caluula and surrounding settlements, besides the pastoralists and fishermen. Above 10% of those interviewed also indicated that the beneficiary list of the Caluula mangroves included the IDPs. About 3% of those interviewed were non-committal on those who benefited from the resources extracted from these mangroves.

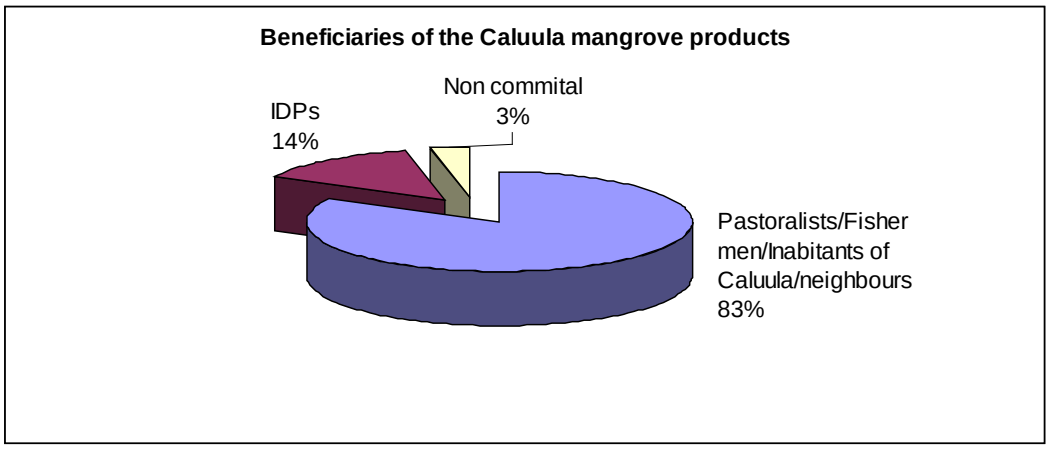


Figure 50: Beneficiaries of the Caluula mangrove products

According to all those interviewed, the destination of the extracted products from the Caluula mangroves includes Caluula settlement itself and the surrounding settlements.

5.4 Mangroves of Kismaayo (84ha)

The mangroves of Kismaayo occupy an area of about 85ha. The prevailing dangerous security situation at the time of the field survey could not allow collection of field data within the Kismaayo mangrove ecosystem. Figure 51 shows the distribution of mangrove forests within the Kismaayo area.

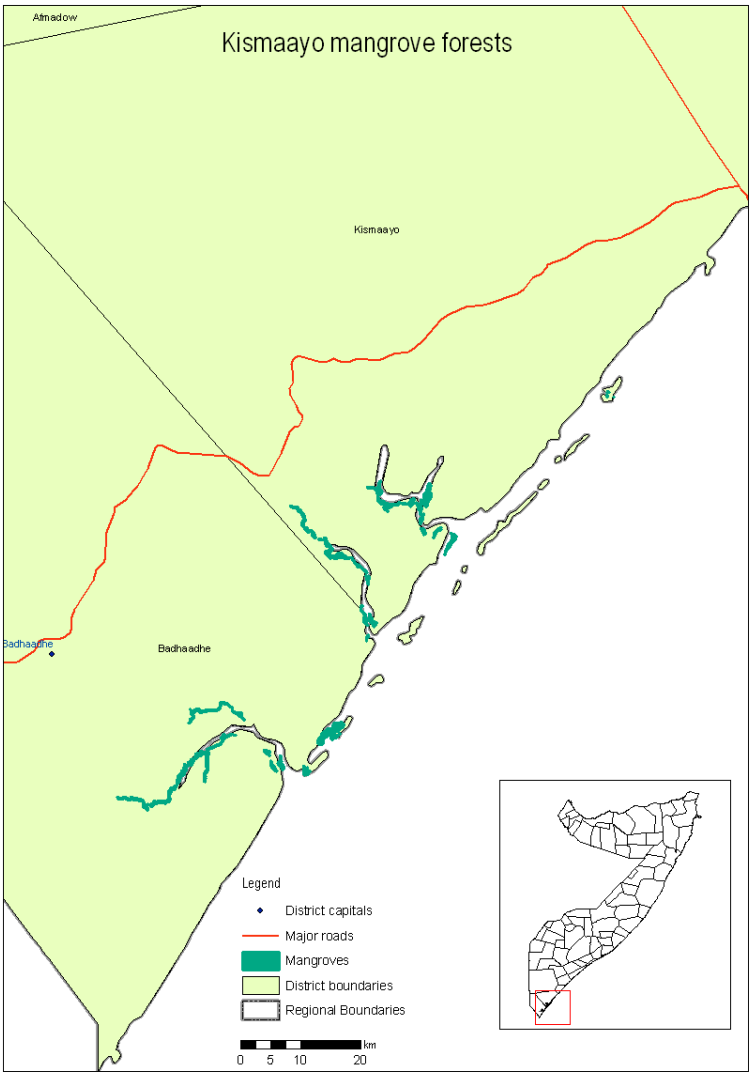


Figure 51: Mangroves of Kismaayo

Figure 52: Mangrove tree nursery in Kismaayo

Figure 52: Mangrove forest in Kismaayo area

6 Discussion and conclusion

Even though Somalia has a coastline of about 3500 kilometers long, mangrove forests are found in specific areas along the coast, in the northern and south western coastal lines. Mapping such a wide ecosystem requires a cost effective method and technology that can be used to gather information in a wide area. Remote sensing tools have been used to map such areas. Availability of high resolution images especially in Google Earth has opened a new window through which geographic information can be extracted and used in studying environmental changes.

Google Earth was used for the verification of presence of mangroves along the Somalia coastline. Compared to other sensors like Landsat or SPOT, Google Earth offers a series of historical free images at a much higher resolution. However, the Google Earth images used in this activity were rather old and there is, therefore, need to update the mangrove maps by more recent high resolution images. It was also not very possible to discern the various land cover types within the mangrove forests as the resolution of the Google Earth images was rather limiting. Higher resolution images like Quick Bird will facilitate clearer observation of the mangroves in Somalia. With such higher resolution images, it will be possible to map the different land cover types within the mangrove ecosystem. This was not possible with the Google Earth images.

The national staff that will be responsible for the mangrove monitoring activity requires more training involving field data collection, data analysis and report writing. This staff also requires some training on map preparation. These areas that require more training were found wanting during the training session that preceded the field survey activity. It is important to make operational the mangrove monitoring initiative within the regional authorities. An operational mangrove monitoring initiative will help check on the environmentally negative activities of the local people on the mangroves. It was evident that the existing local authorities were trying to fight the environmentally unfriendly actions of the local people on the mangrove ecosystems. Some environmental conservation rules have been put in place and whether this is yielding any fruits can only be revealed by an active monitoring system put in place.

When the situation returns to normalcy, it will be necessary to initiate a monitoring activity on the mangroves of Kismaayo in South Somalia. It is also important to extend the monitoring activity on the mangroves of Berbera. Cutting of the mangrove trees for timber and construction poles is a serious problem in all the areas visited during the field survey activity. It is therefore important to check on tree cutting in the mangrove forests.

Training on the environment is also wanting in all those areas visited during the field survey. It would, therefore, be useful to initiate, for example, environmental awareness creation campaigns in these areas. These would help have the local people informed about the environment and how they can help conserve it. However, certain questions are imperative. Why do they cut the mangrove trees? Do they have alternative sources of construction poles and firewood? Do they have alternative dry season grazing grounds for the animals? Apparently, the beneficiaries of the mangrove resources include mainly the dwellers in the overlying settlements. Informed utilization and management of these mangroves will guaranty sustained coexistence between the inhabitants and the trees. Subsequently, the trees will there for a long time.

Finally, this study forms a basis for future mangrove monitoring activity in Somalia. The study has put together simple methodologies that can be replicated over time to establish the trends in the mangrove resource status, utilization and management. Baseline data has been collected from points with known coordinates. Data can therefore be collected from the same points again and again, year after year. The study has also put together a mangrove monitoring strategy that is workable given the prevailing situation in Somalia. However, modifications of this strategy can be put in place as the monitoring activity progresses.

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8 Appendices

Appendix 1: FAO-SWALIM Mangrove monitoring Questionnaire form

Part 1: GENERAL INFORMATION

Questionnaire Number: ……..

Administered by …… Date……..

Location: x …….. y ……

Altitude ……

Village/site ……District …… Region ……

What is the population of this village? ……

What is the approximate family size? ……

PART 2: Livelihood and land degradation

1. When did you settle here? ……

2. What is your major source of livelihood? >…….
   - **a.** Pastoralism……..
   - **b.** Fishing……..
   - **c.** Crop production……
   - **d.** Mangrove cutting……
   - **e.** Other tree cutting……..
   - **f.** Other (specify)……

5. List some of the main environmental degradation problems in this area

Degradation problems	

PART 3: Knowledge and understanding

Can you list the main goods and services provided by the mangroves?

a. ……..
b. ……..
c. …….
d. …….
e. ……..
f. …….

How are mangroves important to human beings?

a. ……..
b. ……..
c. …….
d. …….
e. ……..
f. …….

How are mangroves important to other animals (fish, birds, etc)?

a. ……..
b. ……..
c. …….
d. …….
e. ……..
f. …….

Are mangroves important in other ways?

a. ……..
b. ……..
c. …….
d. …….
e. ……..
f. …….

Have you attended any classes, seminars, meetings or workshops on the environment over the last year, and if so what?

a. ……..
b. ……..
c. …….

Do you think that you now know more about mangroves than before, and if so why?

a. ……..
b. ……..
c. …….
d. …….
e. ……..
f. …….

PART 4: Attitude and perception

Do you think that the mangroves here are in good shape, and if so why? (explain yourself with examples)

a. ……..
b. ……..
c. ……
d. ……
e. ……..
f. ……

Are the mangroves here threatened? And if so, what are the major threats in order of importance?

a. ……..
b. ……..
c. ……
d. ……
e. ……..
f. ……

Is the status of the mangroves improving or declining?

……

Are the threats to the mangroves increasing or decreasing?
……..

Does this community own the mangroves in any way?
……
……
……

PART 4: Mangrove ecosystem resources extraction (Practice and use)

Does anyone extract resources from the mangrove ecosystem? If yes, what do they extract?

a. ……..
b. ……..
c. ……
d. ……
e. ……..
f. ……

Does anyone extract resources from the mangrove ecosystem? If yes, what do they extract?

a. ……..
b. ……..
c. ……
d. ……
e. ……..

f. …….

Is the extraction of products within the mangroves increasing or decreasing?
……..

Who benefits from the products extracted from the mangroves? List the beneficiaries

a. ……..
b. ……..
c. …….
d. …….
e. ……..
f. …….

Is the number of beneficiaries increasing or decreasing?
……

What are the products extracted and their destination?

Products extracted	**Destination**

Appendix 2: FAO-SWALIM MANGROVE VEGETATION SAMPLING DATA FORM

Woody Layer

Transect NO:_____ Area Name:_____Location:_____Observer:_____Date:_____
Time:_____Transect Length_____
Coordinates (Start) N or S:_____ East:_____UTM
(End) N or S:_____ East:_____UTM

Height Class	**Species Name**	**Interceptions**	**Count**	**Total (meters)**	**% Cover**
<1m, 1-7m, 7-14m, >14m					
Herbaceous Cover					
(Only % cover for all)					
<0.3m, 0.3-1m, >1m					

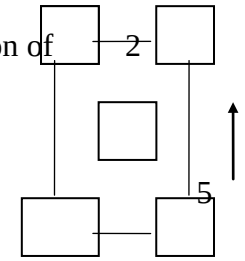
Appendix 3: FAO-SWALIM LAND COVER FIELD VERIFICATION FORM (LCCS)

A. GENRAL INFORMATION

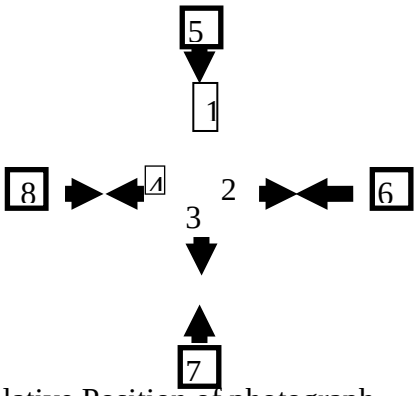
RELEVEE N^0		ACCESSIBILITY	☐	Very Good
AREA NAME			☐	Good
LOCATION			☐	Medium
OBSERVER			☐	Bad
DATE				
TIME				
PLOT SIZE		(in m $^{3 \text{ or}}$ ha)		

COORDINATES	N or S	East

On the spot	Observing the spot from a distance
Indicate relative position of 3 Coordinate N 4	Distance from viewpoint to observed point (m) ☐ ☐ The bearing of the observed point (^{0})



FIELD PHOTOGRAPHS



Relative Position of photograph

GENERAL LANDFORM

Slope
- ☐ Flat to Gently Sloping Terrain (0-7%)
- ☐ Gently Sloping to Moderately Sloping (8-3%)

☐ Sloping to Moderately Steep, Undulating to Rolling terrain (14 - 20%)

B. GENERAL LAND COVER INFORMATION

LAND COVER

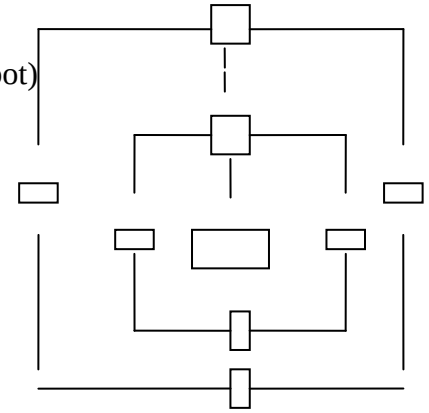
- General land cover Type	A. ☐ Vegetated	☐ Non - Vegetated
Relevee Site	B. ☐ Terrestrial	☐ Aquatic or Regularly Flooded Land (including WADY Areas)

- Specific Land Cover Type	Single major Land Cover Aspect	Two Mixed major land Cover Aspects	
		Most Important	Second
Cultivated	☐	☐	☐
Natural/Semi-Natural	☐	☐	☐
	☐	☐	☐
Bare	☐	☐	☐
Artificial water Body	☐	☐	☐
Inland Water	☐	☐	☐

AREA LANDCOVER HOMOGENITY (Applicable if on spot)
150m

Land cover Homogeneous for more than ☐ m Yes
150m

Around the sample area: ☐ No



LAND COVER SEASONAL ASPECTS

	Natural/Semi-Natural vegetation				Cultivated Mangrove Fields		
	dry	green	flowering	fruits	initial stage ☐	full mat stage	harvested
TREES	☐	☐	☐	☐	☐	☐	☐
SHRUBS	☐	☐	☐	☐		☐	☐
HERBS	☐	☐	☐	☐	☐	☐	☐

C SPECIFIC LAND COVER INFORMATION

NATURAL & SEMI-NATURAL VEGETATION

	Level	Cover	Height	Leaf Type: Broad	Leaf Type: Needle	Leaf Type: Aphyllous	Leaf Phenology: Evergreen	Leaf Phenology: Deciduous
WOODY				☐	☐	☐	☐	☐
Trees	1			☐	☐	☐	☐	☐
	2			☐	☐	☐	☐	☐
	3			☐	☐	☐	☐	☐
Shrubs	1			☐	☐	☐	☐	☐
	2			☐	☐	☐	☐	☐
HERBACEOUS								
Graminoids								
Forbs								

Cover Estimation of vegetation Visual ☐ Instrumental ☐ Other ☐

CULTIVATED TERRESTRIAL AREA AND MANAGED LAND

-Planted Mangroves	Leaf Type: Broad	Leaf Type: Needle	Leaf Phenology: Evergreen	Leaf Phenology: Deciduous	Plantation
☐ Trees	☐	☐	☐	☐	☐
☐ Shrubs	☐	☐	☐	☐	
☐ Herbaceous					
☐ Graminoids					
☐ Other					

. Mangrove Name ☐

- SECOND Planted Mangroves	Leaf Type: Broad	Leaf Type: Needle	Leaf Phenology: Evergreen	Leaf Phenology: Deciduous	Plantation
☐ Trees	☐	☐	☐	☐	☐
☐ Shrubs	☐	☐	☐	☐	
☐ Herbaceous					
☐ Other					

Mangrove Name ☐

-Average Field Size ☐ (m^2 or ha)

BARE AREAS

☐ Consolidated	☐ Bare Rock ☐ Gravel, Stones and Boulders ☐ Hardpans		
☐ Unconsolidated	☐ Bare Soil ☐ Loose and shifting sands	☐ Stony (5 - 40%) ☐ Very Stony (40 - 80%)	
☐ Dunes	☐ Barchans ☐ Parabolic ☐ Longitudinal	☐ Saturated ☐ Unsaturated	

Appendix 4: FAO-SWALIM WOODY VEGETATION SAMPLING DATA FORM (10 m X 10m quadrat) - ***Mangroves***

FAO-SWALIM WOODY VEGETATION SAMPLING DATA FORM (10 m X 10m quardrat) - ***Mangroves***
Quardrat NO:_____ Area Name:_____Location:_____ _____Observer:_____Date:_____
Time:_____ _____
Coordinates (Upper left) N or S:_____ East:_____UTM
(Lower left) N or S:_____ East:_____UTM

Height Class				Species Name	Count	Total count
<1m	1-7m	7-14m	>14m			

Appendix 5: Mangrove Forest Field monitoring Sites - Puntland

Town	ID	X	Y
	M1	473989	1322906
	M2	474256	1323130
	M3	474513	1323002
	M4	474545	1323355
	M5	474780	1323633
	M6	475101	1323580
	M7	475337	1323783
	M8	475208	1323976
	M9	475626	1323773
	M10	475487	1324350
	M11	475797	1324329
	M12	475872	1324650
	M13	476075	1324522
	M14	476396	1324639
	M15	476460	1324875
	M16	476931	1324843
	M17	476921	1324425
	M18	477263	1324179
	M19	477520	1324179
	M20	477423	1324489
	M21	477242	1324736
	M22	477498	1324800
	M23	477605	1324639
	M24	477894	1324671
	M25	478290	1324639
	M26	478558	1324222
	M27	478986	1324158
	M28	449032	1305355
	M29	449257	1306113
	M30	449565	1307179
	M31	449734	1308134
	M32	449930	1309172
	M33	450267	1310548
	M34	450716	1311446
	M35	451081	1312148
	M36	451418	1312709
	M37	451783	1313186

Appendix 6: Somaliland Mangrove Monitoring sites

	Code	X	Y
1	MS1	322611	1259959
2	MS2	322820	1260008
3	MS3	322896	1259771
4	MS4	323069	1259917
5	MS5	327397	1258549
6	MS6	326953	1258736
7	MS7	326050	1258750
8	MS8	325529	1258778
9	MS9	325195	1258368
10	MS10	325223	1258827
11	MS11	323952	1258646
12	MS12	324654	1258354
13	MS13	323251	1259494
14	MS14	323709	1259014
15	MS15	324258	1258493
16	MS16	324918	1258334
17	MS17	324008	1258959
18	MS18	323494	1259278
19	MS19	324195	1258709
20	MS20	324515	1258569
21	MS21	324508	1258834
22	MS22	324793	1258577
23	MS23	325119	1258598
24	MS24	326307	1258743
25	MS25	332216	1262811
26	MS26	331998	1263240
27	MS27	330933	1264596
28	MS28	332468	1255531
29	MS29	332716	1255587
30	MS30	327195	1258744

Appendix 7: the mangroves of Somalia

Characteristics of Mangroves

1. A unique characteristic feature of all mangroves is the muddy bottom. The bottom is muddy due to the absence of wave actions and strong water currents. The muddy bottom is exposed during low tides.

2. The mangroves are always shallow in nature, and rarely show high depth at certain regions.

3. Generally mangroves are developed on coasts where the atmospheric temperature is never below 20°C even during the winter season.

4. A high rainfall is necessary for the development of mangroves.

5. The water of mangrove shows high salinity due to the concentration of salts such as sodium chloride, and magnesium sulphate. Besides, the water shows dissolved ions, manganese and molybdenum.

6. They are water logged or stagnant with high nutrients brought in by the incoming fresh water. The muddy bottom also contains rich organic matter.

- Salt Tolerance mechanisms of Mangrove plants
    - Salt absorption control of root
    - Transportation control of salt to related tissues (Ex. Photosynthesis organ)
    - Excess absorbed salt re-transports to root and excretes
    - Storage and excretion of salt at salt hair
    - Preferential excretion of salt from salt gland
    - Accumulation of excess salt in vacuole
    - Biosynthesis stimulation of osmo-regulation substances.

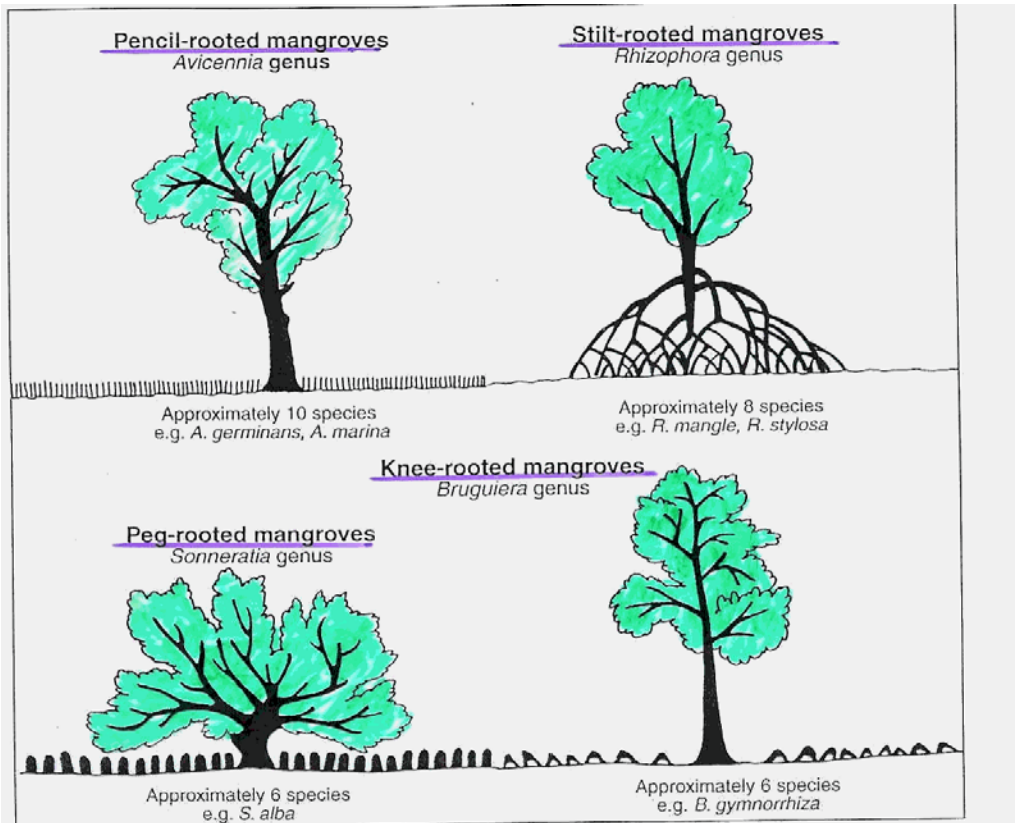


Figure 4.5.3: Mangrove tree structure

The mangrove tree structure varies with species. For example, the *Avicennia marin, Rhizophora mangle, Sonneratia spp., and* Bruguiera spp., have rooting structure as shown in figure 4.5.3. The rooting system also varies with species as shown in figure 4.5.4.

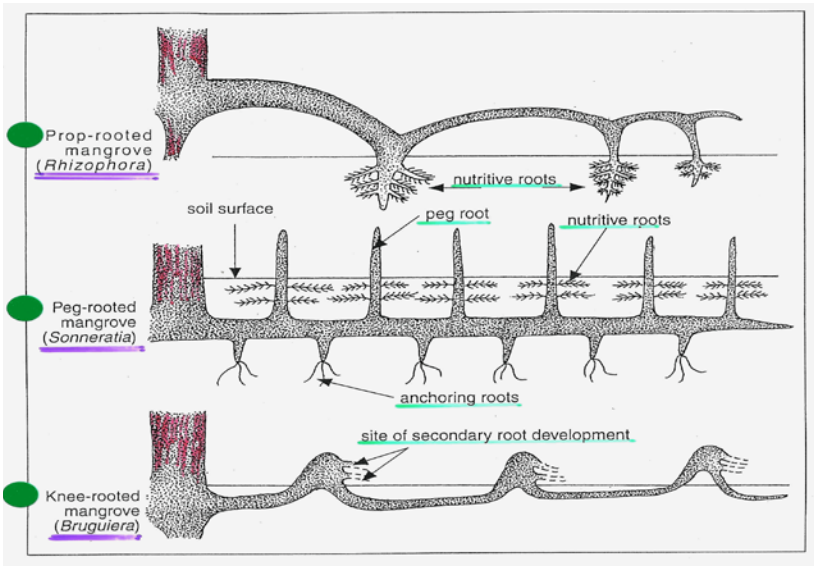


Figure 4.5.4: Mangrove root systems

Uses of Mangroves

- Mangroves are used for various purposes
    - Fire Wood, Timber, Charcoal, Fodder, Paper and Pulp
    - Tannin extraction and other by products

- Mangroves swamps are rich in larvae of economically important fishes, prawns, crabs and bivalves
- Mangroves are suitable areas for feeding, breeding and nursery grounds of many aquatic organism and hence importance for aqua culture.

The plantation, propagation and protection of the mangroves help to minimize the effect of a tsunami.

Where do Mangroves grow?

- Inter tidal regions along the estuaries, back waters, islands, and other protected areas
- The prefer soft clay mud for their growth (Slide on mud)
- Show different salinity tolerant limits (diagram on salinity)
- The inundation of the mangrove region during floods or tides is also one of the important factors

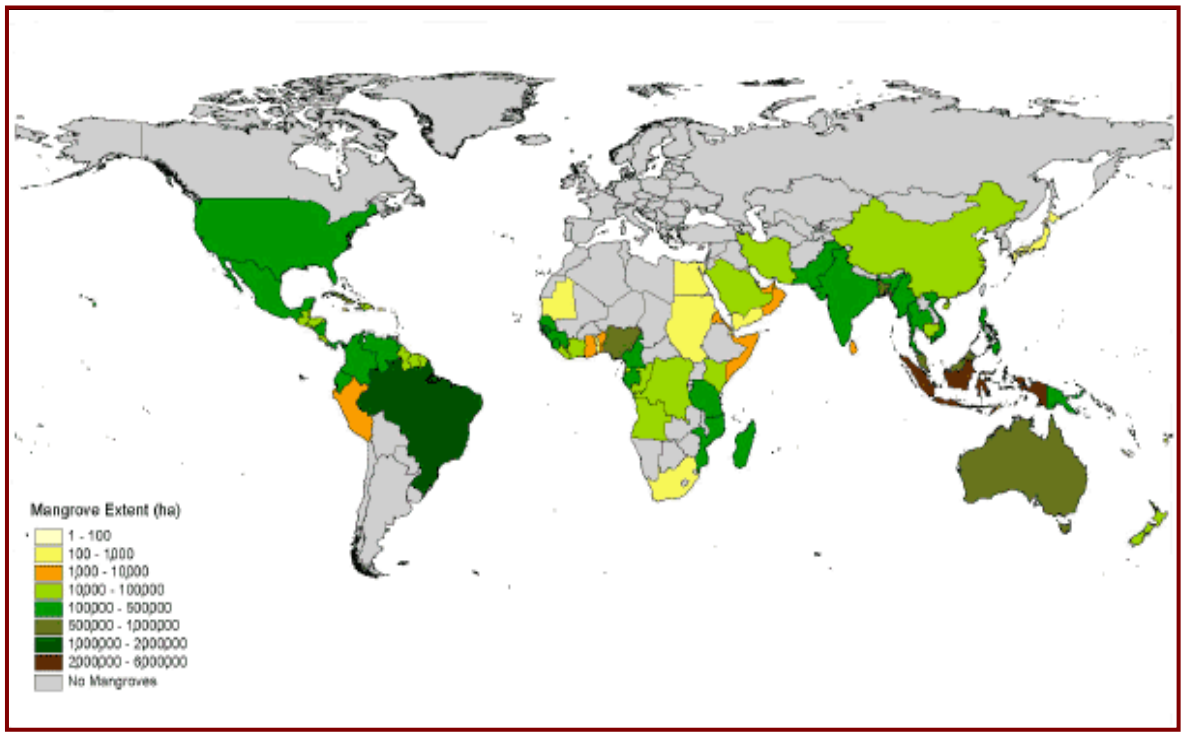


Figure 4.5.5: World wide distribution of mangroves
The Figure 4.5.5 shows the world wide distribution of mangroves

East African Mangroves

- The East African mangroves are an eco-region consisting of mangrove swamps along the Indian Ocean coast of East Africa in southern Mozambique, Tanzania, Kenya and southern Somalia

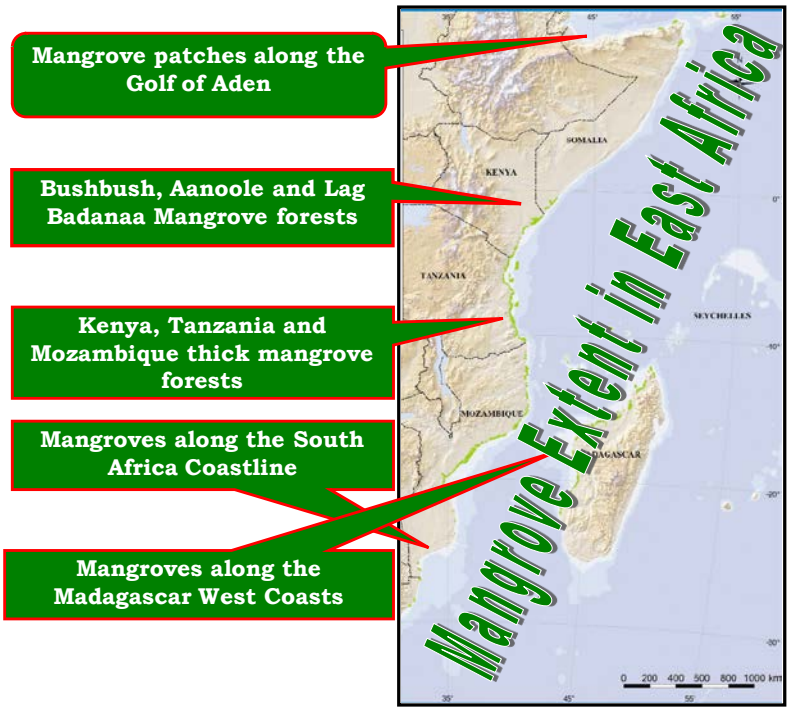


Figure 4.5.6: Distribution of mangroves in Eastern Africa

The mangroves of Somalia

Somalia mangroves belong to the East African coast.

- In Somalia mangroves are found in several main tidal estuaries along the Gulf of Aden and leading into the Indian Ocean (Figure 4.5.6): Those locations include:
- The area near the Saada Din Island around Zeyla',
- Saba Wanak on the Golf of Aden,
- Along this 50 km stretch of coast line about 30 watercourses come close to or enter the sea adding fresh water
- Also the extensive lagoon at Khoor Shoora located to the east of Berbera is another *mangrove location.*
- The mangrove spots continue to east of Karin, and from Mait to Ras Kalwein,
- and few more patches from Bosaso to Qandala, Alula and Hurdiyo to Ras Hafuun.
- In the far south, close to the Kenyan border, the mangroves occur on the coast, along the chain of dozen offshore islands along Somalia.

The three major estuaries on the mainland includ Bushbush, Aanole and Lag-Badanaa ranging from 30 to 45Km inland

Species of Mangroves in Somalia

- Mangrove in Somalia/ Somaliland
    - Species found in Somalia/Somaliland are mainly:

Avicennia marina, Rhizophora mucronata, Ceriops somalensis, Bruguiera gymnorrhiza, Sonneratia alba and *Xylocarpus obovatus* (Figures 4.5.7 to 4.5.15).

Avicennia Marina

- Avicennia marina is known commonly as the “Grey Mangrove”
- Grey mangroves grow as a shrub or tree to a height of three to ten meters, or up to 14 meters in tropical regions.
- It is a very interesting plant, and has very little competition from other species, that is why it grows so well if left alone.

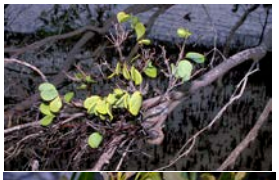
Figure 4.5.7: *Avicennia marina* mangrove tree species

- A few mangroves can tolerate high levels of salt in their tissues. They then secrete the excess salt through special cells on their leaves.
- *Avicennia* has superior tolerance for high levels of salt in their tissues than all other mangroves.
- *Avicennia* is often the only tree to survive well in hot salty regions like Somalia.

- Illustration of Avicennia marina (grey mangrove) fruit

- Vegetative plant showing succulent, round leaves parasitic on *Avicennia marina*. Queensland, Australia..

Floating Avicennia seedlings



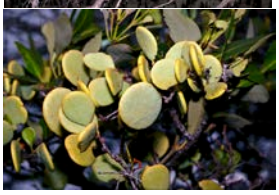


Figure 4.5.8: *Avicennia marina* mangrove tree species with fruits

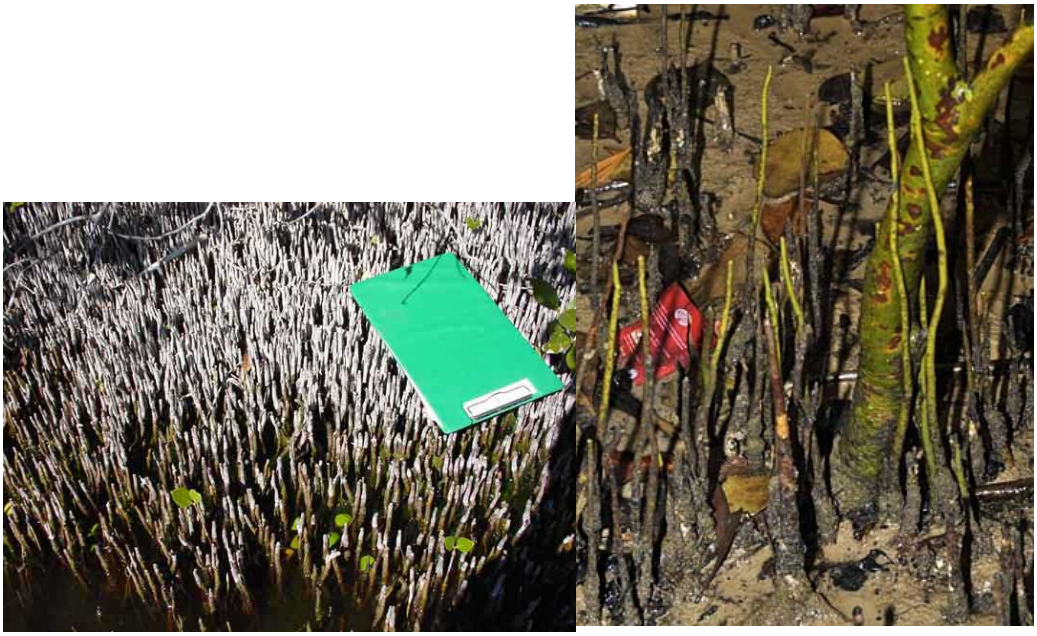


Figure 4.5.9: Breathing roots (pneumatophores) of Avecicennia marina obtain oxygen directly from the air

Figure 4.5.10*:Rhizophora mucronata*

Rhizophora-mucronata

- **Rhizophora mucronata leaves** & fruits

Bruguiera gymnorrhiza

Propagule of *Bruguiera gymnorrhiza* with red calyx and long green hypcotyl.

Figure 4.5.11: *Rhizophora mucronata* fruits for germination

Rhizophora stylosa

- The prop roots of *Rhizophora stylosa* enable these mangroves to grow low in the intertide zone where the roots become inundated during high tides. (photo Jon Knight, UQ)

Rhizophora stylosa

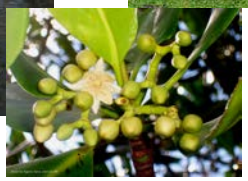


Figure 4.5.12: *Rhizophora stylosa* fruits and roots

Xylocarpus obovatus

Ceriops tagal

- *Ceriops tagal* occurs as a distinct zone, just landward of the *Rhizophora mucronata* zone. The trees in this zone exibit a certain degree of dwarf-growth, since their heights are usually not exceeding 4 meters.

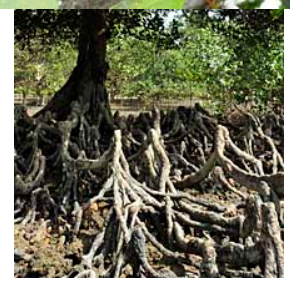


Figure 4.5.13: *Xylocarpus obovatus* and *Ceriops tagal*

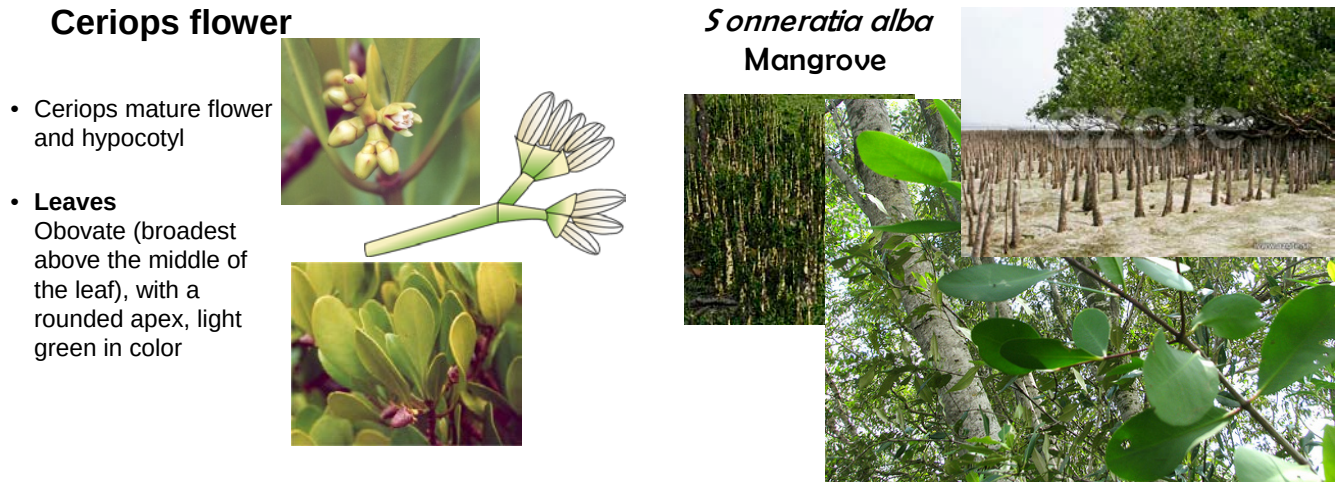


Figure 4.5.14: *Ceriops tagal* and Sonneratia alba

Figure 4.5.15: *Sonneratia alba* fruits and flowers

Status of the Somalia mangroves

General

- Since 1991, Somalia has been subjected to extreme environmental degradation, natural and man-made associated with the current war and lawlessness.
- Consequently, the mangroves of Somalia now remain degraded and so urgent solutions have to be sought.
- The main environmental concerns in the Horn of Africa Region especially Somalia are many:
    - The loss of biodiversity,

- habitat degradation,
- The modification of mangroves and,
- Coral reef ecosystems along the coastline,
- Hazardous waste damping,
- Deforestation and overgrazing ….

- The loss of biodiversity and the degradation of mangrove habitats in Somalia remain apparent with possible environmental consequences on the coastal and marine environment :
    - causing rising sea level
    - high sea temperatures
    - leading to coral bleaching
    - combined with the,
        - Climate change and
        - direct human pressures
        - increasing coastal populations,
        - Increased pollution

Another key concern regarding the mangroves of Somalia is

- the lack of public and government awareness on hot issues on use of the shores
- and the dumping of hazardous wastes from some industrial countries along the Somali coastal waters

Importance of mangroves to reefs

- Thousands of people depend on reefs for food and livelihood along the Somalia coastline
- Reefs also create sheltered lagoons and protect coastlines and mangroves against wave damage.
- Mangroves in turn protect reefs from sedimentation and eutrophication

Factors that influence mangroves

Many factors influence the development of mangroves, namely, human activities, coupled with natural processes, Sea level rise, Coastal processes and Hydrological process

Monitoring of mangroves

Mangroves can be monitored using the following parameters:
Area – this will take into account of the area covered by the mangrove vegetation
Density – density as a parameter shall consider the number of trees per unit area
Zonation – zonation will take into account the area occupied by each species population. The zonation is dependant on special features related to the different mangrove species. For example, different mangrove species have different salt tolerance levels within the ecosystem. As such, the mangrove species populations will also be distributed according to the different salt concentration regimes.

Types – the mangroves can me monitored by the different species represented in the ecosystem.
Growth – growth here pertains to the structure of the trees in the ecosystem. Favourable conditions will result in healthy plants with rapid growth, for example, while unfavourable conditions will result in stressed growth (or even death) of the trees.
Changes in biodiversity, flora and fauna – the mangrove ecosystem includes fauna like shrimps and oysters. Mangrove ecosystem also offers favourable breeding grounds to fishes. Pollution of the mangrove environment, for example, will result in subsequent changes in the biodiversity, including the mangrove population.

Hazards affecting Mangroves

Hazards affecting Mangroves include Seasonal surges, permanent inundations, coastal erosion & sedimentation and human activities.

Tools and data sets for monitoring mangroves

The following are important tools and data sets to consider when monitoring the mangrove ecosystem:

- Aerial photography (useful as mapping tools)
- Multi-temporal Satellite Images (useful as mapping tools)
- Land Use Systems, Topographic Maps (useful datasets)