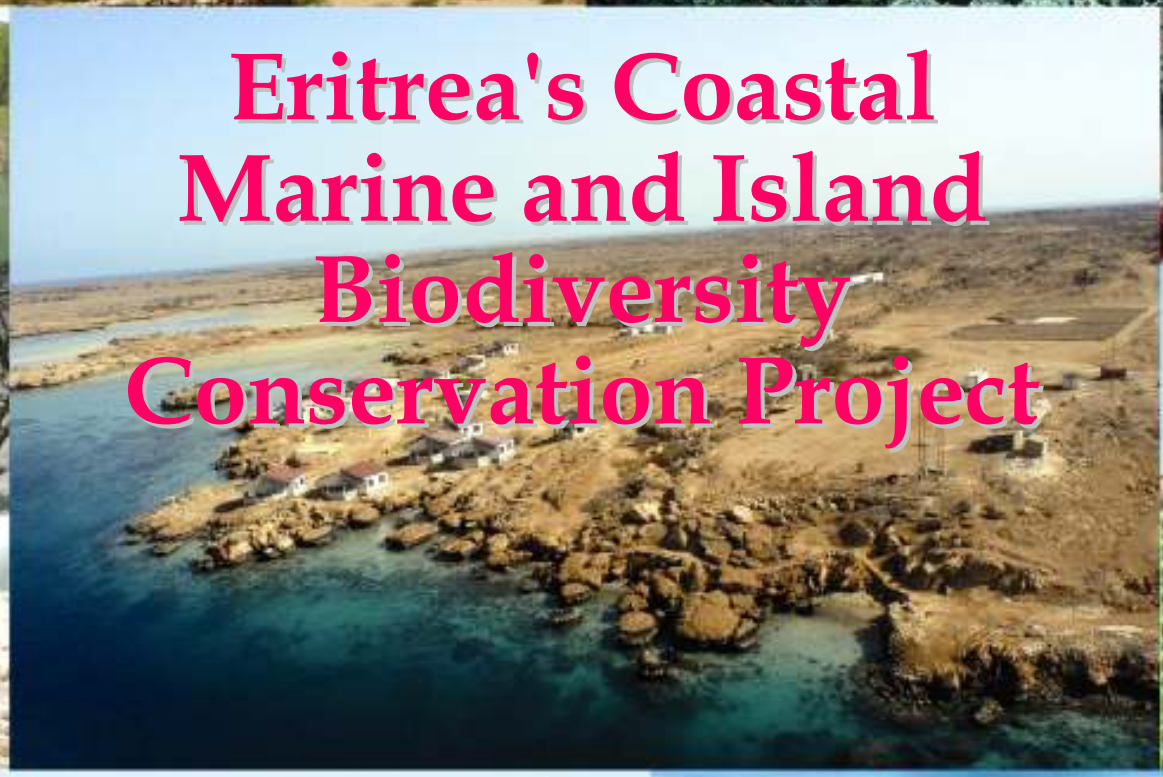
Eritrea's Coastal Marine and Island Biodiversity Conservation Project



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For more information, you can also consult our website under construction (May 2007) www.eritrearedsea.org

FOREWORD

With a mainland and islands coastline of more than 3,300 km, Eritrea has a major asset and part of its future is along this coastline, as numerous activities are linked to the sea, including fisheries, tourism and transport.

Since mid 2005, numerous meetings and national expert knowledge have allowed the preparation of the present document, the "State of the Coast of Eritrea", of the Coastal Policy, of the "Integrated Coastal Area Management" Guidance for Implementation. At the same time, the supporting legislation is under preparation with the Coastal Proclamation and the Coastal Authority Proclamation.

The Eritrea's proposed Coastal Policy is a framework meant to serve as base for laws, rules, regulations, guides and institutional structures for sustainable management of the coastal area natural and human-made assets. It was prepared by the participation of practically all concerned ministries and organisations, inter alia, has four main objectives: sustainable use of the coastal area for multiple purposes, location of coastal facilities and development projects in consideration of the coastal process, protection of public foreshores or establishing appropriate setbacks (public property areas) and protection of natural and cultural values of the area. Any Policy is based on principles; in our case the guiding principle, as clearly stated in the Constitution is- we shall meet our needs without comprising the ability of future generations to meet their needs or we shall develop without destroying the chances of future generations to develop.

In 1995, the Government of Eritrea adopted integrated opposed to sectoral development approach. The preparation of the Integrated Coastal Area Management Plan is trying to apply the overall Government development approach to the coastal area as defined above. ICAM is a mechanism that avoids and mitigates environmental damage through coordinated planning and implementation of activities and minimizes unknown risks using the precautionary principle. It can also be understood as a tool that enables conservation of ecosystems by managing development activities. In addition to ecosystem conservation benefits ICAM enhance the value of the coastal assets. ICAM will enable us to define location of facilities and development activities in line with national needs and sustainability opposed to investor preferences only in the coastal area; and to resolve and mitigates conflict of interest over the assets.

Implementing specific activities is the responsibility of relevant line ministry, organisation, region, community, civil society, etc., but there will be a lead ICAM coordinating Authority. After all, as the name indicates, ICAM is coordination and integration of plans and activities of different sectors for sustainable management of the coastal area assets.

Mainly because of the independence struggle, the coastal area, particularly the marine domain, is considered relatively pristine, and we need to appropriately address developmental issues in the coastal area to benefit from and safeguard its integrity.

The Minister of Fisheries, H.E. Mohamed Haj Ali

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- Ministry of Fisheries
- Ministry of Agriculture
- Ministry of Land, Water and Environment
- Ministry of Justice
- Ministry of Education
- Ministry of Transport and Communication
- Ministry of Tourism
- Ministry of Defence

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The Project Technical Committee (PTC) was the core team responsible for the preparation of this document and responsible for review and editing.

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The final editing has been realised by Dr. Alain Jeudy de Grissac, ECMIB Technical Adviser and by Kaleab Negussie, ECMIB National Project Manager.

For each section of this report, you will find the names of the main contributors.

Acronyms

CBD	Convention on Biological Diversity
CCD	Convention to Combat Desertification
CITES	Convention on International Trade of Endangered Species
CMS	Conservation of Migratory Species
DAP	Di-Ammonium Phosphate
DOE	Department of Environment
ECMIB	Eritrea Coastal marine Island Biodiversity
EDF	Eritrean Defense Force
FAO	Food and Agriculture Organization (UN Agency)
FCCC	Frame Work Convention on Climate Change
FRP	Fiber Reinforced Plastic
GEF	Global environment facility
ICAM	Integrated coastal Area Management
IFREMER	Institut Français de la Mer
IMO	International Maritime Organization
IOSEA	Indian Ocean and South East Asia (MoU)
MoA	Ministry of Agriculture (MoA)
MoD	Ministry of Defence
MoF	Ministry of Finance
MoFish	Ministry of Fisheries
MoLG	Ministry of Local Government
MoND	Ministry of National Development
MoPW	Ministry of Public Works
MoTC	Ministry of Transport and Communications
MoU	Memorandum of Understanding
MPA	Marine Protected Areas
MSY	Maximum Sustainable Yield
NEAPG	National Environmental Assessment Procedures and Guidelines
NEPFP	National Economic Framework and Program
NFC	National Fishing Corporation
NN	No Name (used for islands without official or local name)
NSO	National Statistic Office
NRSR	Northern Red Sea Region (Zoba)
PIC	Prior Informed Consent (Rotterdam Convention)

PCC	Project Coordination Committee
POP	Persistent Organic Pollutant (Stockholm Convention)
PTC	Project Technical Committee
SRSR	Southern Red Sea Region (Zoba)
TED	Turtle Exclusion Device
TPR	Tri Partite Review
UNDP	United Nations Development Program
UNEP	United Nations Environment Program

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Introduction

Eritrea gained its independence in 1993 after 30 years of armed struggle with Ethiopia. Due to this situation, little or no developmental activities were carried out in the coastal area. As the result, the country owns relatively pristine coastal environment.

Recent developmental activities in general infrastructure, tourism, fishing, petroleum or gas exploration, maritime transport, etc., are threatening the integrity of the coastal ecosystems. But still Eritrea has the advantage of its relatively pristine coastal environment to capitalize on and develop the coastal assets sustainably through Integrated Coastal Area Management (ICAM).

Integrated coastal zone management is an on-going process involving not only planning, but implementation, monitoring and making adjustment based on monitoring results and new information or opportunities. For these reasons ICAM is a priority on the National Development Agenda of the Government of Eritrea. Its implementation requires considerable effort, including assessment of the state of the coast based on existing national policies, rules and regulations, and studies; training of managers, scientists and operatives, and identification of information gaps, specific natural resources and socio-economic surveys.

The preparatory phase also requires the involvement of all stakeholders at the national, regional and community levels to create awareness and induce behavioral change in addition to the advantages of sound preparation and smooth implementation of the plan. This phase should also include the definition and establishment of the institutional mechanisms to sustain the ICAM program and the selection of tools and methodologies that will be used during the process.

This first version of the "State of the Coast" is meant to serve as one of the building blocks for the preparation of the Integrated Coastal Area Management Plan and associated guidelines by sectors.

1. Eritrean Marine and Coastal Environment Overview

1.1. Geography and Geomorphology

Eritrea is located in between the latitudes 12°45'N and 18°03'N, and the longitudes, 37 35'E and 43 07'E. It possesses a mainland coastline of more than 1350 km along the south-western coast of the Red Sea. The Eritrean coastline stretches from its northern border with Sudan at Ras Kesar to its southern border with Djibouti at Ras Dumera. In addition, the Red Sea of Eritrea contains more than 350 islands that form a shoreline of more than 1,950 km. The area of the Eritrean landmass is estimated about 124,000 km^2 and its territorial waters cover an area of about 55,000 km^2.

The continental shelf (down to a depth of about 200m) extends from the coast to a maximum distance of 120 km east of Massawa, narrowing to about 20 km in the north and south of the country. It includes flat coralline islands such as Dahlak Kebir and Nora, some fewer islands of continental origin such as Hawakil and Dissei, and the volcanic island of Senaboor.

Eritrea in numbers

Country coastline: 3300 km
Mainland coastline: 1350 km
Islands coastline: 1950 km
Islands and islets: 354
Country area: 124,000 km^2
Territorial waters area: 55,000 km^2
Exclusive Economic Zone (EEZ): 120,000 km^2
Watersheds linked with the coast: 44,000 km^2

Source ECMIB GIS Unit 2007

1.2. Climate

As a result of its morphology, lying between sea level and 2300m, Eritrea has distinct geographic features within short distance and experiences a wide range of climatic conditions. Nevertheless, semi-arid to desert climate dominates the environment with average to low rainfall at national level which is the main cause for the absence of perennial rivers with the exception of the Setit river in the western highlands.

The climatic regimes of Eritrea follow the geography. The low eastern zone is the hottest with little rainfall, average 200mm, and temperature between 30^oC and 39^oC, occasionally higher during the hot season (June to September) and 25^oC to 32^oC during the cooler season (October to May). The

coastal area is also occasionally subject to dust storms and strong wind during the summer. There is no permanent river that drains the Red Sea coast of Eritrea, only a number of dry river beds ("wadis") experience occasional flash flooding and reach the coast.

In the highland zone average temperature is about 18^{o}C (Asmara 17^{o}C). May is the hottest month when temperature reaches as high as 30^{o}C and December to February the coldest months and temperatures reach freezing point during night. Average rainfall is 540mmm.

The western zone reflects the temperature of the low eastern coastal area during hot season and rainfall of the highland. April to June is the hottest period with temperature range of 30^{o}C to 41^{o}C; and December is the coolest month with temperature of 13^{o}C to 25^{o}C.

1.3. Geology

Geologically, Eritrea can be split into two different regions. The central and northern highlands consist of complex basement formed during the Precambrian era (more than 570 million years before present), which contain some of the oldest formations (Archean) found in Africa. Similarly, a basaltic flow in the Tertiary era (Cenozoic era: 65 million years before present) formed typical flat-topped mountains in the western highlands. In Western lowland areas, the complex basement was later covered by young quaternary sediments that appear as rocky outcrops. The basement complex contains deposits of metallic minerals (iron, copper, gold, asbestos, magnesium, barite and sulfur).

The second geological region is the Red Sea coast and its associated islands that have evolved from the tertiary and quaternary sediments but in some areas, such as the Zula bay and the Bada area, these sediments are overlaid with basaltic lava flows from recent volcanic activity. These volcanic formations are associated with the rift system (Red Sea and Afar Rift) that cuts from North to South and is marked by numerous fault lines. Hot springs with thermo-mineral waters and sulfur can be found in this area, which is typical for regions with young and active volcanism. Geological formations also reveal that oil and gas traces, evaporites and other non-metallic minerals, are associated with sedimentary formations (Mesozoic and Cenozoic).

Most of the Dahlak archipelago islands are results of quaternary sediments, and in particular uplifts of fossils coral reef formations. However, Dissei Island near the Buri peninsula is an extension of the Precambrian basement of the mainland, mainly composed of granitoids. Towards south there also exist some islands which are of volcanic origin in particular the islands fronting Assab.

1.4. Ecology

The Eritrean marine and coastal environment is characterized by an array of diversified ecosystems: coral reefs, mangroves, sea grass beds, sandy and muddy flats, all important for fisheries activities and offering a significant tourism potential. The intertidal and near-shore zones support a diverse range of marine and terrestrial species and are key areas of ecological and economic importance.

Unlike most oceans of the world the Eritrean Red Sea is characterized by a lesser upwelling phenomenon and lack of permanent streams that flow into the sea. Consequently, the waters are nutrient limited with a low primary productivity. As a projection of the Indian Ocean, water exchange due to the monsoon winds is more pronounced in southern part than in the northern. This phenomenon results in a better nutrient availability, higher primary productivity and species abundance in the south. Furthermore, some species drifted from the Indian Ocean are localized only to the south. Nonetheless, due to the relatively cooler water temperature and higher sedimentation in the south, coral reefs are poorly developed and the associated communities are less diversified.

The Eritrean coastal area is best known as a highly favorable ecosystem for the development of fisheries. Essential reef areas, extensive surface and numerous shelters of the Dahlak archipelago plateau and aggregates of islands contribute to the prospect of a prosperous fishery. Despite the few researches conducted more than 600 species of fish have been recorded in the Eritrean Red Sea.

Compilation of scientific surveys identified 154 species belonging to 38 genera of stony corals (Scleractinians). Eritrea's coastal waters have favorable climatic condition for reef growth with warm waters and low rainfall. Coral reefs formation along the islands coastlines are in good conditions whereas reefs along the mainland coastline are less developed mainly due to sedimentation from the rivers runoff.

Mangrove forests in Eritrea are present along about 380 km of coastline and cover an area of about 70 km². Their distribution is highly patchy all along the mainland and on the islands. In addition, most of the mangrove forests are found mostly in areas where some seasonal freshwater runoff occurs; and also in low lying, poorly draining areas behind dune ridges which are flooded infrequently (e.g. Lake Mandalum, near Mersa Deresa and Mersa Mubarek in the north). Towards south, dense mangrove forests are found near Assab Bay and in patches around Tio. Some offshore islands such Museri, Norah, Harena, and Dergamman Kebir also retain dense mangrove stands.

Along with the coral and mangrove ecosystems, sea grasses also form an integral part of the coastal biodiversity. More than 12 species have been identified so far. In addition to fishes and invertebrates, sea grass communities also support sea turtles and the globally endangered dugongs. Significant sea grass beds are found around Barasole, the western side of Mantola island in the south, Hawakil, Debel Ali, Dergamman Kebir, Baka, Delesen, north side of Harena, west of Adjuz, Norah, Baradu and Dehil islands.

1.5. Socio-Economic Information

Eritrea in numbers
Total Population
Coastal population: 95,000 (2004)
Watershed population
Coastal cities: Massawa and Assab
Coastal villages 62
Source ECMIB Socio Economic Unit 2007

The coastal areas are sparsely populated with approximately 5% of the national population, the majority residing in the two main coastal cities of Massawa and Asseb. Five ethnic groups, Afar, Saho, Tigre, Rashaida, and Tigrigna dominate the rural population (see section on coastal people). Shortage of fresh water is a characteristic feature of the Eritrean coastline and islands. Individually owned or commercially operated wells are the primary sources of fresh water supply. Due to the meager annual precipitation and extremely harsh weather conditions, the principal agricultural activity remains small number ruminant livestock-herding. The majority of the coastal communities' livelihoods depend on fisheries activities coupled with trade in fishery products and other goods with the neighboring Saudi Arabia and Yemen. Basic infrastructures such as schools, clinics and transportation facilities are progressively improving.

Although at its nascent stage of development, Eritrea's coastal area has the potential for a range of tourism activities. Healthy coastal marine habitats with variety of species, safe, secure and enjoyable environment in addition to of hospitable population are the distinct features of the coastal area and a strong basis for developing sustainable tourism industry. Unpolluted sandy beaches, colorful underwater life, aggregated islands of the Dahlak archipelago, and its historic Nakura Channel and ship wrecks are few of the additional products waiting to be harnessed.

Current tourism products, though at miniscule level given the potential, include recreational excursions, cruising, swimming, snorkeling, diving and recreational fishing. Likewise the terrestrial biodiversity, historical sites such as Adulis-Zula, the Bada-Crater-Lake, volcanoes, thermal vents and coastal villages are among the main coastal inland spots of tourism.

1.6. The Sea (Definition and Bathymetry)

The marine environment of Eritrea extends from the mean low water level, derived from the mean of lower tide in reference to the last 11 to 12 years readings. Human activities start from the highest water level, but its position is expected to change over the years (sea level rise, exceptional natural events).

Countries are usually setting a distance from the highest water level for coastal protection, infrastructure, military or customs activities. This zone is named the setback. In Eritrea, following technical meetings for the preparation of the Coastal Policy, a horizontal distance of 100m from a datum (geological or biological) is the accepted but not yet formally adopted standard.

According to the International Law of the Sea, Eritrea's territorial waters extend to 12 nautical miles (about 22 km) from the mean low water line of the coastline of the mainland and of the islands. The total area of the Eritrean territorial waters is therefore estimated to be 55,000 km².

The maximum extension of the Exclusive Economic Zone (EEZ) is 200 nautical miles but is reduced to the median line between two countries' territorial waters. The area of the EEZ (including the territorial waters) is estimated to be 120,000 km².

1.7. Coastal Erosion, Climate Change, Sea Level Rise and Setback Datum

Natural coast is subject to changes due to sedimentation or erosion. The nature of the coast, rocky or sandy, is important in planning and implementing development activities. Rocky coast is stable but sandy coasts changes with the movements of the sea and the input of sediment, reduced in Eritrea due to the lack of permanent rivers.

Low lying and sandy areas are at risk from erosion, in particular from eventual sea level rise, specific events such as equinox tides, low barometric pressure, strong wind and waves during storms or in relation with climatic changes over a longer period of time. For the impact of climate change, scientific forecasts indicate a rise of about 50 cm in the coming century with the possibility of being higher in specific areas. The impact of such sea level rise will be different on different coastal areas subject to the nature of the coast, rocky or sandy and elevation level.

A coastal setback is a horizontal distance along the coastline (mainland and islands) defined on the basis of coastal morphology, exposure, stability of the coastline, nature of coastal resources, nature of the activity and other relevant criteria. In Eritrea, the setback distance meant to protect development investments such as roads, industries or tourism facilities by absorbing the impact of severe storms, by allowing the shoreline movement, the global sea level rise and the fluctuation of natural coastal processes.

The proposed 100m setback will be applied from a defined line known as the horizontal setback datum (HSD). The HSD is determined with regard to physical or biological features of the different coastal types such as sandy, rocky, mangrove, wetland, exposed to storm or with acute erosion process.

2. Coastal People

2.1. Coastal settlement

In spite of its economic and historical importance, because of the arid climates, lack of fresh water resources and inhospitable environmental conditions, the coastal area population is very small (Hillman & Tsegay, 1997). Only 5% of the national population resides in the coastal area of the Northern and Southern Red Sea Zobas.

Due to shortage of water, only 10 of the offshore islands support human population: Abbaguba, Adjuz, Harena, Baka, Dilemmi, Dissie, Hawakil, Dehil, Dahlak Kebir and Norah, the last three being part of the Dahlak archipelago. Historical evidence suggests that more islands were inhabited in the past and many more used at least as temporary locations from which marine resource harvesting was conducted.

According to the 2001 population estimate, the Eritrean coastline has a population of about 70,000. As per the 2004 demographic data, the estimation was 95,000 for the coastal population of which 42.1% (40,000 people) live in Massawa, 22.9% (21,800 people) resides in Assab and the rest (35%) lives scattered in other villages (70), the biggest being Tio and Ghel'alo (ECMIB survey, 2005).

There are five main ethnic groups in the coastal area: Afar, Saho, Tigre, Rashaida and Tigrigna.
Afar is the largest tribe on the coast and lives mainly from Ghel'alo to Rahita and the Dahlak islands. Saho is found dominantly in the south-east of the Northern Red Sea Region in villages such as Foro, Erafaile and in the Debub Region. Tigre is found mainly concentrated in Zula, Afta and Hirgigo and in the coastal area north of Massawa up to the border with Sudan. The Rashaida is highly mobile and found scattered in different past of the coast.

To support their livelihoods most coastal population depend on artisanal fishing and livestock production. These communities are usually involved in a variety of fishing practices such as shell fish collection, commercial fishing and the recently growing sea cucumber collection. Moreover, in some places, crop production with irrigation also complements the livestock rearing activities. Furthermore, trade activities, tourism opportunities and port and industrial developmental activities also create significant employment opportunities in the cities of Massawa and Assab. Nevertheless, due to the border conflict with Ethiopia, the majority of these activities slowed in Assab.

Unlike those in the north, southern dwellers are the most actively engaged in fishing and are considered fisheries dependent communities. Half of the total fishing communities (representing about 30,000 people) are estimated to be engaged in fishing and processing dried marine products (snail nail, shark fin, dried mullets, sea cucumbers) for export. For them fishing is an inherited economic tradition that closely attaches them to the sea. Fishermen use traditional boats known as Houri, Sambuk or Canoes and very primitive fishing gear such as hand line and gill nets. Moreover, fishing is a

stereotypic occupation reserved only for men. By the culture of all tribes, women are not allowed to engage in fishing except to collect nails and shells in collection areas adjacent to their residences.

2.2. Fresh Water Resources

Diverse climatologic, topographic, and geologic features characterize the hydrology and the hydrogeology of the eastern escarpment and the coastal plains.

Climatologic factors such as temperature, rainfall, and humidity directly affect the rate at which water enters and leaves the river systems that flow to the coast and to the groundwater basins and aquifers located along the coast. The average rainfall is very low along the coast, from 100 to 200 mm every year. This is far below the limit of 600-700 mm which is usually considered to be necessary to cause a substantial recharge of groundwater in this hot climate. Therefore, fresh groundwater is found only underneath the larger ephemeral rivers crossing the coastal plain, also known as wadis.

There is no comprehensive study on the groundwater and surface water resources and the development potential for the coastal plains of Eritrea. Only localized hydro-geological and geophysical characterization of aquifers, which are commonly done for the purpose of identifying groundwater sources for community water supply projects are available and their coverage is very limited to describe the coastal groundwater sources.

In relation with water, the coast can be divided in four domains:
- The main cities of Massawa and Assab
- The coastal zone North of Buri Peninsula
- The coastal zone South of Buri Peninsula
- The islands

2.2.1. The main cities of Massawa and Assab

The two port cities, Massawa and Assab get their water supply from boreholes and dug wells located within the wadi channel aquifers of east flowing wadis. Massawa has additional water supply from the desalination plant attached to the Hirgigo power plant with a capacity of 1000m³ per day. This facility is now under the responsibility of the Massawa Free Trade Zone.

2.2.2. The coastal zone north of the Buri Peninsula

The coastal plain north of the Buri Peninsula is crossed by six major streams (of which Felket, Moga'e, Laba, Desset and Haddas) which originate from the plateau of the central and northern highlands and/or the eastern escarpments.

These wadis carry much runoff during the summer season from July to September and the Eastern Slope Agricultural Development Potential Study conducted in 1996 has estimated that a total of 730 million cubic meters of flow reaches annually the Red Sea in this area.

The spate flows of most of the wadis north of Massawa are utilized for agriculture through diversion practices during the flood season. This type of irrigation is commonly known as "spate irrigation". Irrigation water from these wadis spate flows are usually diverted using traditional diversion embankments, known as 'Agums' constructed across the wadis using materials from the wadi bed including bush and stones. The diverted flow are conveyed and distributed by large channels and basins.

2.2.3. The coastal zone from south of the Buri Peninsula

The major river (Ramod-Regalle) drains into the Danakil depression. The coastal plain is fed by small wadis that originate from the top of the ridges separating this area from the Danakil depression. These small wadis are with insignificant surface flows and have negligible impact on the groundwater of the coast. They are active during the winter season, from November to March.

These types of wadis are not favorable to build up fresh groundwater by infiltration of water through the coarse-grained wadi bottom. Recent assessments have revealed that all coastal fishing villages between Tio and Marsa Fatma are getting potable water by trucking water from about 45-97 km distance.

2.2.4. Fresh Water Resources in the islands

The inhabited Eritrean islands are suffering from critical shortages of potable water. Usually, residents excavate big holes or build cistern like on Dahlak El Kebir to capture the little run-off generated from the limited precipitation in the area and these are usually not sufficient to meet demands. On the long term, the only option for islands is to consider small scale desalination facilities (as already installed in Dahlak El Kebir) and to supply by truck potable water to these communities. On islands, any tourism development will have to be self sufficient for water and provide support to the local community.

2.2.5. Major issues and future options

In general, availability of potable groundwater is limited and it is worst in the southern section of the Red Sea Coast. When available, groundwater at the coast is widely utilized as a source of water supply for domestic purposes (human and livestock consumption), based on dug wells with masonry lining or shallow temporary open wells to extract water from alluviums of wadi bottoms and banks.

Groundwater salinity increases towards the coast, mainly due to low recharge rate towards the coast. In the Southern Part, major faults in the basement rocks associated with the formation of the Red Sea rift valley, acts as pathways along which deep circulating brackish and saline groundwater returns to the surface.

Nevertheless, there is a need for a complete survey of the availability of water all along the coast and on the islands in order to plan for sustainable development, sharing the existing between essential activities and looking for other options for potential growth of the population and activities along the coast. Cities, islands, the potential development of tourism and of the Free Trade Zones in Massawa and Assab are the main areas of concern not only for supply of freshwater, but also for the treatment of sewage water, allowing the reuse of water and limiting the pollution of the groundwater. The main option to explore is desalination.

2.3. Agricultural activities

Agriculture forms one of the main economic bases for the Eritrean coastal communities. Nevertheless, due to the low level of precipitation, cultivation mainly relies on spate irrigation systems but supports significant production over many of the Zula and Sheib areas communities. Most importantly, the majority of the coastal communities' agricultural practices rely on livestock which is the single most economically viable sector.

2.3.1. Soils and soil association

Areas suitable for agriculture are usually concentrated in the southern central highlands and in the South-West part of the country. However, soil shallowness and permeability reduces the advancement of agricultural in significant portions of these areas. Shallowness is mostly the result of intensive farming and subsequent soil degradation, especially in the highlands.

Soils around the coastal zone have dusty and salty natures and are unfavorable for agricultural practices. They are very poor, being described as highly saline solonchaks with no agricultural potential. However, where temporary rivers carve through the mountains to the coastal plains, such as at Bada, Zula, Sheib and Wadi Labka areas, fertile alluvial soil support the livelihoods of local communities through seasonal cultivation.

Little research has been carried out on coastal erosion and sea intrusion. Nevertheless, in relation with the low level of sediment transported by rivers, one can expect spontaneous transformation of the coast structure, and subsequently effect on oceanographic conditions (tides, waves, currents, storms).

Some areas have already been identified as more sensitive to coastal erosion and sea intrusion such as the Gurgussum area and the low-lying areas of Massawa used for salt extraction. Thus, taking the dynamic nature of coastal structures and the associated environmental changes into account, coastal infrastructure development plans and human settlement plans should be properly worked out and considered in future planning.

2.3.2. Cultivation

Agriculture in the coastal areas is essentially dependent on irrigation. Rain-fed cultivation is practically non-existent due to the fact that the amount of rain that falls in the coastal areas is not enough to support cultivation. Farming is hinged upon agro-pastoralism practices, whereby crop production (mainly sorghum) is only possible when supplemented by spate irrigation. A characteristic of the system is the yearly migration of people and livestock to the highland areas as of mid-April and returning to the wadis as of mid-September to engage in cultivation.

Sorghum being the major crop, when moisture levels permit, the sorghum crop is collected and a second harvest of grain is possible. When the floods are particularly good, farmers may plant maize instead of sorghum because of the greater yields that can be achieved. Minor crops include maize, finger millets, sesame, groundnut, beans cotton and vegetables. Moisture availability limits the productivity of crops and pests such as stink bugs, army worm, stalk borer, locust and aphids are important threats affecting agricultural harvests.

Spate irrigation farming system is practiced in Sheib, Wadi Labka, Bada and Zula localities in the Northern Red Sea Zone and to a much lesser degree, in the Rahaita area of the Southern Red Sea Zone. To support local farmers' production the Ministry of Agriculture has been developing diversion schemes in the Sheeb and Wadi Labka regions. The intention is to harness the flash floods that come from the nearby mountains and use them efficiently and effectively over the extensive cultivable lands. In other areas, spate irrigation is practiced by the traditional method.

2.3.3. Livestock and Rangeland

The livestock industry in the coastal areas is founded on migratory patterns, roaming from place to place in search of food and water over existing natural rangelands. Herders predominantly rear the small ruminants, and to a lesser extent cattle, camels and donkeys. In general, the coastal area harbors 28% of the total livestock population of the country, and stands second to the western lowlands.

It has been reported that vegetation cover of the rangeland is deteriorating because of the high pressures inflicted upon it by the excessively large numbers of livestock. The desirable carrying capacity of cattle on the Eritrean rangelands is 1.4/ha, whereas for sheep it is 7.0/ha. But these thresholds have been exceeded by over 200% resulting in the depletion of available forage biomass. Moreover, the value of rangelands is diminishing, as the desired grass species are being replaced by the less desirable ones.

To rehabilitate the severely affected rangelands, the MoA under the National Livestock Development Project, is piloting a rangeland development at Gahro, at the tip periphery of the Southern Red Sea region. By ameliorating the range condition the project will serve the communities of the Rahayta administrative region with a better rangeland for animal grazing.

2.5. Traditional Conservation Practices

The Afar people have traditional beliefs against cutting trees and the killing of wild animals. According to their belief, cutting the entire canopy of a tree would entail anger and wrath from the heavens, and the killing of wild animals in particular the grazers and browsers, is the direct cause for drought; they believe in 'God gives rain for the sake of wild animals, and if all wild animals are decimated, there will be no rain.'

The inhabitants of Dahlak Kebir Island also have a cultural approach to conserve the wild Soemmerring's gazelles. Young goats and sheep that are born in the absence of an owner are not marked for ownership. These unmarked goats and sheep remain the property of the community, and are used during public celebrations or in welcoming guests. The inhabitants of this island use this practice as a trade-off to save the Soemmerring's gazelles.

3. Policies and Legal Issues

3.1. Fisheries Activities and Environmental Issues

The Ministry of Fisheries as the major actor in the marine and coastal environment has a relatively well organized institutional and management setup that takes sustainable development and environmental protection into account. The Ministry of Fisheries has produced regulatory proclamations and legal notices (Eritrean Gazette) that govern fisheries related activities. These legal practices are in general embedded under two proclamations and thirteen legal notices.

The Fisheries Proclamation: Proclamation No. 104/1998
The Fishery Product Proclamation No 105/1998
The Foreign Fishing Vessel Regulation: Legal Notice No. 38/1998
The National Fishing Vessel Regulation: Legal Notice No. 39/1998
The Fishery Product Regulation: Legal Notice No. 40/1998
The Fishery Product Hazard Analysis Critical Control Points Regulation: (Legal Notice No. 41/1998)
The Potable Water Regulation: (Legal Notice No. 42/1998)
The Aquaculture Products Regulation: (Legal Notice No. 64/2003)
The Additives Regulations: (Legal Notice No. 65/2003)
The Heavy Metals Regulations: (Legal Notice No. 66/2003)
The Factory Vessel Regulations: (Legal Notice No. 67/2003)
Potable Water Regulations in Fishery Product Activities: (Legal Notice No. 68/2003)
The Fishery Product Importation and Exportation Regulations: (Legal Notice No. 69/2003)
Regulations issued to amend the Foreign Fishing Vessels Regulations:(Legal Notice No. 38/1998 & Legal Notice No. 70/2003)
Regulations issued to amend the Fishery Product Regulations: (Legal Notice No. 40/1998 & Legal Notice No. 71/2003)

These laws provide comprehensive coverage about the development and management of the marine sector in Eritrea and contain a number of articles relevant to the protection and conservation of marine resources, including the establishment of marine protected areas. The Ministry of Fisheries is bound to ensure the proper conservation and management of marine resources (Proc.104/98 art.8 (1)). It is particularly bound to ensure that marine resources are not endangered by exploitation (Proc.104/98 art.8(1-a)).The Proclamation further provides the Ministry of Fisheries with the power of declaring closed seasons and closed areas; prohibited fishing methods and gear and specification of gear that may be used (including the mesh size of the net); the species, sizes and other characteristics of fish and other aquatic organisms that it is permitted or prohibited to catch; and schemes for the, limitations of entry into all or any specified fisheries (Proc. 104/98 art.9(2)). Before declaring a protected area the Minister may consult the occupiers of adjoining land, the authorities responsible for other use of the area, the appropriate local government councils and the Fisheries Advisory Council (a

council set to assist the management development of fisheries). A declaration of a protected area may prohibit or restrict fishing; dredging or taking any sand or gravel; or otherwise destroy or disturb the natural habitat with in such area (Proc.104/98 art. 13).

The Ministry of Fisheries is further provided to participate in environmental protection issues through the powers vested on it to license fishing vessels and reserving areas for Eritrean citizens and national vessels (Proc.104/98 art. 18 & 49). It can also set conditions to the type and method of fishing or related activities, the allowed areas, the target species, the amount to be collected, including any restrictions (such as size limit), the period (opening and closure) and measures to facilitate enforcement of this Proclamation (Proc.104/98 art.12). This further strengthens the Ministry's role on protection of the marine resources.

It may be important to point out at this stage, however, that there is lack of clarity with respect to integration of the responsibilities of the Ministry of Fisheries with other government sectors (for example the Ministry of Agriculture; the Ministry of Land, Water and Environment and the Directorate of Cultural Heritage), which in one way or another are involved in sustainable management and in particular protected area. So the potential for overlap and duplication of efforts appears to be imminent. In addition the mechanism of the creation of protected species and protected areas is not fully described. Without a formal procedure this part of the legislation may be difficult to put in practice.

During 2005 and 2006, the Ministry of Fisheries has formulated a Fisheries Management Plan with FAO. This Plan is intended to define the mechanisms for sustainable fisheries.

3.2 Agriculture and Environmental Issues

The following legislations on agriculture have relevance of varying degree to the coastal area development and protection.

Forestry and Wildlife Conservation and Development Proclamation, No 115/2006; Regulations for the Issuance of Forestry Permits, Legal Notice 111, 2006; Regulations for the Issuance of Wildlife Permits, Legal Notice 112/2006; Draft CITES Implementing Legislation, 2005

The Forestry and Wildlife Conservation and Development Proclamation, No 115/2006 provides, among other things, for the establishment of protected areas (FWCDP: art. 16) national action plan for forestry and wildlife resources (art. 10); management plans protected areas and riverine forest areas, among others, which may include water shed management, as well as a permit system for sustainable utilization of these resources; further detailed in the two regulations. The proclamation accentuates the need for public participation and requires solicitation of public input in the preparation and revision of the national action plan; management plans and pertinent regulations. (art 15). As a way of ensuring integration, the Proclamation further establishes the forestry and wildlife advisory board, composed of public and private actors.

Wildlife is defined such that fish and marine living organisms are excluded (art 2/9) while other wildlife, including all those in the coastal area are apparently included. Forest and forest products (e.g. mangroves) in the coastal area are also apparently covered. These aspects are no doubt areas of concern, in the interest of ensuring integration and avoiding unhealthy overlaps.

The draft CITES implementation proclamation also has relevance in the sense that it is meant to give regulatory teeth to the Convention on Trade in Endangered Species of Fauna and Flora to which Eritrea is a party.

3.3. Tourism and Environmental Issues

Tourism related activities are governed by the Ministry of Tourism pursuant to Proclamation No. 152/2006, the Tourism Proclamation. According to this proclamation the Ministry can grant six types of permits for tourism activities (art.6). The proclamation further provides that the Ministry can "stipulate minimum standards and requirements for the establishments providing service to tourists and to regulate and control establishments providing such service" (art.3/g).

Specific requirements to acquire permits for different types of tourism activities are addressed under;

The Tourism Proclamation, No. 152/2006,Legal Notice No. 104/2006 – Permit for Operating Hotel or Tourist Supplementary Accommodation Establishment, Legal Notice No.105/2006 – Permit for Operating Restaurant and Food Catering Establishment, Legal Notice No.106/2006 – Permit of a Tour Operator of Travel Agent, Legal Notice No. 107/2006 – Permit to a Tour Guide, Legal Notice No. 108/2006 – Permit of Operating Tourist Pleasure Craft Boats.

3.4. Port Services and Environmental Issues

The Port Authority (established under Proclamation No. 148/2005) administers the port activities. A general port manager – chief executive officer of the port - is appointed for each port responsible for the efficient day-to-day management of the port, and establishing and implementing policies and enforcement mechanisms enabling the protection of the port environment from any form of pollution (art.9 & 10(3-m)).

One of the Port Authority's objectives is to carry out and monitor security, safety and environmental conservation activities in harmony with national laws and international conventions and agreements (art. 7)

Pursuant to the Port Regulation Legal Notice (No. 103/2005) "No ship may pollute or by pollution cause the marine environment or injury to human beings and/or biodiversity. If damage or injury is caused by pollution it shall render the ship liable for compensation and other remedies under the

relevant national laws and international conventions." (art.90).The Authority can detain a vessel suspected of discharging a marine pollutant (art. 86, 89)

3.5. Free Trade Zones and Environmental Issues

The Ministry of Finance pursuant to the FREE ZONES PROCLAMATION (No.115/2001) may declare any part of the national territory of Eritrea, including any part of the territorial waters of the State and/or buildings thereon as *free zone* (art. 2, 5). An authority with not more that nine members established under this Proclamation administers activities related to this zone including granting of license (art. 6, 7 & 23). It is a zone where investment, export, and re-export is allowed without the payment of tax or customs duties (art. 31). The Minister is required to issue regulations concerning maters of physical and environmental planning and control with the consent of the relevant authorities (36(3)).

The Minister declared: Assab port, Assab Airport, Assab Salt Works, All public warehouses and all public fuel deposits outside the Assab Port and Assab Airport compounds but within Assab serving the Assab port and Assab Airport; Massawa Port, Massawa Airport, and All public warehouses and fuel deposits outside the Massawa Port and Massawa Airport compounds but within Massawa serving the Massawa Port and Massawa Airport as free zones (Eritrea Profile Asmara, August 18, 2006).

3.6. Infrastructure and Environmental Issues

During major urban construction works the Department of Infrastructure of the Ministry of Public Works has the premier authority of assuring environmental friendliness of proposed infrastructures in coordination with the Department of Environment (DOE). The Department of Infrastructure is the policy making and regulatory body in relation to all infrastructure works. Overall, this department is in charge of supervising roads, bridges, airports and railway constructions in the coastal areas. Nevertheless, the department has no formal regulations or directives regarding environmental issues and most of its practice is based on informal directives and guidelines.

Besides its effort to protect the environment, the Department of Infrastructure also values the preservation of historical and cultural heritage before and during infrastructure constructions. As a measure of minimizing environmental damages, EIA (Environmental Impact Assessment) is applied as a rule of thumb in certifying infrastructure endeavors. In addition, the department also engages in monitoring implementation of projects against EIA. To consolidate this strategy, the department has a plan to prepare Environmental Management guidelines in conjunction with the DOE.

3.7. Urban Development and Environmental issues

Urban development plans in the major cities are governed by Urban Development Department of the cities' administrations or municipalities. Urban Development Departments oversee whether city plans and buildings are fulfilling major regulations; placing livestock market place and solid waste disposal site outside of a town, constructing septic tanks for buildings that are not connected to sewerage systems, proper drainage of domestic liquid waste into septic tanks, dumping of excavated soil and construction wastes in proper places.

Currently the urban development department at a national level is conducting an evaluation assessment of urban developmental activities in the major cities of Eritrea. This assessment will help in capturing lessons learned over many of the works so far accomplished. It will mainly focus on proposing the possible integration of multi-organizations which actively involve in developmental activities, in setting up urban plans and laying major infrastructures such as electric cables, telecommunication lines, water supply and sewerage lines, roads renovation and expansion works.

3.8. Energy and Environmental Issues

Energy as a major environment related endeavor is being properly dealt for its production and management processes in minimizing environmental disturbances. As part of the effort the Ministry of Energy and Mines has been practically demonstrating its role by participating in the preparation of the National Environment Management Program for Eritrea (NEMP-E) and the Environmental Impact Assessment (EIA) guidelines. Its awareness has thus helped in the installation of the largest energy producing plant in the country, Hirgigo power plant with acceptable EIA standards.

Electricity Proclamation: (Proclamation No. 141/2004)
The Eritrean Electric Corporation Establishment Proclamation: (Proclamation No. 142/2004)

Currently the ministry is preparing Energy Laws Regulations and Standards to develop an environmentally sound and sustainable energy production system. Concurrently, efforts are also being made at reducing energy wastage and finding alternative environment friendly sources of energy that can reduce desertification and air pollution. Researches are resuming on finding ways of utilizing renewable energy in the Eritrean Southern Red Sea region. The energy department is also conducting researches on solar energy harvest, such as solar heaters and solar cookers.

3.9. Mines and Environmental Issues

Though it is a slowly growing sector in the coastal area, mining is carried out in compliance with the mining legislative body's theme "ensuring mining operations in Eritrea lead to the development of national capacity and optimum utilization of resources in an *environmentally healthy and safe way"*. Minerals are defined in the Minerals Proclamation (article 2-13) as all natural substances found on the earth's crust, including salt, mineral water and geothermal deposits, but excluding petroleum, natural gas and oil shale as defined in petroleum legislation.

A Proclamation to Promote the Development of Mineral Resources: (Proclamation No. 68/1995)
Regulations on Mining Operations: (Legal Notice No. 19/95)

These legislations are generally intended to regulate mining activities. They are widely applicable both in the terrestrial and marine environment. As per article 18, all mining operations in Eritrea require permission from the licensing authority of the Ministry of Energy and Mines. Besides, with the exception of petroleum operations mining license can be given for under sea mineral operations.

The Department of Mines has the vested responsibility to ensure the conservation and sustainable development of mineral resources. When the competent authority permits mining, it has three operational procedures to protect the environment; (a) presenting EIA (b) assuring intended methodology and technology has no or only little impact of damage to the environment and (c) license holder shall take all environmental protection measures consummate to his operations.

The Ministry of Energy and Mines is granted with the power of identifying areas as reserved or excluded for mining. Article 6 of the proclamations states '*the Government may designate any area or mineral as reserved or excluded for particular mining operations and exclude any area from mining operations particularly as it regards sites of historical, cultural or religious interests and public buildings, infrastructure and other installations.'* Legal Notice No. 19/95 further restates that it should not be even within 100 meters of these places (art. 13).

Together with the Ministry of Fisheries, it has vested power to declare protected or preserved area on Eritrean marine environment. Nonetheless, both agencies fail to present any mechanism of coordination between their jurisdiction (this comment is also valid for the ministries of Agriculture, Tourism and the Directorate of Cultural Heritage).

3.10. Petroleum Exploration and Environmental Issues

Petroleum operations of the country lie under the jurisdiction of the Ministry of Energy and Mines. The Minister is authorized to direct the implementation of proclamations, and has the power of controlling the operations.

A Revised Proclamation to Govern Petroleum Operations: (Proclamation No. 108/2000)
Revised Regulations on Petroleum Operations: (Legal Notice No. 45/2000)

Environmental protection measures are treated as part of the whole operation. Article 2 (10) of Proclamation No.108/2000 includes 'environmental protection' in the context of 'petroleum operations'. Unlike legislations of other sectors environmental damage has been defined explicitly in under Article 2 of Legal Notice No. 45/2000 as: '*inter alia,* soil erosion, removal of vegetation, destruction of wild life and marine organisms, pollution of ground water, pollution on surface water, land or sea contamination, air pollution, bush fire, disruption to natural drainage and damage to

archaeological, paleontological and cultural sites.' These legislations also apply to the search, exploration and exploitation of sea-beds and the subsoil (art. 3(3)).

The Petroleum Legal Notice provides detailed provisions on environmental protection. Like the mine operations it applies the principles of EIA at two stages in seismographic survey and exploration stage. The EIAs has to include; fuel storage & handling; use of explosives; camps & staging area; liquid & solid waste disposal; cultural & historical sites; selection of drilling sites; terrain stabilization; protection of fresh water horizons; blowout prevention plan; flaring during completion & testing of gas & oil wells; well abandonment; rig dismantling & site completion; reclamation for abandonment; and noise control (art. 11 (6) Legal Notice). Moreover these proclamations make a general reference to three international standards of environmental protection. All activities shall be in accordance with the 'accepted international petroleum industry standards and practices'; it must be reasonable; and must protect anthropological, archaeological and historical objects and site (art.14 & 17 of Proclamation, and art. 2 & 11(4) of Legal Notice).

3.11. National Environmental Assessment Procedures and Guidelines (NEAPG)

An Environmental Impact Assessment (EIA) examines development project proposed by the public or the private sectors with respect of its potential environmental impacts including socio-cultural and economic impacts, to ensure that no serious negative impacts will result during its development and operation phases. If such impacts are likely to occur, then the project will need to have an accompanying mitigation strategy or if necessary, abandoned.

In 2000, the Eritrean National Environmental Assessment Procedures and Guidelines (NEAPG) have been officially disclosed for public use. The NEAPG demands that adequate level of environmental assessment take place for all development projects with potentially negative environmental consequences. According to the procedures, all proposed projects should pass through a screening process done by relevant agencies with appropriate authority for regulations, development implementation or supervision.

The EIA guidelines, when applied rigorously have proved to be an effective mechanism for ensuring an integrated approach for development. The objectives of the National Environmental Assessment Procedures and Guidelines are to; assess the significance of the potential impacts of proposed projects on environments, reduce delays in project approval procedures by providing a standardized and transparent system for environmental assessment and promote sustainable economic development without unnecessary decline in environmental quality.

Due to the sensitivity of the coast and the irreversible effects of environmental impacts on marine life and in particular coral reefs, mangroves and sea-grasses, it is recommended that all proposed projects along the coast or with potential influence on the marine and coastal environment are subject to a full EIA before project environmental clearance can be considered (Category A). The full EIA process require that an EIA report and an Environmental

Management Plan (concerning the construction and operation phase and including regular monitoring procedures) are prepared by the project responsible stakeholder, public or private.

3.12. Biodiversity

As part of the biodiversity conservation ongoing effort the Department of Environment has prepared the National Biodiversity Strategy and Action Plan (NBSAP) to promote a coordinated management of the Eritrean biodiversity resources.

Following the ratification of the Convention on Biological Diversity (CBD) in 1996, Eritrea undertook the necessary measures to formulate NBSAP, which was adopted in July 2000. As part of this endeavor, Eritrea worked on preparing the inventory of biodiversity resources as categorized into three core areas that are also recognized by the NBSAP; terrestrial, marine, and agricultural biodiversity.

The strategy and action plan for biodiversity conservation and sustainable use is featured from the perspectives of; integrated management, sustainable use of natural resources, alien invasive species, pollution management, i*n-situ* conservation (protected areas), e*x-situ* conservation, - taxonomic knowledge, - information acquisition and storage, - public awareness and education, - legal and institutional structure (capacity building).

3.13. International Conventions, Treaties and Agreements

To facilitate the protection of local and regional biodiversity resources Eritrea has been committed to carry out all possible roles and responsibilities, and as concrete measures has ratified numerous International Conventions, Treaties, Agreements and Frameworks;

INTERNATIONAL CONVENTION, PROTOCOL OR TREATY TO WHICH ERITREA IS PARTY	**RATIFICATION ACCESSION DATE**
Convention on Biological Diversity (CBD)	*May 21, 1996*
Convention on Migratory Species (CMS)	*February 01, 2005*
The Basal Convention on the Control of Trans-boundary Movements of Hazardous Wastes and their Disposal	*March 1, 2005*
The Rotterdam Convention on Prior Informed Consent (PIC) for Certain Hazardous Chemicals and Pesticides in International trade	*March 1, 2005*
Stockholm Convention on Persistent Organic Pollutants (POPs)	*March 1, 2005*
Vienna Convention for the Protection of the Ozone Layer	*March 2, 2005*
Cartagena Protocol on Bio-safety to the Convention on Biological Diversity	*March 1, 2005*
Framework Convention on Climate Change (FCCC)	*April, 24,1995*

Kyoto Protocol of the Climate Change Convention	*July 28, 2005*
Montreal Protocol on Substances that Deplete the Ozone Layer	*March 2, 2005*
Convention on International Trade of Endangered Species (CITES)	*14August, 1995*
Convention to Combat Desertification (CCD)	*14August, 1999*
International Treaty on Plant Genetic Resources for Food and Agriculture	*April 10, 2002*

Based on the significance of the conventions and agreements, Eritrea is undertaking practical measures to implement them at a national level such as the CCD to prevent land degradation, reducing poverty, adopting moisture retention, groundwater conservation and water recycling measures and mobilizing civil society through participatory processes and so on.

4. Fisheries

4.1. Fisheries Resources and Potential

The Eritrean Red Sea is generally recognized as being highly favorable for the development of artisanal fisheries. Important coral reefs areas, extensive surface of soft bottoms and numerous shelters of the Dahlak archipelago plateau and, to the north and south of this plateau, short distances to the continental shelf break, are all conditions conducive to such development. Diversified coral reef communities, extensive mangrove mud flats, sea grass or seaweeds beds and standing kelps harbor diversified commercially important fisheries resources. Outside the coralline zones its sedimentary floors, while not particularly attractive for artisanal demersal fishing activities, offer quite favorable conditions for bottom trawling operations.

Eritrea possesses a variety of fish resources as per their natural habitats:
(a) Soft bottom demersal fishes and shrimps, caught by trawlers, such as lizard fishes threadfin breams and catfishes,
(b) Hard bottom demersal & reef fishes (food and ornamental), found on rocky bottoms and caught by industrial trawlers and by hook & line artisanal fishermen and long-liners such as snappers, emperors, grunts, job fishes, groupers, etc.,
(c) Small pelagic, such as Sardines and Anchovies that are targets for beach-seines and purse-seines
(d) Large pelagic, usually caught by gill nets and occasionally as a by-catch in commercial trawlers mostly tunas and mackerels
(e) The sharks that are caught for their highly valuable fins rather than the body flesh
(f) Specialized fisheries such as sea cucumber, snail nail and Trochus
(g) Unexploited species such as shellfish that include crabs, sepia, lobsters, squids and octopus

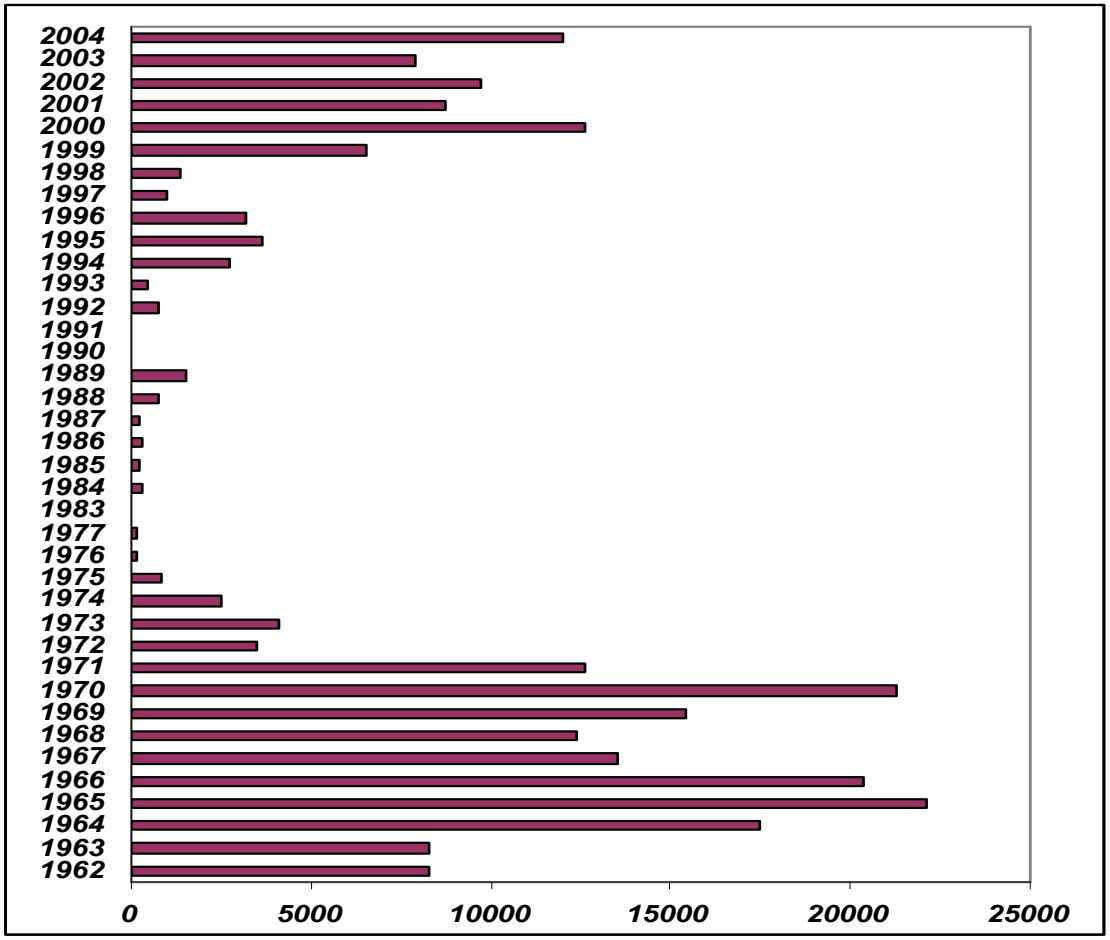
No comprehensive quantitative surveys of the resources and the productivity of the Eritrean Red Sea have been carried out, although various short-term exploratory surveys for specific stocks were conducted between the mid-1950s and the late 1990s. Several attempts have been made to estimate the maximum sustainable yield (MSY) of the Eritrean marine fish resources and they fluctuate between a high of 79,500 and a low of 36,000 tons per year. These estimated figures are derived from catch rates, experimental fishing, extrapolation from other areas or neighboring countries and biomass estimations from limited trawled areas. Therefore they should be considered with caution as the values are very much greater than actual landings, even in the most productive years.

4.2. Historical and Current Fisheries Catch Trends

Fisheries in Eritrea started to develop in the 1960s and were active until early 1970s. The fisheries grew very quickly mainly due to the presence of fishmeal industries, and was dominated by small pelagic. Accordingly, catch records of those periods had reached 20,000 MT per year.

Fisheries yield started to decline with the Ethiopian colonization and the sector collapsed during the period 1984 to 1990. This period is marked by the closing down of pelagic fishing for fishmeal and the annual fish catches were less than 250 metric tons.

Since the Independence, in 1993, fisheries started to be revitalized through the building of new or the repair of old or obsolete infrastructures along the Eritrean Red Sea coast. This was targeted at improving fisheries harvest to increase revenue both to the local fishermen and contribute to the national economy. In the attempt to maximize fisheries production new efficient resource planning and exploitation strategies were introduced, and emphasis was given to expand both the artisanal and industrial fisheries. Consequently catch started to grow, largely dominated by the industrial catch, in particular since 1999.



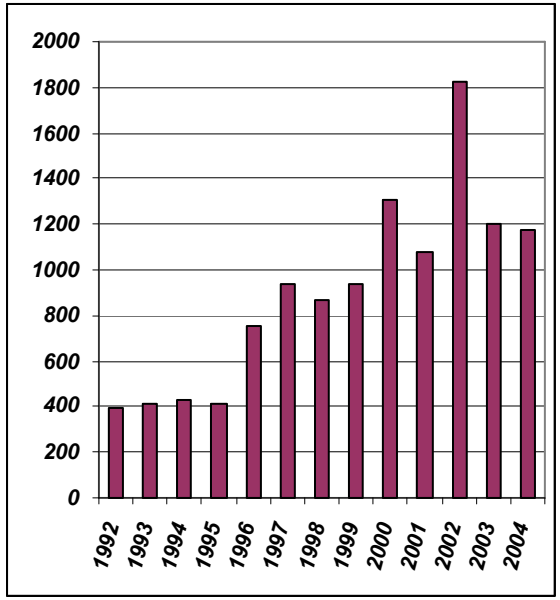
Trends in Annual catches (1962 – 2004) including artisanal and industrial activities.

4.3. Artisanal Fisheries

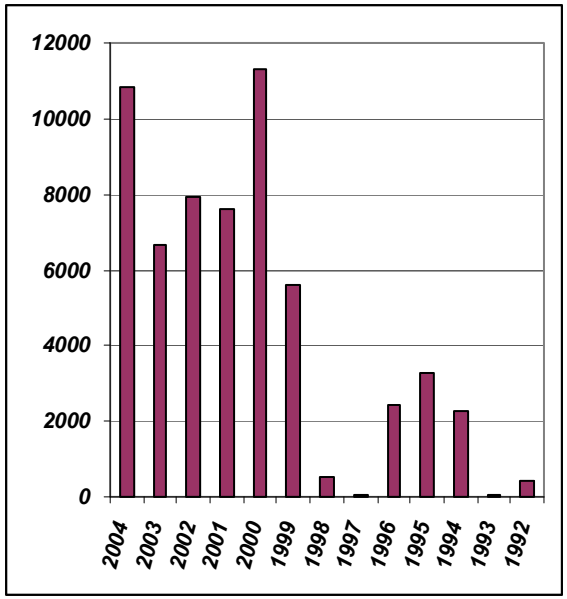
Artisanal fishery is conducted by local traditional fishermen along the coast in the relatively shallow waters. It involves wooden or fiberglass boats with a maximum length of 15-18 m. Artisanal fishermen can employ a combination of different gears (beach seine, gill nets, hook and line) and stay at sea over a period of 8 to 10 days per trip.

Three traditional types of boats are common which are named by their local names and they represent about 80% of the fleet:
- *Canoes*, non-motorized, double-ended small craft,
- *Houris*, mid-sized units generally with open decks and fitted with outboard engines (petrol),
- *Sambuks*, the largest units generally decked and equipped with inboard engines (diesel).

In addition, Fiber Reinforced Plastic boats (FRP) are the fourth type with a length of 15-18. These are constructed locally and have an inboard engine. They are equipped with GPS and other advanced navigational equipments, trawl gears and long-lines. Some of them are involved in semi-industrial fishing.



Artisanal annual catches 1992 – 2004



Industrial annual Catches 1992 – 2004

4.4. Industrial Fisheries

The industrial fishery is characterized by vessels (usually bottom trawlers) capable of fishing in deeper waters on the continental shelf (down to 200m depth). Though there are no significant trawling operations by local vessels except for shrimps, trawling has been active in Eritrea and is pursued by

foreign vessels from Egyptian and Saudi Arabia fishing companies. Such activity is based on annual contractual agreement. Currently discussions have started with European Union for fishing agreement.

4.5. Shrimp Fishing

During the 1960s, only about 30 tons of shrimp were landed from Zula and Hirgigo bays (Ben Yami, 1975). Nevertheless, various surveys showed that large quantities of shrimp exist in several areas along the Eritrean coast. Surveys conducted in 1990s with local trawlers indicates potential fishing grounds exist around Dahlak area as a result of which shrimp harvest (landing) showed a dramatic increase. In 1998, only 9 tons of shrimp had been harvested. By intensifying fishing in 1999, the production increased to 75 tons, then the annual catch was 520 tons in 2000, 790 in 2001, 512 in 2002, 450 in 2003 and 400 in 2004 (Research and Statistics Division, Data base, 2005). Much of the shrimps being harvested are from the family of Penaeidae (such as *Penaeus semisulcatus, P. japonicus* and *P. latisulcatus).*

4.6. Sea Cucumber Collection

There is no custom of eating sea cucumber (local name Hedra) in Eritrea. Until 2003, sea cucumber fishing was done in small scale by some local artisanal fishermen and the harvest was sent primarily to Yemen. The collection was done by skin diving only in shallow waters. The legal landing never exceeded 82 tons up to 2002. Starting in 2004, local investors have become involved in the business, and hence scuba dive fishing was introduced. This is carried out using scuba equipment and air compressors from onboard fishing boats. The harvest increased to over 300 tons in 2004 (National Fisheries Corporation -NFC).

4.7. Aquaculture and Mariculture

The first aquaculture initiative was developed during the armed struggle for Independence in the late 1980's. Milkfish, mullet and tilapia were grown in ponds in the northern part of the Eritrean Red Sea. After independence, small-scale research oriented efforts were made to culture mullet, artemia and others under the Ministry of Fisheries.

The objective was to develop, produce and market aquacultural and agri-products using integrated seawater farming and proper technologies in order to generate wealth, improve human welfare and enhance environment. The concept of integrated seawater farming developed by the Seawater Farms Company claimed to be different and environmentally enhancing unlike most conventional aquaculture practice functions in three main integrated components. The front end, the aquaculture component, receives pumped seawater to grow shrimps and fish. The mid part, the halophyte agriculture, reuses effluent from the aquaculture farm to irrigate fields of salicornia, a saltwater oil-seed crop. The last component is the creation of wetlands that

uses all excess water in the system to grow mangroves, artemia etc, create marshy areas that provides new animal habitat, and increasing biodiversity. Finally water in the wetlands is used for the production of salt thus avoiding direct discharge of effluents to the sea. Although each unit has been projected to generate revenue and even profit, the system as a whole has generated little income and eventually led to the failure and cessation of operation at the end of 2004.

4.8. Fisheries Management Efforts

Following the flourishing of trawlers after independence, the Monitoring Control and Surveillance Division of the Ministry of Fisheries has been reporting that trawling operations have been concentrated to a small area of the Dahlak archipelago. Subsequently, this area has been over-exploited with habitat destructions and discards of large volumes of juvenile fishes and shrimp bycatch.

As a responsible body, the Ministry of Fisheries has thus been attempting to manage the fishery through zoning and closed season approaches. The closed season extends from three to four months (July-October).

The three predefined zones for fishing (see map):
- Area I (Southern Fishing ground), extending from the Djibouti border Saroyta village (14° 30‘latitude);
- Area II (Central Fishing ground), extending from 14°30‘N to 16°30’N (north of Mersa Gulbub), covering an important part of the Dahlak archipelago, open from January to April and,
- Area III (Northern Fishing ground), between 16° 30’N and the Sudanese border.

The following general and specific regulations apply:
- All shrimp trawlers of less than or equal to 20 m length are allowed to fish in specific areas at specific times of the year.
- Fishing is closed from July to October and each area has specific timing and number of trawlers:
    - Area I is closed from January to April, due to the windy season;
    - From May to June and from October to December, the favorable sea condition allows the majority of the trawlers to fish in Area I and the rest in areas II and III.
- Any boat or vessel had to obtain a license (permit) in order to fish in the Eritrean Red Sea, delivered by the licensing unit of the Ministry of Fisheries. This requirement is valid for national or foreign vessels. The licensing fee depends on the size (length) or on the engine power.

To prevent any kind of illegal fishing the Ministry of Fisheries undergoes monitoring, control and surveillance carried by the Monitoring, Control and Surveillance Unit. However, illegal fishing is recorded especially by foreign artisanal vessels and trawlers from neighboring countries in areas where the frequency of patrolling is reduced.

5. Marine and Coastal Resources

5.1. Coral Reefs

Coral reefs are tropical shallow water ecosystem largely restricted to the areas between latitudes 30°N and 30°S. They rank among the most biologically productive and diverse of all natural ecosystems. Their high productivity stems from efficient biological recycling, high retention of nutrients and a structure that provide habitat for a vast array of other organism.

Living coral reefs support thousands of species including crustaceans, fishes, sponges, algae and molluscs. For centuries coral reefs have formed a vital component of coastal economies in many tropical countries. In 1980, the World Conservation Strategy identified coral reefs as one of the "essential life support systems" necessary for food production, health and other aspects of human survival and sustainable development. At the ecosystem level coral reefs play significant ecological and economic roles through; sheltering, feeding and breeding grounds for numerous marine species, fishing grounds for coastal communities, fostering the tourism industry, protection of coastline against wave and storm surge, prevention of erosion and contribution to the formation of sandy beach and sheltered harbors etc.

5.1.1. Coral reefs in Eritrea

Along the 1,350 km Eritrean coastline (18 % of the Red Sea) and around most of its 350 islands, coral reefs are common, occurring as patches in a relatively pristine condition. During the period between 1993 and 2006, numerous surveys and expeditions have been conducted to study the status of Eritrean coral reefs and propose an appropriate management strategy. Most important missions include: the Tel Aviv University in conjunction with Asmara University and the Research Section (Ministry of Fisheries) in 1993 for Dahlak Kebir and Norah Islands; the University of Wales Aberystwyth (UK) and the MoFish in 1994; the UNDP/GEF funded mission for the preparation of the ECMIB project in 1995-1997; the University of Newcastle (UK) and the MoFish in 1997 for the reefs around Massawa; and the continuous efforts of the Asmara University (Department of Marine Sciences) and the specific input of the Conservation of Eritrea Coastal Marine Island Biodiversity project within the Ministry of Fisheries (2004 to 2007).

Results of previous and recent surveys realised in November 2007 by Dr John *Charlie) Veron from Australian, the world leader taxonomist on coral reefs indicate high diversity of coral and fish in many parts of the coast and the islands. At least 38 existing coral genera and 220 species have been recorded such as Acropora, Echinopora, Favia, Favites, Fungia, Galaxea, Goniopora, Montipora, Platygyra, Porites, Stylophora, Tubipora, Xenia and Pocillopora.

The most common reef fishes are Acanthuridae, Chaetodontidea, Haemulidea, Labridea, Lutjanidae, Lethrinidae, Sphyranidae, Pomacanthide, Pomacentridae, Serranidae, Siganidae, Muraenidae and Scaridae.

5.1.2. Threats to corals

In most cases, the corals are away from human influence and hence relatively unaffected, except near the most important urban centres of Massawa and Assab. The coral reefs contribute to the livelihood of the coastal communities, through artisanal fisheries, ornamental fish collection (till 1997) and trade of other reef products. Current threats mainly arise from rapid coastal development like fisheries and fishing infrastructures, tourism, oil exploration, sedimentation as result of land reclamation, road construction and coastal population increases due to the establishment of new settlements.

The major threats, including permanent and occasional, are presently located near existing settlements such as the city-ports of Massawa and Assab and include:
- Destructive fishing activities such as trawling in shallow waters;
- Solid waste disposal, sewage from septic tanks or local activities;
- Occasional oil spill (oil terminal, boat, petrol station or wreck dismantling),
- Effluents from desalination station or power plants (temperature and chemicals)
- Dust for industrial activities (cement dust); or,
- Curios collections (shells, corals).

In addition, corals are also threatened by natural factors such as the crown of thorns starfish, sea urchins or drupella infestation or from or human induced impacts such as bleaching related to global climate change.

5.2. Sea grasses and Seaweeds

Unlike phytoplankton, sea grasses are plants with well developed roots, stems and leaves. Usually existing in enormous quantities and often forming large, dense meadows in tropical areas, sea grasses perform a wide spectrum of biological and physiological functions, serving as nursery, shelter or feeding area for fish, invertebrates, dugong and sea turtles. Sea grass beds also produce sediments from the associated fauna and interact with coral reefs and mangroves in reducing wave energy and regulating water movement.

The recent findings (ECMIB, 2005-2007) indicate that out of the 60 species existing worldwide, the 10 present in the Red Sea are found in the Eritrean waters: *Thalassia hemprichii, Thalassodendron ciliatum, Halodule uninervis, Syringodiun isoetifolium, Halophila ovalis, Halophila stipulacea, Cymodocea rotundata* and *Enhalus acoroides XXX add the two missing*. The majority of the shallow intertidal zones in Eritrea are dominated by *Thallasia hemprichii* and by *Halodule uninervis* (co-dominance). *Enhalus acoroides* stands are also found covering large areas at depths below 4m in specific sites, such as Norah Island.

Seaweeds are non-flowering water plants, can grow from a few centimeters up to several meters long and are attached to hard bottom. Out of the 26 common sea weed species identified, 9 species are green algae (Chlorophyta), 9 brown algae (Phaeophyta) and 4 red algae (Rhodophyta). Spatially, the distribution of sea weeds along the Eritrean coastline and island is not uniform. *Sargassum* and *Turbinaria* are the most dominant over rocky substrate such as in the southern part of Gurgussum, Dehil and Baradu, while they cover a relatively small portion of the muddy bottoms of the Southern Red Sea coastal area of Tio, Sahil, Haarasan, Morah and Mersa Fatma. Likewise, *Padina gymnospora* and turf algae are abundant in most parts of the Eritrean coastal waters while *Caulerpa lintellifera* is more frequent in the southern Red Sea.

5.2.1. Threats to Sea grasses and Seaweeds

The main threats to sea grasses and seaweeds are linked to human activities such as:
- Changes in water quality due to different types of pollution
- Building infrastructures at sea
- Dredging for channels access or for sand extraction
- Repetitive trawling changing the quality and stability of the sea bottom

5.3. Seabirds and Shorebirds

The Eritrean coasts and islands are well known for the large diversity of seabirds and shorebirds. The two groups are basically differentiated by their relative spatial location: seabirds spend the greater part of their lives at sea, diving to hunt for prey, where as shorebirds spend most of their time in the intertidal zone mostly feeding by scavenging fishes or invertebrates that are washed out to the shore.

Many species of seabirds and shorebirds exhibit migratory life styles. Most of them are migrating from the temperate or arctic northern hemisphere before winter in search of warmer breeding places to the tropics and southern hemisphere. Eritrea being in the subtropical region, it contains a number of habitats that are suitable for migratory and resident bird population. These include the coasts from Massawa to Assab, from Massawa to Sudan, the islands of Dahlak Archipelago, Hawakil, Anfile and Assab Bays. These islands and coastlines vary from sand bars to complex ecosystems: salt diaper, which consists of salt deposit and dead coral, bare sands, exposed uplifted coral, spare shrub and grassland vegetation (e.g. *Acacia, Panicum, Salicornia spp, Euphorbia spp, Atriplex*) and mangrove vegetation. All support large number of breeding seabirds.

As per 2005 and 2007 ecological surveys, 78 species of seabirds and shorebirds have been identified, of which 22 are known to breed on the islands, mainly in summer. While 25 species are true seabirds belonging to different families such as tropic bird, booby, gull, tern and cormorant, the remaining

utilize the marine environment partly or completely, including families such as pelican, spoonbill, heron, flamingo, duck, plover and sandpiper. In addition more than 50 species of land birds were identified on the Eritrean islands.

Specific areas on the mainland shore and numerous islands support diversified and large numbers seabirds populations such as:
- *In Assab Bay*: Umal Bager, Delgus, Om el Assela and Gurna islands;
- *Offshore Ras Terma or Near Hanish islands*: Harbi, Sayal, Flat, NN189, NN190 and Haycock islands;
- *Around Edi*: Fanadir (near Barasole), Abeilat, Cod Ali, Sadla and NN195 islands;
- *In Hawakil Bay*: Seil, Estam Aghe, Crulli (near Tio) NN043, Umm en Nayim, Laksu, Galdina, Rakh Howth and Umm Nammus islands
- *In the Dahlak Archipelago*: Sheik el Abu, Mojeidi, Aucan, Museri, Entaasnu, Isratu, Awali Hutub, Abu Sherayu, Sarad, Dur Ghella, Dahret, Dohul Bahut and Madote islands.

Areas such as from Mersa Fatma to Tio, the coast around Barasole, islands such as Ras Fatuma, the eastern side of Dahlak El Kebir and the islands of Handa, Museri, Dhu Ladhiya, Norah, Harat, Dissie and Sheik Seid are potentially important sites as primary feeding and wintering grounds and as migratory stopover for thousands of seabirds and shorebirds such as terns, gulls, boobies, flamingos, spoonbills, herons, plovers, sandpipers, and the crab plovers.

5.3.1. Threats to Seabirds and Shorebirds

The potential threats to breeding seabirds are
- Fishing camps (and in particular sea cucumber - bêche de mer) with disturbance by residence, processing on beaches, habitat destruction, firewood collection, egg collection or solid wastes
- Tourism camps resulting in disturbance, solid waste in particular during breeding season

Islands such as Madote, Dahret and Umm Nammus are some of the major destinations, thus limiting access to these areas during the breeding season (mainly from May to August) will help alleviate the threats.

List of marine and shore birds species recorded in 2005 and 2006 missions

Common Name	Species name	Status
Red-billed Tropicbird	*Phaethon athereus*	RB (frequent)
Brown Booby	*Sula leucogaster*	RB (abundant)
Masked booby	*Sula dactylatra*	RB (uncommon)
Pink Backed Pelican	*Pelecanus rufescens*	RB (abundant)

Socotra cormorant	*Phalacrocorax nigrogularis*	Suspected to breed (frequent)
Lesser Black-backed gull	*Larus fuscu*s	PM (common)
Sooty gull	*Larus hemprichii*	RB (abundant)
White-eyed gull	*Larus leucophthalmus*	RB (common)
Black-headed gull	*Larus ridibndus*	PM (frequent)
Yellow legged gull	*Larus cachinnas*	PM (frequent)
Slender-billed gull	*Larus genei*	PM (frequent)
Lesser-Crested Tern	*Sterna bengalensis*	RB (abundant)
Greater Crested Tern	*Sterna bergii*	RB (common)
Caspian Tern	*Sterna caspia*	RB (frequent)
Gull-billed Tern	*Sterna nilotica*	PM (frequent)
Common Tern	*Sterna hirundu*	PM (common)
White-Cheeked Tern	*Sterna repressa*	RB (abundant)
Bridled Tern	*Sterna anaethetus*	MB (abundant)
Little Tern	*Sterna albifrons*	PM (common)
Saunders` Tern	*Sterna saundersi*	RB (common)
White-winged Tern	*Chlidonias leucopterus*	PM (frequent)
Brown Noddy	*Anous stolidus*	RB (abundant)
Osprey	*Pandion haliaetus*	RB (common)
Sooty Falcon (Land bird)	*Falco concolor*	RB (common)
Eurasian spoonbill	*Platalea leucorodi*	RB (common)
Sacred Ibis	*Threskiornis aethiopicus*	RB (common)
Western-reef Heron	*Egretta gularis*	RB (common)
Little Egret	*Egretta garze*tta	R (frequent)
Cattle egret	*Bubulcus ibis*	R (frequent)
Goliath Heron	*Ardea goliath*	RB (common)
Purple Heron	*Ardea purpurea*	R (frequent)
Grey Heron	*Ardea cinerea*	RB (frequent)
Black-headed Heron	*Ardea melanocep*hala	R (rare)
Squaco Heron	*Ardoela ralloides*	R (frequent)
Red Sea Green-backed Heron	*Butorides striatus*	RB (common)
Abdim`s Stork	*Ciconia abdimii*	RB (frequent)
Greater Flamingo	*Phoenicopterus ruber roseus*	IAM (abundant)
Egyptian Goose	*Alopochen aegyptiaca*	IAM /R (rare)
Northern Shoveller	*Anas clypeata*	PM (frequent)
Gargany	*Anas querquedula*	PM (rare)
Crab-plover	*Dromas ardeola*	RB (abundant)
Eurasian oystercatcher	*Haematopus ostralegus*	PM (common)
Pied Avocet	*Recurvirostra avosetta*	PM (frequent)

Black-winged Stilt	*Himantopus himantopus*	PM (frequent)
Kittlitz`s Plover	*Charadrius pecuarius*	R (uncommon)
White-fronted Plover	*Charadrius marginatus*	PM (uncommon)
Common Ringed Plover	*Charadrius hiaticula*	PM (common)
Little Ringed Plover	*Charadrius dubius*	PM (frequent)
Kentish Plover	*Charadrius alexandrinus*	RB (abundant)
Mongolian Sandplover	*Charadrius mongolus*	PM (abundant)
Greater Sandplover	*Charadrius leschenaultii*	PM (abundant)
Caspian Plover	*Charadrius asiaticus*	PM (frequent)
Grey Plover	*Pluvialis squatarola*	PM (common)
Pacific Golden plover	*Pluvialis fluva*	PM (frequent)
Green Sandpiper	*Tringa ochropus*	PM (frequent)
Common Sandpiper	*Actis hypoleucos*	PM (common)
Terek Sandpiper	*Xenus cinereus*	PM (common)
Common Greenshank	*Tringa nebularia*	PM (common)
Marsh Sandpiper	*Tringa stagnatilis*	PM (frequent)
Spotted Redshank	*Tringa erythropus*	PM (frequent)
Common Redshank	*Tringa tetanus*	PM (common)
Broad-billed Sandpiper	*Limicola falcinellus*	PM (frequent)
Little Stint	*Calidris minuta*	PM (common)
Sanderling	*Calidris alba*	PM (common)
Curlew Sandpiper	*Calidris ferrugniea*	PM (abundant)
Dunlin	*Calidris alpina*	PM (abundant)
Ruddy Turnstone	*Arenaria interpres*	PM (abundant)
Black-tailed Godwit	*Limosa limosa*	PM (frequent)
Bar-tailed Godwit	*Limosa napponica*	PM (common)
Whimbrel	*Numenius phaeopus*	PM (common)
Eurasian Curlew	*Numenius arquata*	PM (common)

Key
RB: Resident breeder
PM: Palearctic migrant
R: Resident
IAM: Intra-Africa Migrant
MB: Migrant Breeder

Abundant - seen any day fair to large number in preferred habitat
Common - few seen almost any day
Frequent - quite often seen or heard
Uncommon - seldom seen or heard, ten times per year
Rare - very seldom seen or heard, less than once per year

5.4. Marine Turtles

The world oceans and seas host seven species of marine turtles representing two families, Cheloniidea and Dermochelyidea. Five of them are known to exist in the Eritrean waters: Loggerhead (*Caretta caretta*), Green (*Chelonia mydas*), Hawksbill (*Eretmochelys imbricata*), Olive Ridley (*Lepidochelys olivacea*) and Leatherback (*Dermochelys coricea*). They spend their lives at sea but return to the land to lay their eggs. Sea turtles are under threat due to natural and human interferences and are considered endangered species worldwide. Since they nest in sandy beaches they are susceptive to coastal development and human activities.

Common	Scientific	Afar	IUCN Category
Green	*Chelonia mydas*	Bisa'e/ Tuhu	Endangered
Hawksbill	*Eretmochelys imbricata*	Lida'e	Critically endangered
Olive Ridley	*Lepidochelys olivacea*	Zahlefa	Endangered
Loggerhead	*Caretta caretta*	Girfa / Sugur	Endangered
Leatherback	*Dermochelys coriacea*	Nea'ma	Critically endangered

Eritrea's 55,000 km² of territorial waters bordering nearly 3,300 km of coastline (mainland and 354 islands) provides feeding (important sea grass and seaweed meadows)and breeding habitats for the five turtle species, and nesting grounds (numerous sandy beaches and little disturbance) for the green, hawksbill and olive ridley.

Conservation and management efforts

The status of turtles in Eritrea was first assessed in 1996-1997 during the preparation of a Global Environment Facility Project. Although stronger conservation and management efforts are underway since mid 2005 along the coast and on the islands of Eritrea, the conservation status of marine turtles in Eritrea remains largely unknown. Information concerning population dynamics is incomplete, while knowledge of nesting populations and feeding habitats is patchy and of developmental habitats almost non-existent.

Research, monitoring and awareness are underway as part of the conservation programs but a significant role in turtle protection through community involvement could be the ultimate choice.

The highly relevant regional dimension to turtle movement is fundamental to conservation strategies, especially in the context of the Convention on Migratory Species, and flipper tags are used to determine turtle movements as well as inter-nesting frequency (no. of times a female nests per season) and re-migration intervals. To date (beginning 2007) about 150 turtles have been tagged. On the other side, tags have been recovered between 1992 and 2006 from nesting females tagged mainly in Oman.

Of the three species known to nest in Eritrea, the Hawksbill and Green turtles are the most common. But in 2005, an Olive Ridley turtle came to nest on the Ras Tarma beach. It was the first nesting record for this species for the whole Red Sea.

For the Hawksbill turtles, the most common species in Eritrean waters, the main nesting season for hawksbills is during the northeast monsoon (*Azieb*), from December to May, although nesting has been observed at other times of the year. Nesting has been recorded on more than 120 offshore islands, the most important being Mojeidi, Aucan, Dhul-kuff, Entaentor, Entaasnu, Urukia, Ras Fatuma and Dissei. Many nests have been also recorded on the mainland coast including Berasole, Ras Tarma, Gahro and Deleme.

During surveys of 2005 and 2006, on Mojeidi Island, more than 2000 Hawksbill nests were recorded, with a peak during February and March. On Aucan Island, 1500 Hawksbill nests were recorded during the same period. On the contrary, no nests have been recorded in Awali Shawra. Historically this was reported to be an important nesting site, but a large sea cucumber (Hedra) fishermen camp is believed to have disrupted the nesting activity.

The Green turtle is a common nesting species in Eritrea. No study has been conducted to estimate population size estimates or the total number of nesting green turtles in the whole of Eritrea. There has been nesting records in offshore islands such as on the sandy beaches of Mojeidi.

Loggerhead turtles are relatively rare in Eritrea and there is no indication that they nest. However, evidence from skull remains have been found in Islands around Dahlak archipelago and Gahro beach. The turtles are often caught in traditional fishing nests of local fishermen probably showing the Eritrean Red Sea area are important foraging grounds for this species. Reports of net captures were confirmed in the reports of the Ministry of Fisheries fishing logbook recorded by observers onboard of industrial shrimp/fish trawlers.

Very little information is available on Leatherback turtles in Eritrea because they are so rarely sighted and indigenous knowledge is limited. There have been no records of this species nesting in Eritrea. Rarely few leatherback turtles were observed washed up in offshore waters and on some fishing villages beaches (Information from fishermen). Fishermen suggest that the species is usually found deep down in the sea.

Uses and myths

Turtles and their eggs have been used for domestic consumption by local coastal communities in Eritrea (Hillman & Gebremariam, 1995). Decades ago there has also been a history of exploitation of hawksbill turtles for tortoiseshell, exporting mainly to neighboring countries such as the Kingdom of Saudi Arabia or Yemen.

Although they are aware that it is illegal, many Eritreans residing in coastal villages and few navies enjoy eating turtle meat but it is occasional and the sale has rarely been considered as a valuable source of income. The meat of the green turtle is most favored, while that of hawksbill is often avoided as believed to be poisonous. Turtle predation by humans is high in Ras Terma, Barasole and Dissie which are nesting areas for turtles.

Coastal communities have a strong belief of their medical value. The blood is believed to treat skin diseases such as 'psoriasis'; the fat and the oil could be good for diabetics, flu, rheumatism, tuberculosis and asthma. Eating the dried sexual organ of a male turtle after mixing it along with honey and cheese is believed to help stimulate sexual desire.

5.4.1 Threats to Marine Turtles

The main threats to marine turtles are linked to the lack of awareness, the limited of enforcement and the absence of protected areas:
- Poaching by local communities for private consumption of flesh and eggs or for medical treatment
- Incidental catches by fishermen in gillnets or commercial fish or shrimps trawlers
- Disturbance of nesting habitats (fishermen camps or tourism) and foraging grounds
- Disappearance of nesting beach (natural by erosion or human through development)
- Land based development or pollution (although the use of plastic bags is forbidden in the country)

Besides predation by coastal communities turtles are also endangered by fishing activities in particular by trawlers. In surveys conducted from 1994 to 2004, it was found that trawlers catch all the species existing in the Eritrean waters; the incidences are high for Hawksbill and Green turtles (79%). Most turtles in the Eritrean waters are caught at depths between 30 and 60m. The introduction of Turtle Exclusion Devices (TEDs) on the trawling nets could minimize the effect.

5.5. Dugongs, Dolphins and Whales

Dugongs are very shy animals, rarely seen and also rarely caught (3 to 4 each year), usually accidentally in shark nets. When caught, they are eaten by the local community. The local names of Dugongs are 'Aurum' along the coast and 'Abu Tewila' in Dahlak islands. Dugongs (*Dugon dugong*) are found in Ras Tarma, Adubaro, Cod-Ali Island, Jerom, Baka, Saribo, Dergamman Kebir & Sekir, Arafile, Barasole, Atskoma, Abullen. Along the coast north of Massawa, they can be found in Mars Ibrahim, Marsa Teklay and Marsa Mubarak.

Dolphins are locally called 'Obari' or 'Abu Salama'. Different species exist, and they are the most common marine mammals in the Eritrean waters. Whales are also seen in offshore waters of Saroyta and are locally named by 'Amber Bahr' or 'Bitan' in the Dahlak islands. The Common dolphin (*Delphinus delphis*) the Spinner dolphin (*Stenella longirostris*), the Bottlenosed dolphin (*Tursiops truncatus*) and the Indo-pacific Hump-backed dolphin (*Sousa plumbea*) have been observed in Eritrean waters or skeleton found on the shore.

Whales are not observed very frequently, the depth of the water being reduced near the shore, but skeleton can also be found. The Tropical whale or Bryde's whale (*Balaenoptera edeni*) and the False Killer whale (*Pseudorca crassidens*) have been reported.

5.5.1. Threats to Dugongs, Dolphins and Whales

For all marine mammals, two main threats have been identified:
- Collision with ships
- Poisoning during red tides

For dugongs, the occasional harvest by coastal communities seems to be the main threat.

5.6. Mangroves

Mangroves are salt tolerant trees and shrubs that form the major component of the complex tropical and subtropical ecosystem. They are frequently encountered on mudflats and banks along the shores, at the outlet of rivers or *'wadis'*. Mangroves stand with their roots in salt water and they are subject to tides and irregular input of fresh water.

Mangroves support a complex food web and provide a unique habitat for numerous animals. They are a breeding, nursery or feeding ground for numerous species. In addition, the presence of mangroves in numerous places stabilizes the coastline by protecting against the effects of storms and wave actions. Mangroves also play an important role in the presence and functions of other ecosystems, including wetlands, salt marshes, sea grass beds and coral reefs.

5.6.1. Mangroves in Eritrea

About 380 km of the Eritrean mainland and islands coastlines are occupied by mangrove forests. Of the seven mangrove species present in the Red Sea area, three are present in Eritrea, on the mainland and on numerous islands namely *Avicennia marina, Rhizophora mucronata* and *Ceriops tagal*.

Estimation results indicate that the country's mangroves cover about 70 km². However this coverage is found in patches all along the Eritrean coastal line and islands. Small mangrove stands are frequently found in small bays (mersas), at the mouth of temporary rivers (wadis), receiving freshwater and nutrients. They form a narrow fringe usually no more than 100 meters wide. On islands, mangroves often occur on infrequently flooded areas, which are separate from the sea by low dune ridges

The dominant species is *Avicennia marina* (white mangrove) with some older trees reaching 10 m high. *Rhizophora mucronata* have also been identified among mangrove communities and a small number of individuals of the species *Ceriops tagal* (yellow mangrove) are also present. Although

mangroves of the Red Sea are not as abundant as those on other tropical coasts, they play similarly important ecological roles. They are nurseries for several commercial fish species, protect coral reefs by trapping sediment loads from the seasonal rainwater influx, and also act as an important breeding, nesting and wintering sites for migratory birds, both shorebirds and seabirds. The pink-backed pelican (*Pelicanus refescens*), the Western reef heron (*Egretta gularis*) and the Goliath heron (*Ardea goliath*) are among the common mangrove associated birds.

5.6.2. Threats to Mangroves

In spite of the ecological and manifold economic benefits, the loss and degradation of mangrove areas are vast. Mangroves are used traditionally and commercially in several activities e.g. as timber and domestic firewood that requires cutting and removal of trees. Furthermore, coastal developments causing pollution, alteration of the substrate and modifying hydrological regimes (in particular by road construction without culvert to allow the essential flow of freshwater and nutrients) are exerting serious stresses on mangroves. There is a growing evidence of continuous deforestation of mangroves in Eritrea as a result of numerable human activities

Animal grazing mostly by camels seems one of the most serious threats. Forests found nearby to human settlements are also cut by people as a source of firewood. Pollution is confined to domestic solid-wastes, e.g. polythene bags and bottles, plastic and metal cans, which are disposed of in small quantities near population centres of the major coastal towns and villages. This may have serious physical impacts by covering the young seedlings and pneumatophores (erected roots that rise above the soil and promote gas and nutrient exchanges), blocking tidal channels and causing disturbance to the mangrove-associated fauna. Alteration of hydrological patterns due to coastal development projects as depicted in Massawa have also been causing significant loss of mangroves. In addition, activities resulting in oil pollution and direct discharge of sewages to the sea may also be threatening mangrove forests found around the major coastal cities. Nevertheless, as most of the Red Sea mangroves grow in a hostile environment, they are highly vulnerable to over-exploitation.

5.6.3. Mangrove Reforestation Program

Since mid 1990s a project named “Manzanar Project” has been taking a mangrove reforestation initiative in the Eritrean coastline. The project’s aim is to plant inter-tidal zones with mangrove plants thereby enhance inshore fisheries and the coastal environment.

Over the past several years, the project has been working to develop innovative methods to create mangrove forests in places where they never grew before. In addition, it was also involved in restoring and conserving some existing mangrove forests. To date the project has piloted a 20 hectare of intertidal area in Hirgigo (*a poverty stricken coastal village located 10 km south of Massawa)* planting half a million trees to restore the severely overgrazed mangrove forests. Accordingly, the project has demonstrated a remarkable success in growing the trees with the method used (Sato, 2004).

The method basically relies on low technology, and involves the input of nutrients that the sea water is deficient; iron, phosphorus and nitrogen or DAP (di-ammonium phosphate). Accordingly a local method of planting has been adopted; the mangrove seeds are planted in a tin can covered with a wire mesh, and to protect wash away by waves and tide it is tied to a physical structure (iron rod) and anchored to the ground.

Over the piloted sites the mangrove forests have contributed to the enhancement of the environment at a micro level, by providing sheltering, spawning and nursery area for many living creatures and protection from coastal erosion. Its litter production provides additional nutrient supply to the system. An immediate economic benefit to the coastal communities is job creation. Local people (mainly women) are hired to work on every activity of the project. Through its projected activities, the project also demonstrated livestock can be grown with foliage and dried seeds of mangrove trees as the main food for the coastal people.

5.7. Coastal Vegetation

The dominant natural vegetation of the coast are sparse coverage of shrubs and grasses of different desert species including *Acacia nubica*, *Acacia tortilis, Callotropis procera,* mangrove species such as *Avicennia marina* or halophytes such as *Suaeda monoica*. *Tamarix aphylla* grows along water courses. Halophytic plants, which serve as animal feed during the dry season, are common in the immediate coastal areas and Dahlak Kebir Island. For example, the Soemmerring's gazelles in Dahlak Kebir consume the halophytic vegetation in reasonable proportion until better feeding conditions prevail.

Occasionally, small patches of some riverine species such as the 'doum-palm' are found in waterlogged areas or along the seasonal waterways that drain into the Red Sea. Of the existing woody vegetation, are represented by acacia species such as: *Acacia laeta, Acacia ehrenbergiana, Acacia tortilis, Acacia asak, Terminalia brownii, Ziziphus spina christi, Combretum fragrans, Vangueria madagascariensis, Hyphaene thebaica,* and *Tamarix aphylla.* The Buri peninsula on the coastal lowlands on the other hand comprises a magnificent landscape of semi-desert plains, Acacia woodlands, lava flows and scenic bays and inlets of the Red Sea. On the islands and along the coastline, mangrove vegetation grows in various spots but mainly in two concentrations around Assab and the nearby islands, and between Tio and Massawa. The vegetation is composed of *Avicennia marina, Rhyzophora mucronata* and *Ceriops tagal.*

5.7.1. Threats to Coastal Vegetation

The main threats to the coastal vegetation are:
- Destruction due to heavy grazing by pastoralists and by other livelihood related activities.
- Coastal fishing camps in particular on islands
- Clearing of coastal areas for tourism activities

5.8. Conservation efforts

Despite Eritrea's extensive coastline share in the Red Sea, majority of the stakeholder institutions lack the adequate knowledge on the dynamics of the marine ecosystems and the appropriate conservation strategies. Nevertheless, efforts are being made to establish an integrated marine and coastal environment conservation system.

Even though there is lack of complete regulations, Eritrea has been practicing and enforcing some regulatory actions to preserve its corals and other marine ecosystems in a haphazard manner; since early 1990s the export of live corals and spear fishing has been banned and trawling has also been delimited to a depth of 30m and deeper. Similarly, in the sense of minimizing stresses from tourism the number of islands accessible to tourists has been determined only to 21.

In order to conserve the nations' major biodiversity elements and to rehabilitate some of its ecosystems, Eritrea has taken concrete actions to the establishment of Marine Protected Areas (MPAs). For this purpose, taking their ecological, research and economic significance into account four sites Dissei-Madote, Museri, Ras Fatuma and Sheik Seid (Green) islands have been proposed. The GEF and Government of Eritrea funded Eritrean Coastal Marine and Island Biodiversity (ECMIB) project taking the leading role is facilitating the implementation of the MPAs. Under the same auspices the ECMIB is also working to set up Integrated Coastal Zone Management; a participatory approach that takes the interest of all partners into consideration, and defines the jurisdiction rights of each stakeholder.

6. Coastal Infrastructures

6.1. Harbors and Maritime Routes

Apart from the natural small harbors and 'Mersas' Eritrea's major ports are found in Massawa and Assab. Coastal villages such as Tio, Edi, Dahlak, Ghel'alo have small ports and jetties that dock large 'Sambucks' which transport commodities and goods mainly from Saudi Arabia and Yemen.

Due to geographical proximity to the remaining part of the country, most of the ship cargo reaches Massawa. In order to upgrade the capacity and efficiency of the Port of Massawa, efforts are being made to expand its rise elevation and to upgrade its equipment to service larger cargo and container vessels. In addition, Massawa is used occasionally to receive cruise ships with tourists and the area between Taulud Island and the mainland serves as a mooring area for private cruising boat (mainly sailing boats) as there is no full service marina. Such a facility is planned in the future near Massawa Island.

The international maritime routes of the Red Sea are derived from the routes marked on the nautical charts. Recently new routing measures have been suggested by the Maritime Safety Committee of the International Maritime Organization (IMO). Introduction of new traffic scheme has been a subject of negotiation for the three coastal states namely Eritrea, Yemen and Djibouti. The scheme designates traffic routes from Bab El Mandeb to be divided into two lanes; the bigger traffic to be through the Haycocks while the other passage through Abu Ali and Zuquar islands. The purpose of this traffic routes is to improve safety in navigations.

In order to assure that maritime activities are carried out with due concern to environmental issues, the Port Authority has the vested power to take measures to protect the port (a port covers a certain area of land & sea) from any kind of damage or pollution, to deal with vessels suspected of discharging a marine pollutant and to refuse the storage of certain goods which are not convenient for handling and dangerous to human, property or the environment.

6.1.1. Massawa and Assab Ports

Massawa Port is located on $15^{0}37''$N and $39^{0}29''$E. It is a natural harbor, built by the Turkish in 1655. From 1888 to 1941; it was expanded to the current size during Italian occupation period and became a competitive port that can play an important role in commercial, trading, and economic and communication developments along the Red Sea. The port is founded over an area of 204,057m^2 which consists of general-purpose berths, aprons, Port Area open shed, warehouse, cold storage, open storage facilities container stacking area and truck area. There are 6 berths with an overall length ranging from 80m to 210m and depth of 5.5m to 12m. These berths are normally used by ocean going vessels handling general cargo, bagged and bulk cargo.

The port of Assab which is relatively new compared to the port of Massawa with its separate break water and the seven berths on the north and south jetties was built between 1957 and 1961 by Yugoslav contractor Pomgrad. It has long side berths with depths of up to 11m. Following the Eritrean independence Assab continued to be the main port gateway for Ethiopia handling almost 90% of all Ethiopian exports and imports. Assab has gone from a vibrant active port prior to 1998 to a port with virtually no traffic thus the environmental threat is minimal.

To increase the efficiency and capacity of the two ports a project that costs USD 57.6 has been launched. This project was focused on; extension of berth pavement, dredging and drainage system for the port of Massawa; Procurement of Cargo handling equipment for Massawa and Assab ports comprising of reach stackers, tug masters, trailers and mobile harbor crane; environmental components including equipments and facilities to improve operational practices at the two ports, reception of liquid and solid wastes from ships, oil spill combating equipment and improving safety standards of the two ports.

6.1.2. Threats from Maritime Routes, Harbours and associated settlements

For the coastal strip of the mainland and islands, the main threats are coming from the maritime transport, loading and unloading and from the associated infrastructure and settlements.

The maritime access to Eritrea is linked to the international maritime route going from Bab El Mendab in the South of the Red Sea to the Suez Canal in the North and to the East West connection between Eritrea, Saudi Arabia and Yemen. With the growing number of boat moving on these routes, there is a growing risk of ship accident. A major oil pollution will be an important issue for Eritrea, as the anti-pollution equipment is limited and the national capacity not trained for such an event.

Harbours are subject to oil pollution from ships while anchoring, from different pollutions during operations (water or fuel supply, solid waste disposal, loading-unloading, storage, transport by road) and from pollution related to the associated facilities (such as oil terminal, cement factory, shipyards, fish processing plants) and nearby settlements hosting companies, warehouses and workers related to the harbours.

For the settlements, the two main sources of pollution are the cities of Massawa and Assab, but all coastal villages are subject to coastal pollution, as there is no comprehensive system for liquid waste collection and treatment. One example of sewage water collection and treatment is the Massawa Housing Complex treatment plant reusing the treated water for gardening, but this facility is facing technical and maintenance issues, in relation with the variability of the load, linked to the change in the number of residents and the limited availability of water during the hot season.

6.2 Airports and Airstrips

As part of the national development strategy to enhance tourism and lay ground for the free trade zone an international airport has been recently constructed in Massawa. The construction of this airport is expected to stimulate the development of tourism and trade and other business activities in Massawa and its environs. A similar airport has been realised in Assab and could serve the economic development of the Southern Red Sea Region. Moreover, though currently less active, a small airport is also available on Dahlak El Kebir Island but needs improvement. Other could be developed along the coastal area in the future.

Airports are governed by the National Civil Aviation Department. It regulates compliance of the national airports with International Civil Aviation Organization (ICAO) management standards. For the newly constructed Massawa international airport, the Civil Aviation Department is in charge of supervising that the airport is meeting international standards. In addition for Massawa and Assab, the Urban Development Department of the Municipalities and the Regional Tourism Branch are also putting forth an overarching input to achieve the desired standards.

There is presently no major threats that could be identified in relation with the existing airports, considering the low level of activities.

6.3. Road Network

The road network of Eritrea that basically constitutes primary, secondary and agricultural roads stretches to about 6000 km. Though not yet asphalted, the road connecting Massawa and Assab that goes from the central to the south tip of the Eritrean coastline has been well laid down. With the construction of this road many of the coastal villages such as Ghel'alo, Tio, Edi and other historical and recreational sites like, Zula-Adulis, the Buri Peninsula, the Danakil depression, will get better access of transportation facilities. On the other hand unlike the central and southern part road networks north off Massawa are poorly developed.

6.3.1. Threats from Road Network and its development

The existing network does not present any threats except the pollution from vehicles and damage related to accident, in particular trucks transporting dangerous substances for the environment such as chemicals, oil or fuel.

The main threat to the environment is the lack of proper planning of the new roads, in particular along the coast. A bad planning will result in a loss of opportunities for future development, in a need for additional maintenance to the road and in the reduction or disappearance of important ecosystem such as the mangroves acting as a shoreline protection. In particular, the following elements can generate problems:

- The distance from the sea (setback) is very often too short and the infrastructure will be subject to erosion by the waves, during winter storms or on the long term with the expected sea level rise linked to climate change.
- The crossing of wetlands and the breach of the natural exchanges between sea and land or land and sea inducing the disappearance of ecosystem such as the mangroves protecting the shore.
- The closure of temporary rivers (wadis) stopping or reducing the transport of sediment or nutrient to the sea and accelerating the natural erosion of the shoreline.

6.4. Railway

The railway between Massawa and Asmara (119 km) was established between 1890 and 1920. This section covers an altitude that ranges from sea level to 2,330m, with an average incline of 2% with many switchbacks, bridges and tunnels. Nonetheless, comparing its time of inception due to the continuous political instability that persisted for decades the railway system did not develop and was instead demolished.

In the wake of independence, enormous efforts have been made to revitalize the railway infrastructure. The section between Massawa and Ginda has been recently rehabilitated but the remaining part is not totally operational.

6.4.1. Threats from the railway

There is presently no real threat form the railway but in reverse, its reactivation and use for transport of goods, in particular from Massawa harbour to Asmara, could reduce the traffic on the road and limit the number of truck accidents.

6.5. Electric Power

Since 1999 Massawa has become the power house of electricity for most parts of the country. With the installation of an 80Megawatts electrical power generating engines in the outskirts of Massawa namely Hirgigo; electricity is distributed from the station to the major cities such as Massawa, Ginda, Asmara, Keren, Dekemhare, Mendefera etc. However, islands and resorts in remote coastal areas lack electricity supply. Power generation will need to be provided on site by the resort developers or the integrated resort development company.

The Hirgigo power plant located at the vicinity of the coastline takes advantage of the nearby sea water for its cooling systems. In the operation system water is pumped from 50m offshore, and is discharged back into the coastal waters at no more than 6^0C above the ambient temperature of the sea water. In addition the power plant has also its own desalination plant capable of producing 1000m³ per day.

The future options for production of energy Eritrea are certainly in the installation of wind mills (experimental project near Assab) or the solar (everywhere) or geothermal energy (near faults and in areas of volcanic activity).

6.5.1. Threats from the Electric Power Production Centres

Power plants using fuel are a source of pollution and they need to be cooled. For this purpose, along the shore, the pumping of sea water and the discharge into the sea at a higher temperature is the most economic option but can generate problems in the marine environment such as damage to ecosystems and creation of red tides poisoning numerous species in the area of influence.

6.6. Industries

Eritrea has traditionally been a major producer and exporter of Sea-Salt. By far the largest part of the production in Massawa and Assab was oriented towards markets in the east African region, especially to Ethiopia and the Great Lakes. The nominal capacity is approximately 80,000 tons per year, but the real production varies annually, depending on natural circumstances such as hours of sun and rainfall production generally varies between 50 and 70,000 tons per year. After the conflict with Ethiopia, the company has failed to export at its traditional export levels.

The Eritrean cement factory is also found in the city of Massawa was erected in 1964, and produces cement using locally obtained coral limestone. The factory is designed to produce a maximum capacity of 60,000 tons of cement per year. Given its age, several part of the plant has been rehabilitated since 1964. Even so due to the old equipment in use, the present capacity is reported to be 40 to 50,000 tons per year. This level of production is not on its own enough to cover the national demand. However, there is a great concern by environmentalists for the cement plant releasing dust and creating siltation in for the surrounding coral reefs.

6.6.1. Threats from industries

Industry being associated generally with pollution, each industrial activity needs to prepare its Environmental Impact Assessment (EIA), even if the installation is installed for a long time, in order to minimise the specific impacts to each sector.

6.7. Free Trade Zones

The Government of the State of Eritrea has introduced the establishment of Free Trade Zones in different administrative districts of the country. Proclamation No 115/2001, also known as " The Eritrean Free Zones Proclamation" defines the objectives of the establishment of Free Zones in Eritrea in general as follows; '*Objectives of the Free Zone program in Eritrea shall be to contribute to the development of an internationally competitive business sector in Eritrea by creating an environment in which domestic and foreign investors will be encouraged to invest in export business activities,'* thereby *; create employment, extending the technology base, developing the technical and managerial skill of the Eritrean workforce, and expanding Eritrea's external business and marketing contacts*

With the plan to increase export oriented domestic production Massawa as the sea gateway of the country will play a key developmental role. For this purpose, the Eritrean Free Zones Authority gazetted the land area of the Gherar and Abdel Kader peninsula, the Ras Dogon headland and a substantial part of the coastal fringe as part of the Massawa free trade zone. Hence, there is a great potential of different infrastructures that support the free trade zone to be built and may affect the coastal environment. In September 2006, another Decree was issued extending the Massawa Free Zone to include Massawa Port, Airport and all public fuel deposits outside serving the Massawa port and airport compounds. For Assab, the Free Zone will include Assab port, airport, refinery salt works and all public fuel deposits outside serving the Assab port and airport compounds.

6.7.1. Threats from Free Trade Zones

As stated before, the main threat generated by any industrial activity is the risk of pollution. As a free zone is expected to concentrate numerous industrial activities, a proper planning is essential. Not only each Free Zone has to be considered internally for its safety, but also externally for its impact on the surrounding population, natural resources (water), transport, liquid or solid waste management, housing or on need in energy in order to avoid to destabilise a nearby municipality. It is generally recommended to prepare a Strategic Environmental Assessment (SEA) for such facilities as it is the case for tourism areas regrouping numerous resorts and associated facilities.

6.8. Oil Terminals

Massawa has two oil importing terminals the "*Mobil/Total terminal*" on Abdel Kader peninsula (enclosed by the present Navy Base) and the "*Shell Terminal*" in the southern part of Hirgigo bay. Petroleum is imported by the Eritrean Petroleum Corporation and unloaded by Shell and Mobil/Total companies, which are also responsible for the products once stored in the deposit tanks.

During unloading, particularly in the shell terminal (Hirgigo bay) sometimes oils leakage occurs, and is dispersed by winds creating a thin oil surface tension layer over the waters of the Sheik Seid Island threatening its corals and hence its tourism potential. Following agreement between the Government of Eritrea and the World Bank, a new jetty will be built at the same site (longer and safer) to replace the existing one which presents numerous weaknesses.

6.8.1. Threats from the Oil Terminals

Oil terminals on the seashore can be a source of oil pollution during access to the facility, during unloading the oil or during the transport from the oil terminal. A permanent review of the security and safety procedures is a normal activity in an oil terminal and they have to be more frequent when the installation is old or near a human settlement. The definition and respect of a very strict setback for oil terminals is essential for the security of the installation.

7. Tourism

7.1. Tourism and the Eritrean Coastal Environment

Eritrea, bestowed with more than 1,350 km of mainland coastline and more than 350 islands and islets with an additional coastline of more than 1,950 km, is characterized by an array of highly distinguished marine and coastal ecosystems. These ecosystems incorporate a variety of habitats which are represented by extraordinarily spectacular creatures that are of high interest for the tourism industry; the sandy beaches and the colourful coral reef communities that attract tourists for snorkelling and diving.

The presence of historical and archaeological sites, such as Adulis or the necropolis on Dahlak El Kebir Island, the prevalence of very unique climatic features and the existence of the awesome wildlife survivors bolster related recreational and tourism activities.

At a national level, future tourism in Eritrea heavily relies on the coastal environment. The establishment of different tourism centres, hotels, resorts, ecotourism opportunities and related supporting facilities; diving centres, marinas and recreation centres pulls in the tourism activities towards the coastal environment.

Different from many coastal environments of the world, the pristine and unpolluted waters of Eritrea will draw the attention of many beach and sea hobbyists. Accordingly, as one the leading resources, the government is working conscientiously on developing and expanding coastal tourism, for it to play its role in building the national economy.

7.2. Sites of Importance for Tourism

In addition to numerous coastal and island landscapes, the Red Sea coast of Eritrea presents specific features of interest that are described in the following paragraphs:

- The Buri Peninsula is one of the areas where Dorcas and Soemmerring's gazelle are found abundantly. More importantly, it is also a home place for the African wild ass (one of the last groups of this endangered species in the world). To the east of the Peninsula, the Hawakil Bay encompasses the rugged islands of the Hawakil archipelago, and a rich marine habitat of mangroves, corals and sea-grass beds. Ostrich (*Struthio camelus*) are also still well distributed in the Buri Peninsula, and are often found close to settlements. For such a combined importance the Ministry of Agriculture (MoA) has proposed Buri peninsula as one of the country's protected areas.

- Despite the harsh environmental conditions the Soemmerring's gazelle is widely distributed in the coastal plains including Dahlak Kebir Island. Soemmerring's gazelles that are found in the Dahlak Kebir Island are referred to as a 'dwarf' mainly because of their smaller size as compared to their mainland counterparts, which is attributed to environmental stresses and water and food limitations.
- The Danakil Depression, proposed also as a Protected Area, extends over the NRSR and the SRSR, and includes volcanic lakes. Desert safaris could be organized including visits to Afar camps and exposure to Afar life style. Accommodation could be developed in adapted Afar Burra's and Rashaida Bedouin tent camps in and nearby Danakil. Oryx (*Oryx beisa*) also used to occur in the Danakil area, but disappeared as it is suspected they were hunted during the liberation war, and could be reintroduced.

- Adulis Archeological Site is the oldest port on the Red Sea, and this archeological site, presently completely covered by sand and sediment, needs to be investigated, and information and relevant facilities available for visitors.

- The old prison of Nokra Island, near Dahlak Kebir, is abandoned but has intact buildings of historic and architectural interest. The site will be investigated for historic value and feasibility for preservation and perhaps tourist facility use.

- The city on the island of Massawa has an historic and architectural interest, with a mixture of Turkish, Egyptian and Italian Moorish style buildings. Rehabilitation is needed and there is a proposal for proposing the island as a cultural site under World Heritage UNESCO classification. With the improvement of the facilities and infrastructure on the Island of Taulud and the development of the city on the mainland including the international airport, the city of Massawa has an important potential for national and foreign tourism. The relocation of the commercial harbour facilities and the creation of a marina are part of this overall improvement, as well as the declaration of the nearby Sheik Seid Island (also Green Island) as a marine and terrestrial protected area for public awareness and education on the marine and coastal environment.

7.3. Tourism Infrastructure

The majority of the tourist oriented activities along the coastal area are presently within the Northern Red Sea Region (Zoba). The present tourism activities within this vast region includes the development of recreational centre on Dissei Island, the opening of a new hotel in Ghel'alo, the building of a resort hotel (Millennium Beach Hotel) at the Gurgussum area, and the maintenance as well as expansion of Dahlak Hotel in Massawa, together with the rearrangements of the coastal areas of Massawa and Taulud islands for the development of a large resort and a marina. This complex will allow activities such as visiting the islands for recreation and diving. The regional tourism office in Massawa regulates and incorporates all the tourism and tourism related activities through out the region.

The Southern Red Sea Region is far from the capital of the country and the road network from Massawa to Assab is not completed. The development of tourism is therefore delayed except some minor activities South of Tio and in Assab. Other options for the future include Beilul, Barasole and Tio.

7.4. Coastal Tourism Development Plan, 2000-2020

The Ministry of Tourism is the National Tourism Administration (NTA) of Eritrea. In general the Ministry has the vested responsibility to regulate tourism and any tourism related activities. As a slowly growing body the Ministry has been engaged in laying down basic tourism facilitating infrastructures and facilities, and institutionalizing and drafting management regulations and guidelines. As indicated in the Tourism proclamation (162 of 2006) Chapter 3, Article 4, the Ministry is ascribed to; regulate the planning and operations of hotels, restaurants, and tourism enterprises; the enforcement of requirements for the preparation and submission of environmental impact assessments for new tourism installations and facilities; initiate new opportunities to strengthen the national tourism, ensure the achievement and maintenance of specified minimum standards; the enforcement of building, fire prevention, hygiene and sanitation regulations and establish regional tourism offices.

For the 2000-2020 period, the Ministry of Tourism has prepared a plan for the country with special sections for the coastal areas and the islands. This plan, embedded in the context of national perspectives, reflects the objectives of the National Economic Framework and Program (NEPFP). From the social, economic or environmental viewpoint, the plan is firmly rooted in national policies and perspectives. At the national level the Ministry of Tourism has planed different tourism development activities including construction of basic infrastructure and different type and size of hotels and of recreational centres. Each regional has been considered separately in order to facilitate the implementation of the activities and to incorporate them into the regional administration and development policies.

Within this plan, for the Northern Red Sea Region, the main sites considered are:
- the war damaged seaport city of Massawa island,
- the numerous coastal beaches, such as Gurgussum Beach Resort located north of Massawa for national tourism, Artau on the northwest coast of Buri Peninsula and in the long term, other sites such as Marsa Gulbub, Marsa Ibrahim and Ras Kubaa on the northern coast have been proposed.
- the islands of Dahlak Kebir for natural and archaeological tourism in relation with the Necropolis of the early Islamic age and Dissie Island for nature oriented tourism.
- Facilities are planned in the proximity of archaeological and historical sites such as Adulis or the Necropolis of Dahlak El Kebir
- Also, the proposed protected areas of the Buri Peninsula area and of the Danakil depression will be considered for some infrastructure
- Inland, the Akwar and Mai-Wooi hot springs are of interest for developing spa health resorts.

From Asmara and its international airport, the only access to the region is via the high scenic escarpment road. The new airport of Massawa can also provide direct international access. In the future the Massawa harbour can receive more yacht and cruise ship. The coastal road will play a major role linking Massawa and Assab and providing access to different tourist sites

The Southern Red Sea Region has an important potential for nature tourism for both national and regional markets. The coastal road is under construction and will allow for the development of tourism in the medium to long term. The tourism development plan include basic activities such as adventure safaris focused on the Danakil Depression and in relation with the Rashaida tribes cultural patterns, beach resort development at Beilul and Barasole, and new tourism facilities in the Assab area and in Assab bay. Other opportunities could be defined for this region.

7.5. Threats from Tourism

The main threats from tourism have been identified as follows:
- Lack of proper planning, in relation with the lack of legislation, regulations and enforcement.
- Environmental Impact Assessment is obligatory but not implemented.
- No respect of a setback for tourism or related infrastructure
- Impact on limited resource such as water indicates that tourism development have to be in total autonomy for water and energy and including sewage water treatment plant
- Limited consultation with local population: social impact can be positive or negative

8. The Way Forward

With a coastline of more than 3,300 km (mainland and islands), Eritrea has a major asset and part of its future is along this coastline, as many different activities are linked to the sea, including fisheries, tourism and transport.

Commonly coast or coastal area is equated with shores of an ocean, sea, lake or any large body of water, areas surrounding such water body. For environmental sustainable management purposes coastal area means all areas that have connection to the water body. Such areas have an impact on the water body and are impacted by the water body. In our case coastal area includes the entire watershed on terrestrial/land side and the territorial waters of Eritrea including the islands on the marine side.

From the first draft of this document in May 2005, numerous changes have occurred along the coast and it is evident that without proper regulations and management, the country can loose numerous opportunities.

For this reason, the ECMIB project has accelerated two other activities, the preparation of the Coastal Policy (final draft in December 2006) and of the Integrated Coastal Area Management Plan (ICAM - on going activity). The next step is the preparation of the legislation for the coast and the definition of the administration for its implementation.

The Eritrea's proposed Coastal Policy is a framework meant to serve as base for laws, rules, regulations, guides and institutional structures for sustainable management of the coastal area natural and human-made assets. It was prepared by the participation of practically all concerned ministries and organisations, inter alia, has four main objectives: sustainable use of the coastal area for multiple purposes, location of coastal facilities and development projects in consideration of the coastal process, protection of public foreshores or establishing appropriate setbacks (public property areas) and protection of natural and cultural values of the area. Any Policy is based on principles; in our case the guiding principle, as clearly stated in the Constitution is- we shall meet our needs without comprising the ability of future generations to meet their needs or we shall develop without destroying the chances of future generations to develop.

In 1995, the Government of Eritrea adopted an integrated approach for development. The preparation of the Integrated Coastal Area Management Plan is trying to apply the overall Government development approach to the coastal area as defined above.

ICAM is a mechanism that avoids and mitigates environmental damage through coordinated planning and implementation of activities and minimizes unknown risks using the precautionary principle. It can also be understood as a tool that enables conservation of ecosystems by managing development activities. In addition to ecosystem conservation benefits ICAM enhance the value of the coastal assets. ICAM will enable us to define location of facilities and development activities in line with national needs and sustainability opposed to investor preferences only in the coastal area; and to resolve and mitigates conflict of interest over the assets.

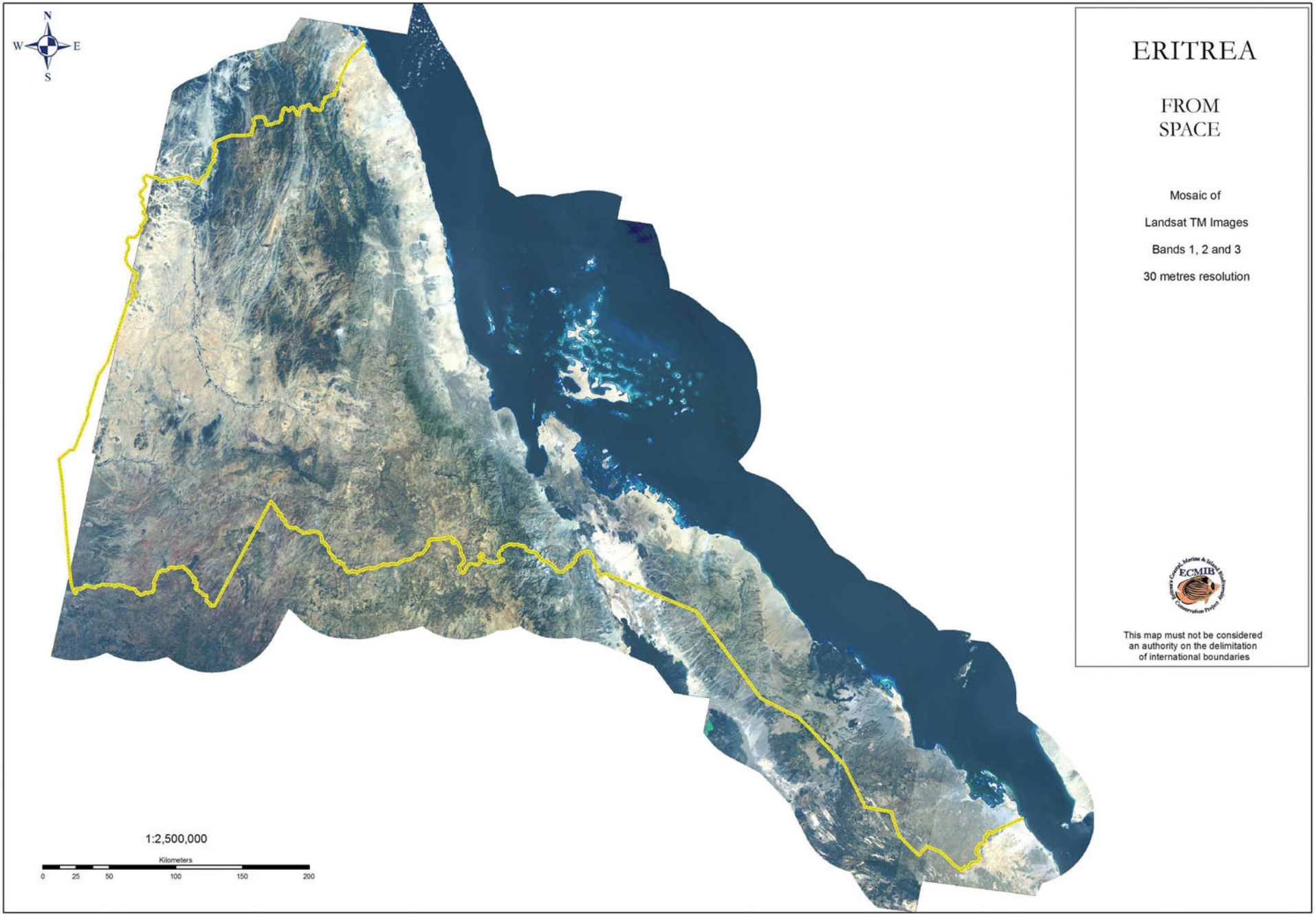
Some progress has been made in preparing the ICAM plan, for example, in defining set back area (horizontal distance from a point at the sea shore where no structural development is permitted and such area is public property even for use), in collecting data and information, mapping the coastal area, etc.

Implementation of the Coastal Policy requires enacting law, establishing appropriate body mandated by law and preparation of ICAM plan. The ECMIB project, in cooperation with all key national stakeholders, is making concerted efforts to prepare this legislation (first draft under preparation).

Implementing specific activities is the responsibility of relevant line ministry, organisation, region, community, civil society, etc., but there will be a lead ICAM coordinating body. After all, as the name indicates, ICAM is coordination and integration of plans and activities of different sectors for sustainable management of the coastal area assets.

Mainly because of the independence struggle, the coastal area and the marine domain are considered relatively pristine, and we need to appropriately address developmental issues in the coastal area to benefit from and safeguard the integrity of the ecosystem in the area.

Kaleab Negussie,
National Project Manager – ECMIB - GEF
May 2007



ERITREA

FROM SPACE

Mosaic of

Landsat TM Images

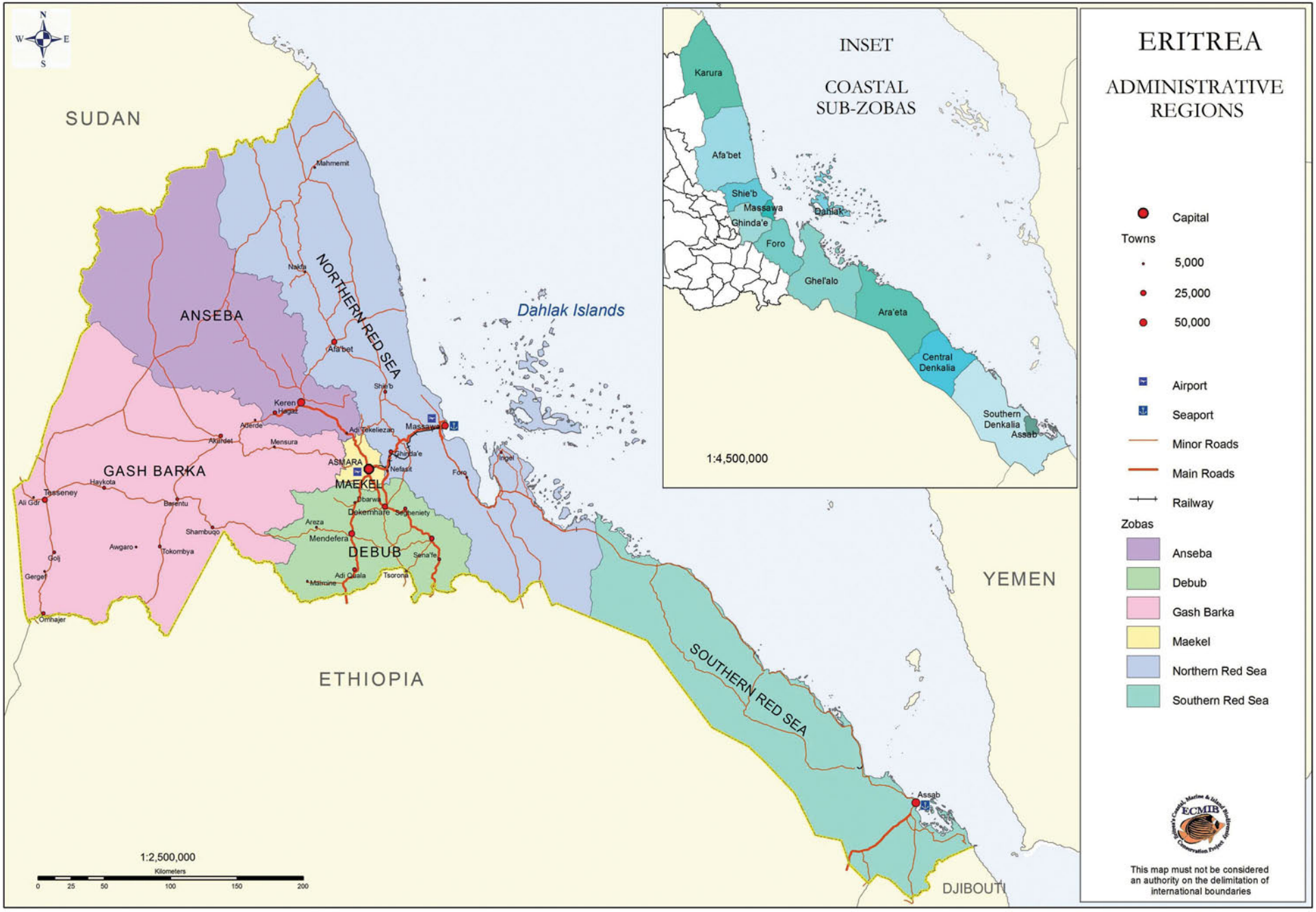
Bands 1, 2 and 3

30 metres resolution

ECMIB

Coastal, Marine & Island Biodiversity Conservation Project

This map must not be considered an authority on the delimitation of international boundaries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Afa'bet
Shie'b
Massawa
Ghinda'e
Foro
Dahlak
Ghel'alo
Ara'eta
Central Denkalia
Southern Denkalia
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ANSEBA
GASH BARKA
MAEKEL
DEBUB
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SOUTHERN RED SEA
Dahlak Islands
Mahmemit
Nakfa
Afa'bet
Shie'b
Keren
Hagaz
Aderde
Akurdet
Mensura
Adi Tekeliezan
Massawa
Ghinda'e
Nefasit
ASMARA
Ingel
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Haykota
Tesseney
Ali Gdr
Barentu
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Tokombya
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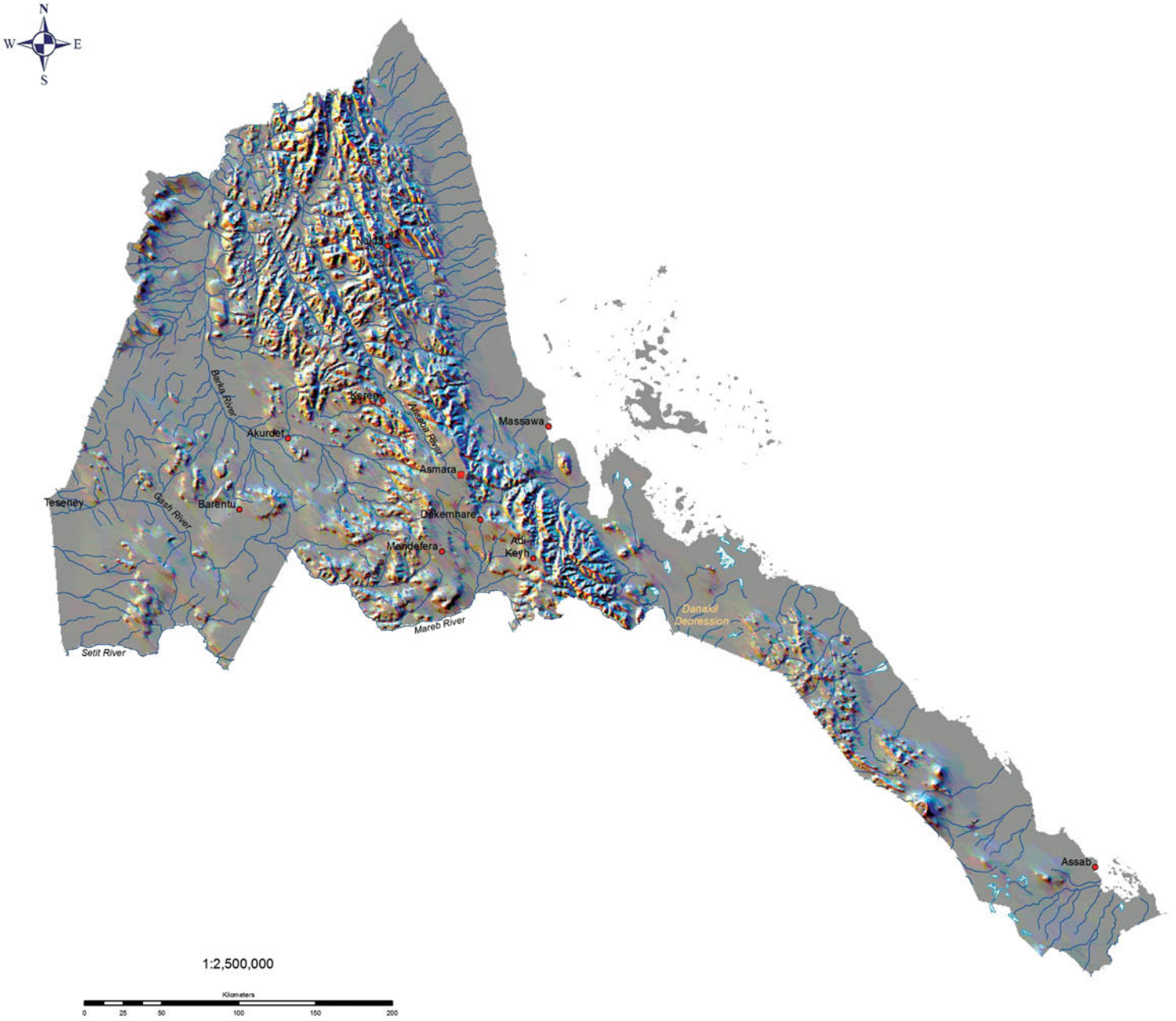

ERITREA

SHADED RELIEF

RGB Multiband Relief Shading
based on illumination from
three coloured light sources.
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Source data : digital contours from
Ministry of Land, Water and Environment

Major Towns

- Capital
- Other Centres

Salt Lakes

Main Rivers
(Many intermittent)

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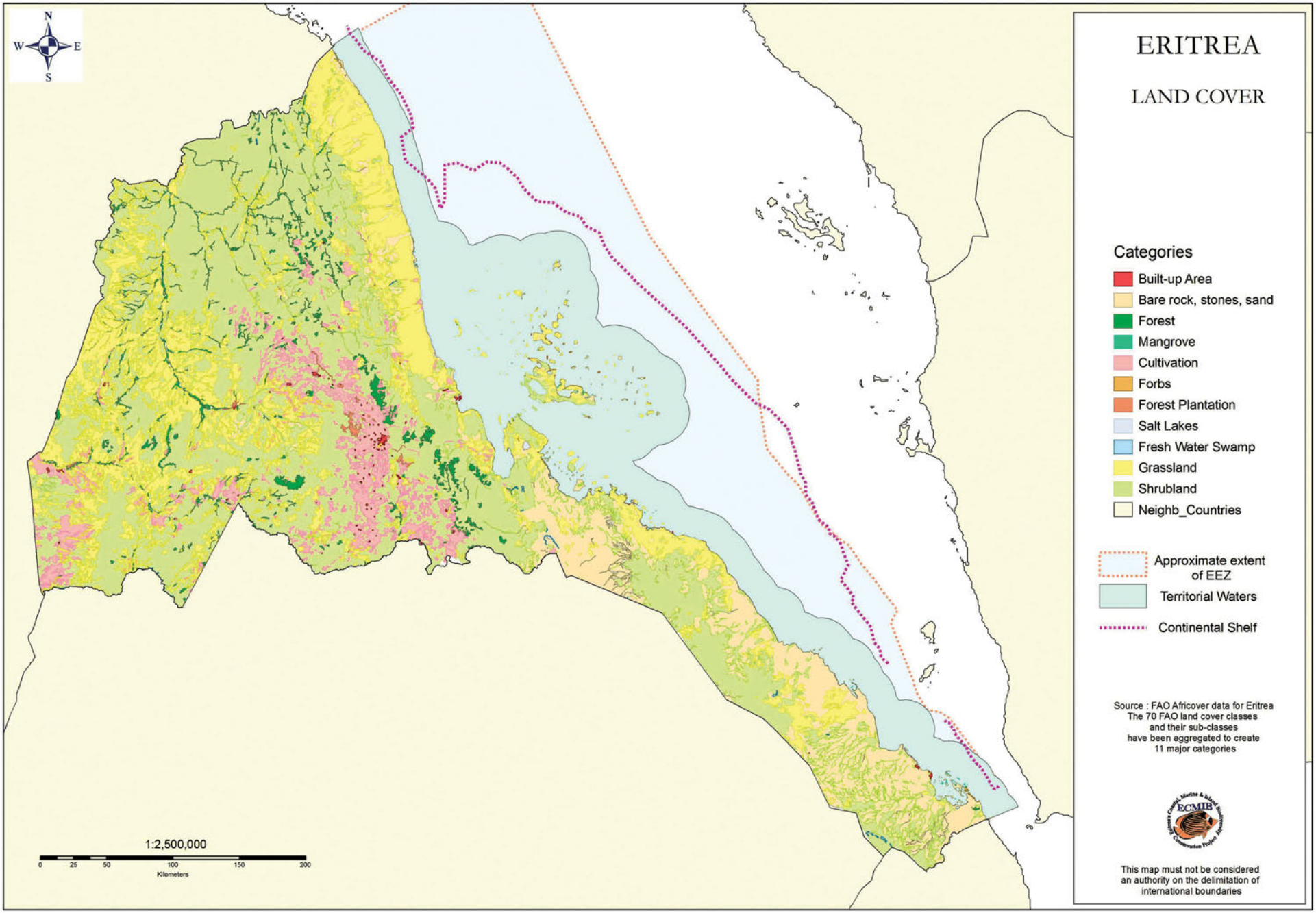
an authority on the delimitation
of international boundaries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ERITREA
LAND COVER
Categories
Built-up Area
Bare rock, stones, sand
Forest
Mangrove
Cultivation
Forbs
Forest Plantation
Salt Lakes
Fresh Water Swamp
Grassland
Shrubland
Neighb_Countries
Approximate extent of EEZ
Territorial Waters
Continental Shelf
Source : FAO Africover data for Eritrea
The 70 FAO land cover classes and their sub-classes have been aggregated to create 11 major categories
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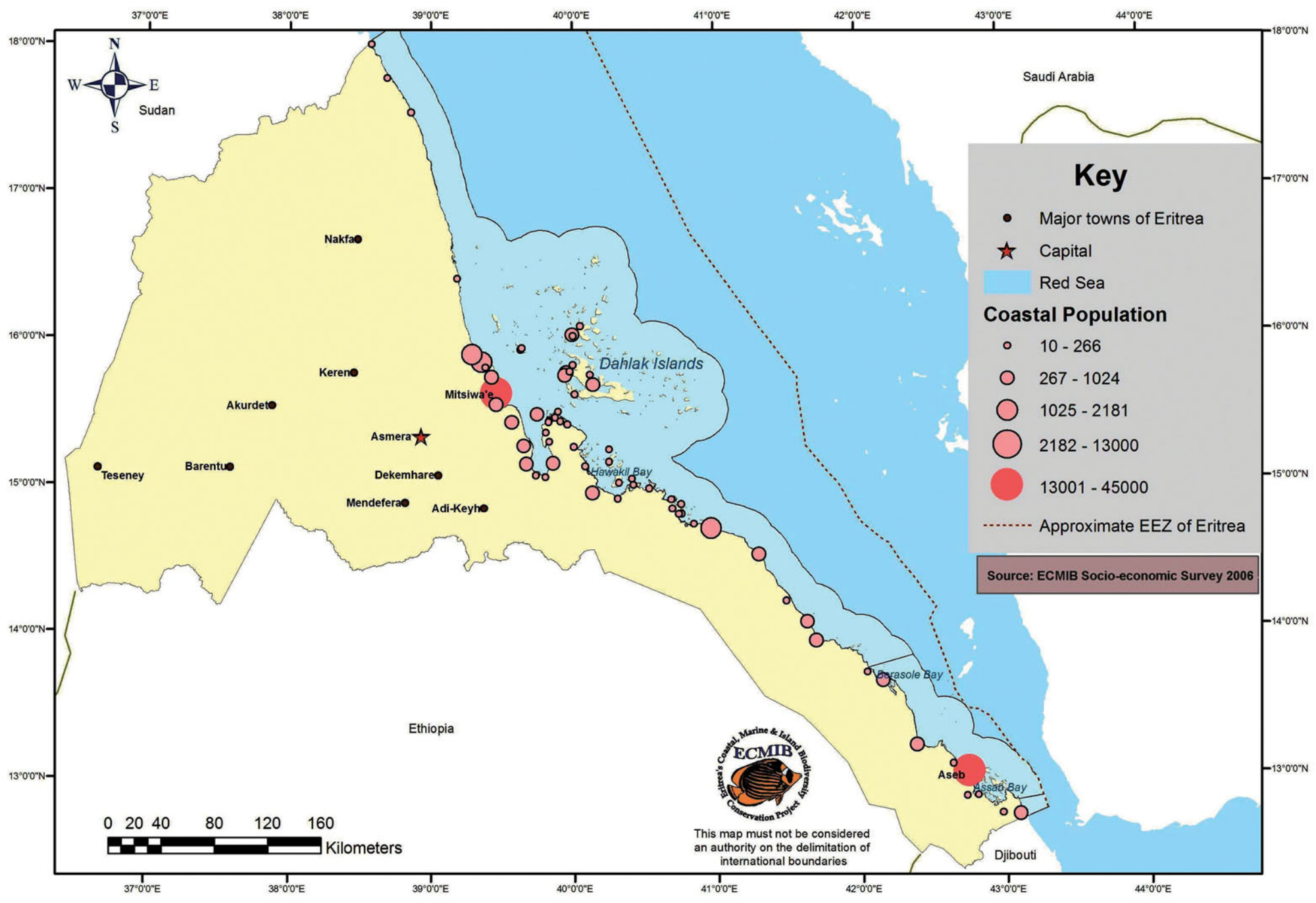
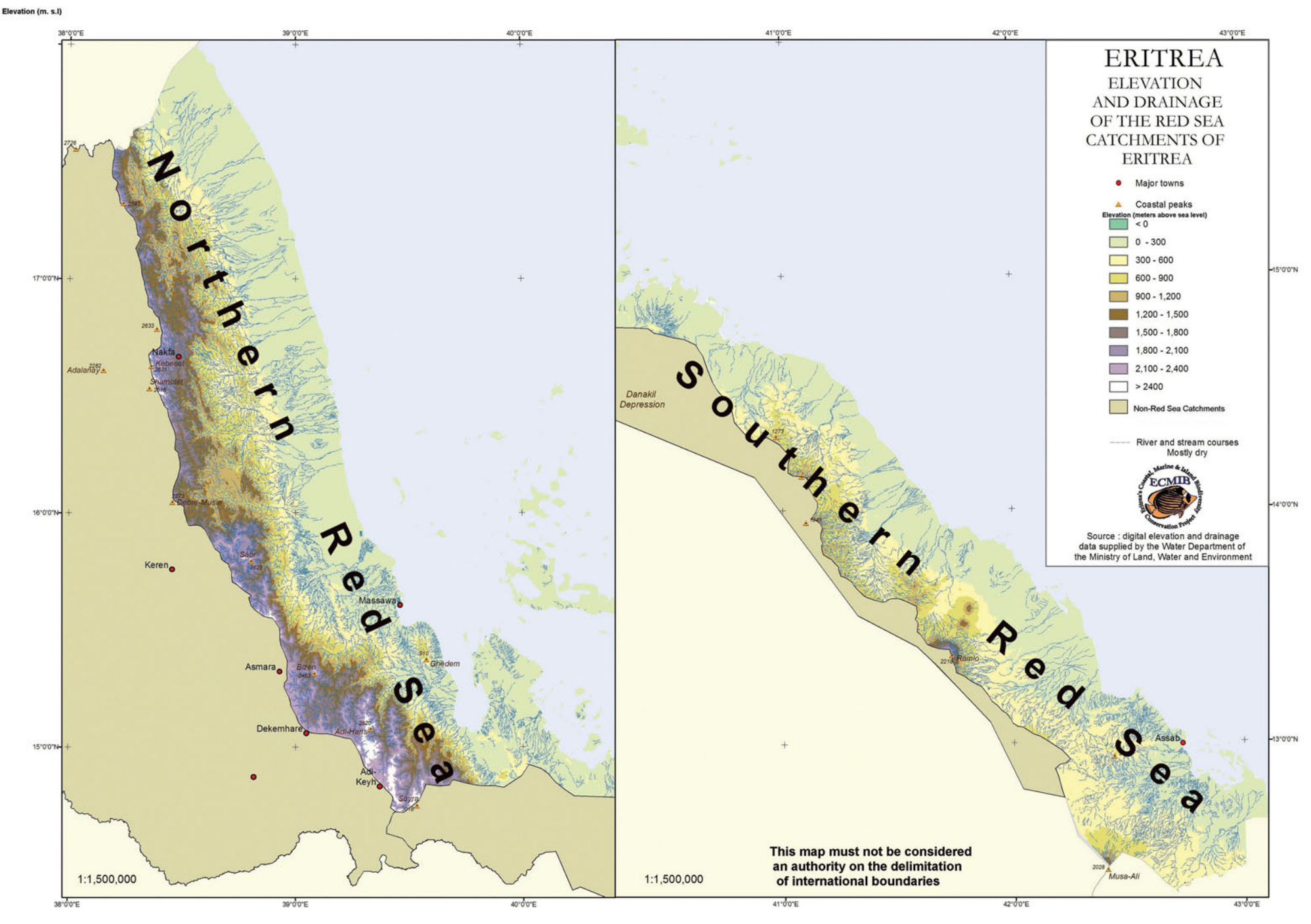
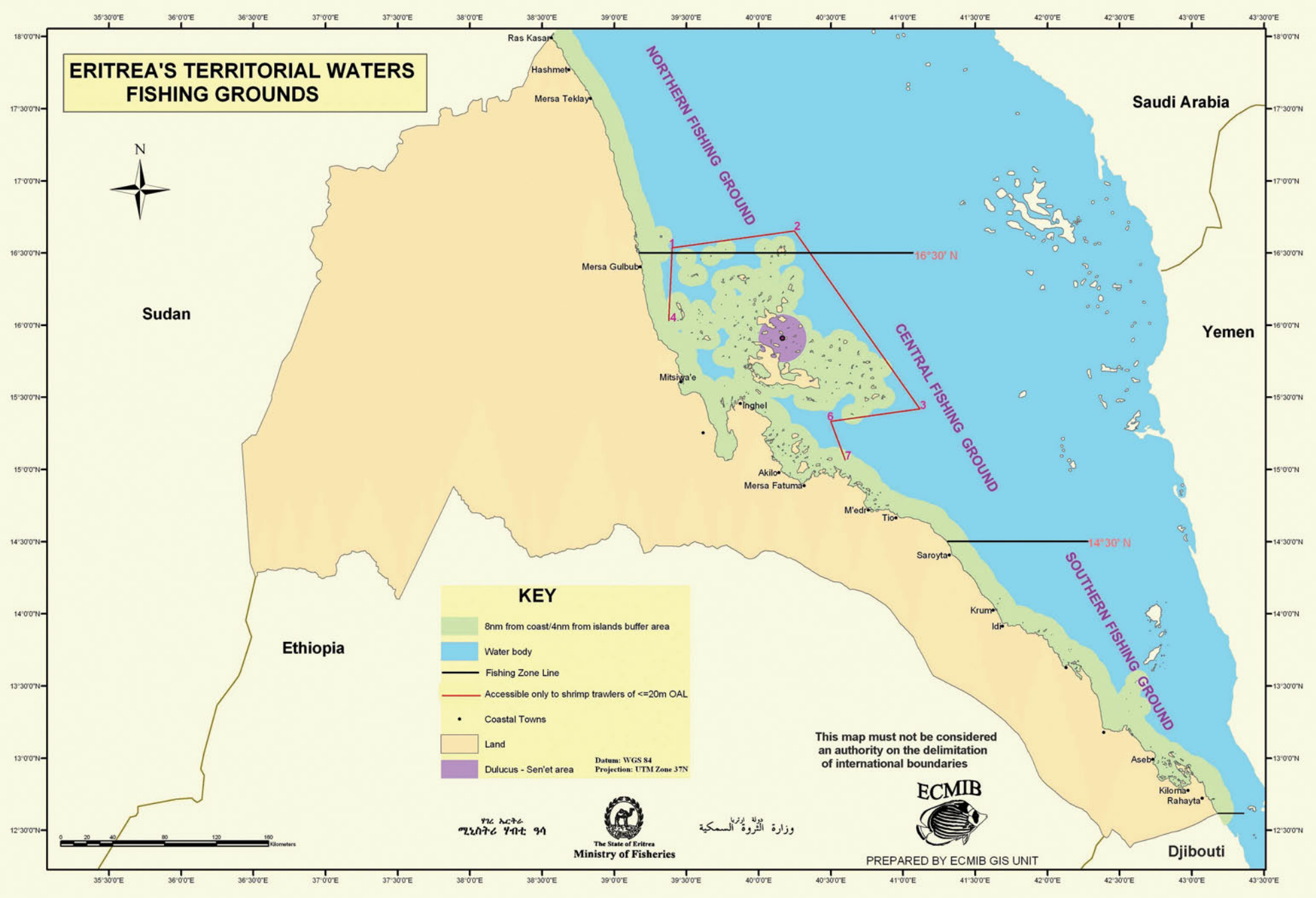
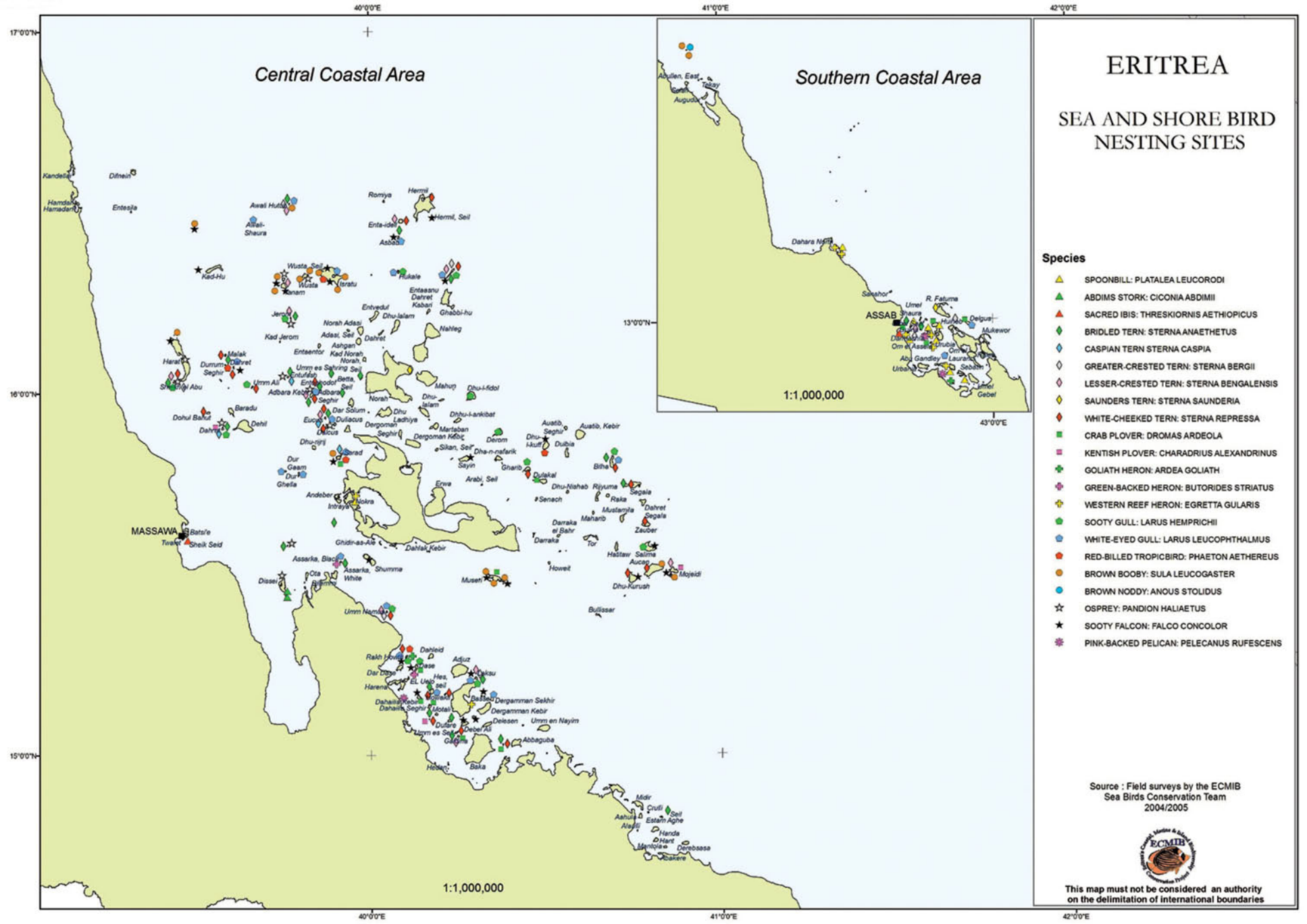
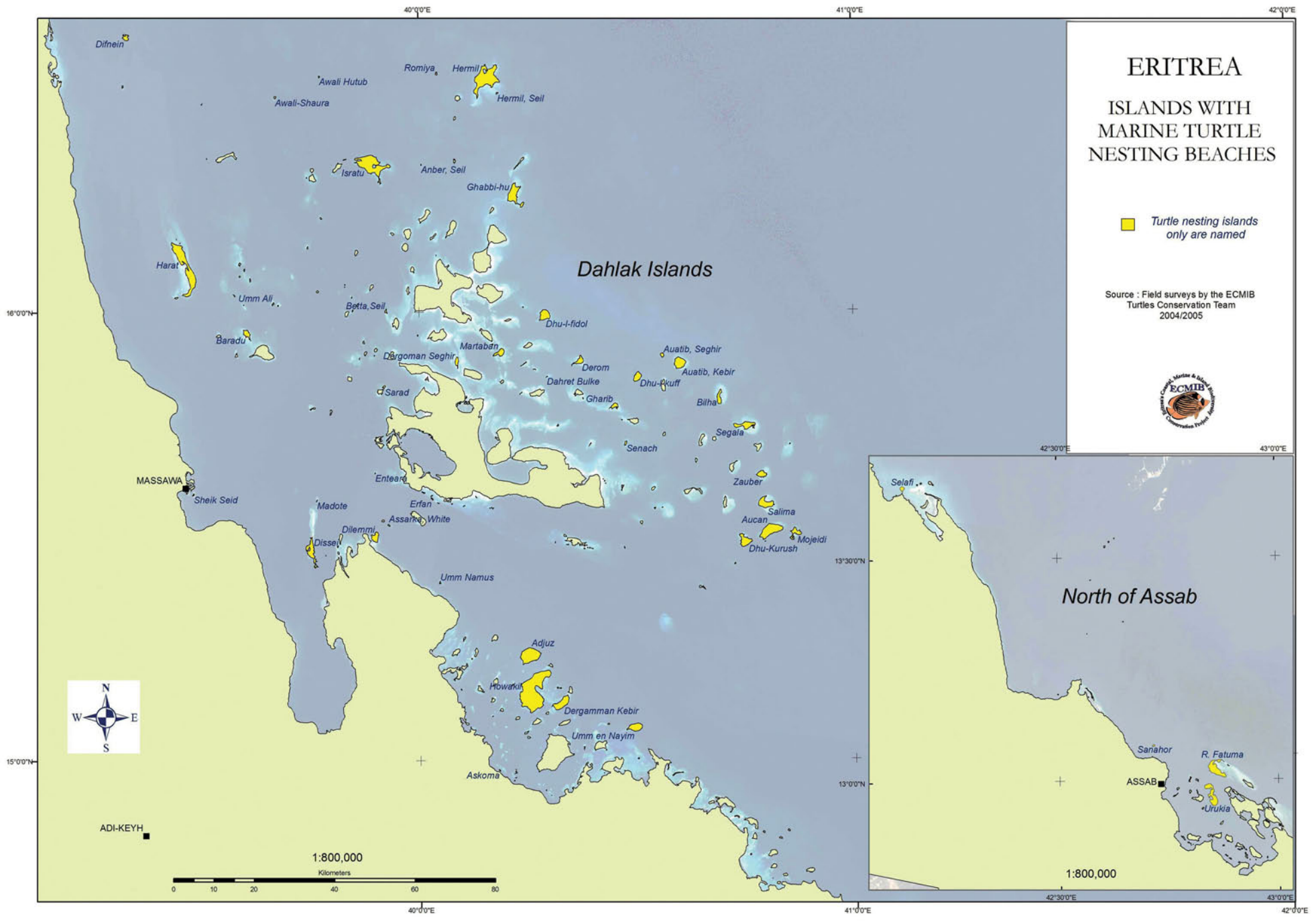
0 25 50 100 150 200
Kilometers

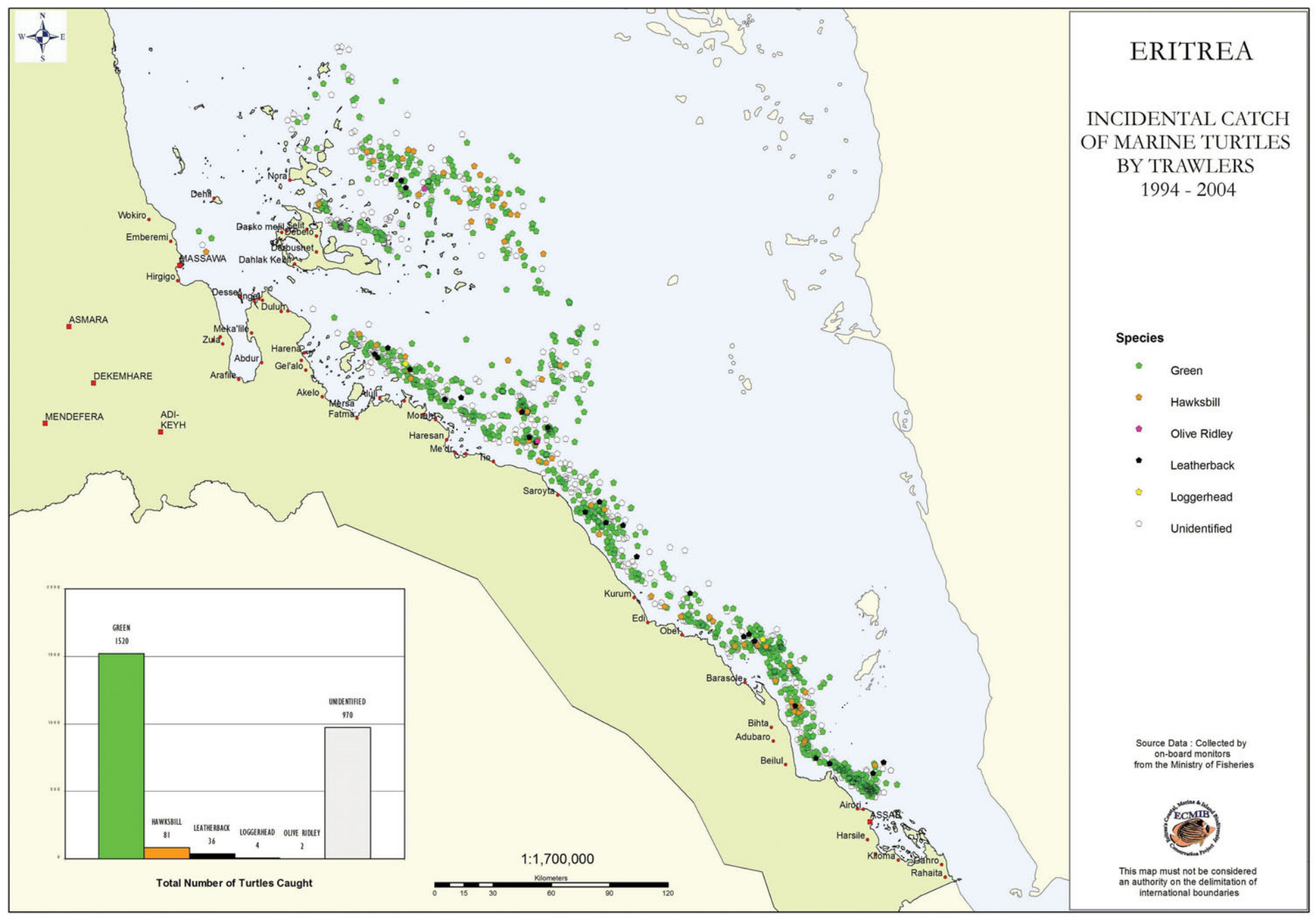

37°0'0"E
38°0'0"E
39°0'0"E
40°0'0"E
41°0'0"E
42°0'0"E
43°0'0"E
44°0'0"E
18°0'0"N
17°0'0"N
16°0'0"N
15°0'0"N
14°0'0"N
13°0'0"N
N
W
E
S
Sudan
Saudi Arabia
Ethiopia
Djibouti
Nakfa
Keren
Akurdet
Mitsiwa'e
Asmera
Teseney
Barentu
Dekemhare
Mendefera
Adi-Keyh
Dahlak Islands
Hawakil Bay
Zula Bay
Assab Bay
Aseb
Key
Major towns of Eritrea
Capital
Red Sea
Coastal Population
10 - 266
267 - 1024
1025 - 2181
2182 - 13000
13001 - 45000
Approximate EEZ of Eritrea
Source: ECMIB Socio-economic Survey 2006
0 20 40 80 120 160
Kilometers
ECMIB
Eritrea's Coastal, Marine & Island Biodiversity Conservation Project
This map must not be considered an authority on the delimitation of international boundaries

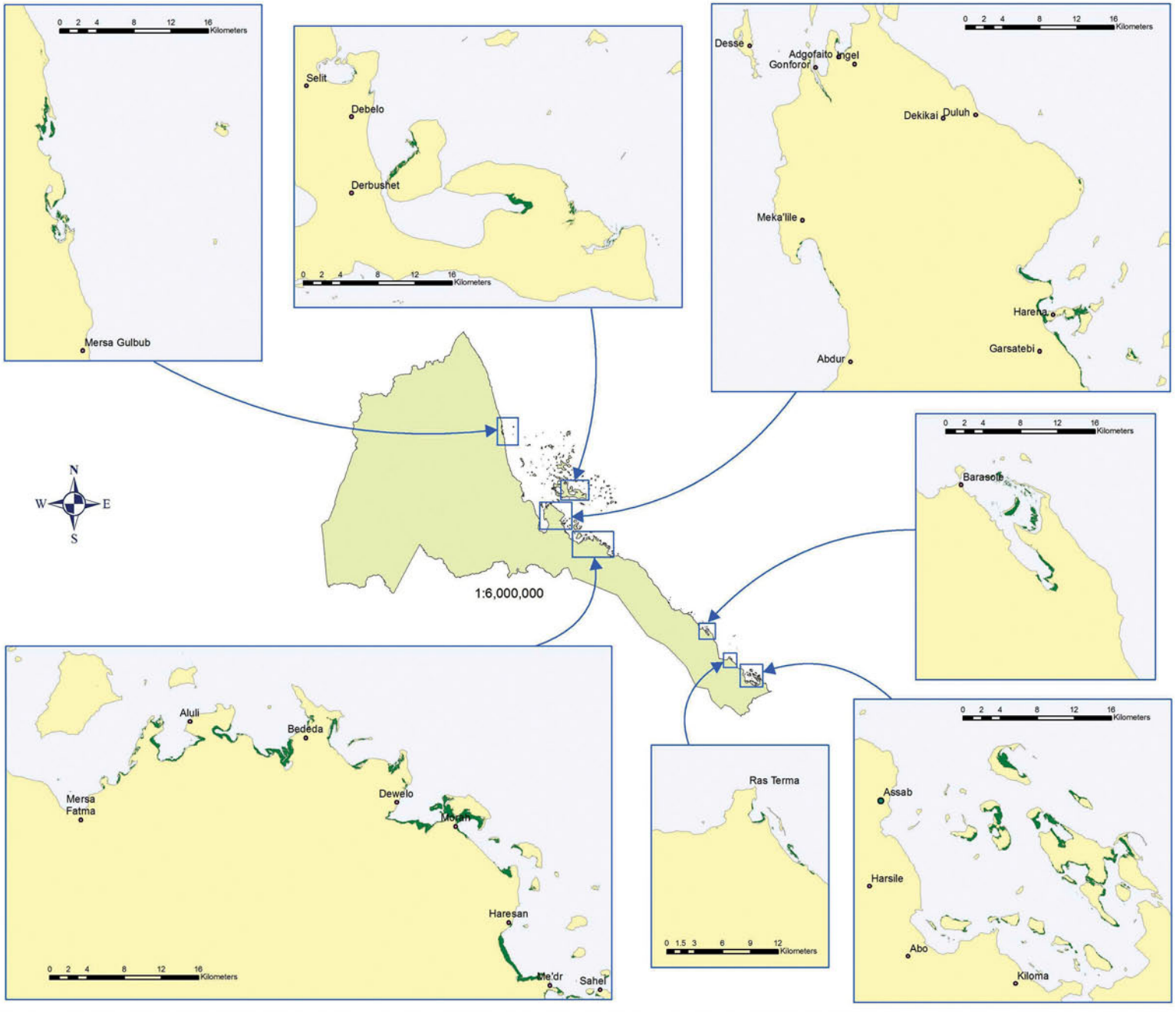

Elevation (m. s.l)
38°0'0"E
39°0'0"E
40°0'0"E
41°0'0"E
42°0'0"E
43°0'0"E
17°0'0"N
16°0'0"N
15°0'0"N
14°0'0"N
13°0'0"N
Northern Red Sea
Southern Red Sea
Nakfa
Keren
Massawa
Asmara
Dekemhare
Adi-Keyh
Assab
Adalanay
Debre-Musie
Sabr
Bizen
Ghedem
Adi-Hanis
Sayra
Danakil Depression
Ramlo
Musa-Ali
1:1,500,000
1:1,500,000
This map must not be considered an authority on the delimitation of international boundaries
ERITREA
ELEVATION AND DRAINAGE OF THE RED SEA CATCHMENTS OF ERITREA
Major towns
Coastal peaks
Elevation (meters above sea level)
< 0
0 - 300
300 - 600
600 - 900
900 - 1,200
1,200 - 1,500
1,500 - 1,800
1,800 - 2,100
2,100 - 2,400
> 2400
Non-Red Sea Catchments
River and stream courses
Mostly dry
ECMIB
Source : digital elevation and drainage data supplied by the Water Department of the Ministry of Land, Water and Environment

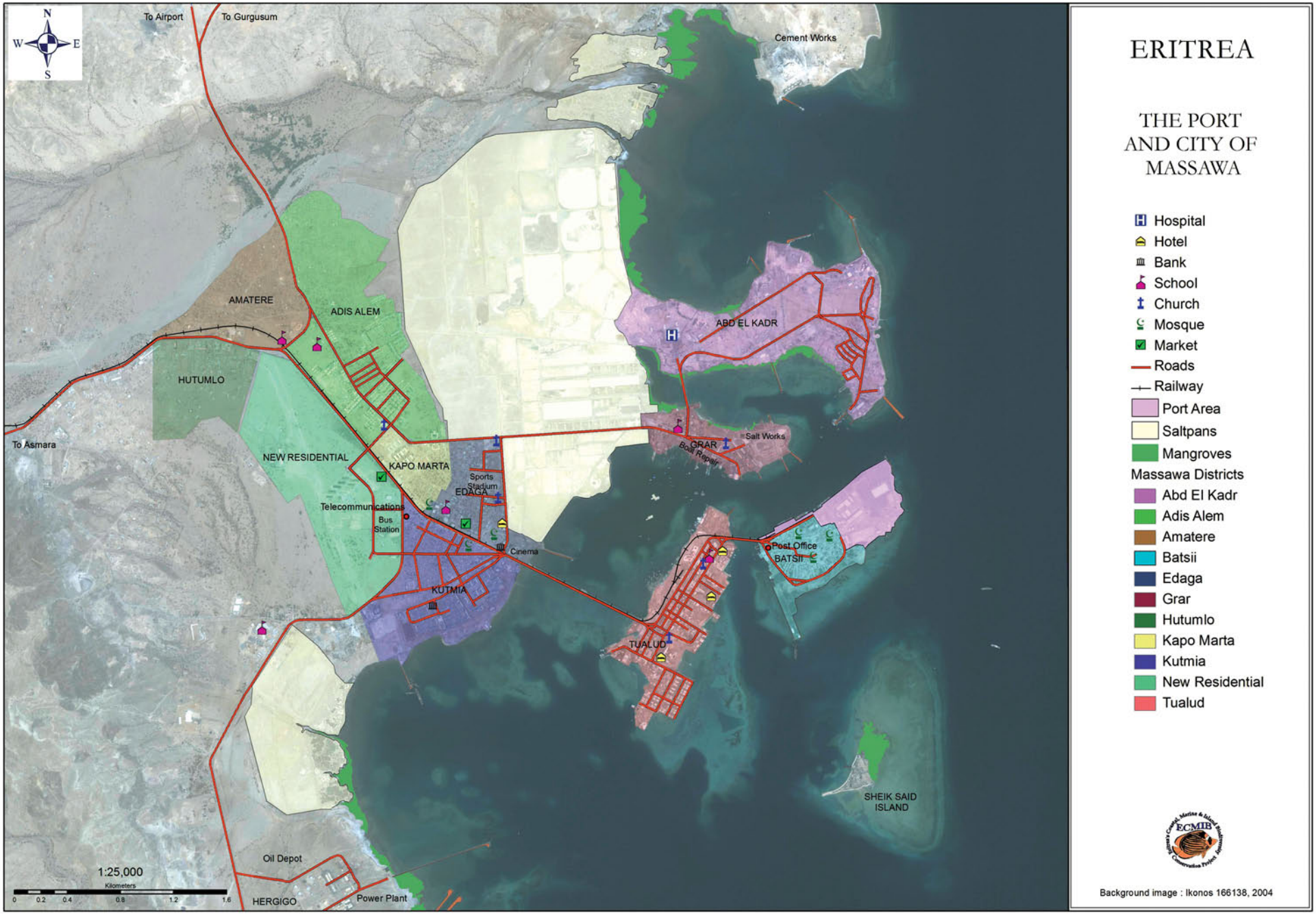

ERITREA'S TERRITORIAL WATERS
FISHING GROUNDS
N
Ras Kasar
Hashmet
Mersa Teklay
Mersa Gulbub
Mitsiwa'e
Inghel
Akilo
Mersa Fatuma
M'edri
Tio
Saroyta
Krum
Idi
Aseb
Kiloma
Rahayta
NORTHERN FISHING GROUND
CENTRAL FISHING GROUND
SOUTHERN FISHING GROUND
16°30' N
14°30' N
1
2
3
4
6
7
Saudi Arabia
Yemen
Djibouti
Sudan
Ethiopia
KEY
8nm from coast/4nm from islands buffer area
Water body
Fishing Zone Line
Accessible only to shrimp trawlers of <=20m OAL
Coastal Towns
Land
Dulucus - Sen'et area
Datum: WGS 84
Projection: UTM Zone 37N
This map must not be considered
an authority on the delimitation
of international boundaries
ECMIB
PREPARED BY ECMIB GIS UNIT
The State of Eritrea
Ministry of Fisheries
وزارة الثروة السمكية
0 20 40 80 120 160 Kilometers


ERITREA
SEA AND SHORE BIRD NESTING SITES
Central Coastal Area
Southern Coastal Area
1:1,000,000
1:1,000,000
Species
SPOONBILL: PLATALEA LEUCORODI
ABDIMS STORK: CICONIA ABDIMII
SACRED IBIS: THRESKIORNIS AETHIOPICUS
BRIDLED TERN: STERNA ANAETHETUS
CASPIAN TERN STERNA CASPIA
GREATER-CRESTED TERN: STERNA BERGII
LESSER-CRESTED TERN: STERNA BENGALENSIS
SAUNDERS TERN: STERNA SAUNDERIA
WHITE-CHEEKED TERN: STERNA REPRESSA
CRAB PLOVER: DROMAS ARDEOLA
KENTISH PLOVER: CHARADRIUS ALEXANDRINUS
GOLIATH HERON: ARDEA GOLIATH
GREEN-BACKED HERON: BUTORIDES STRIATUS
WESTERN REEF HERON: EGRETTA GULARIS
SOOTY GULL: LARUS HEMPRICHII
WHITE-EYED GULL: LARUS LEUCOPHTHALMUS
RED-BILLED TROPICBIRD: PHAETON AETHEREUS
BROWN BOOBY: SULA LEUCOGASTER
BROWN NODDY: ANOUS STOLIDUS
OSPREY: PANDION HALIAETUS
SOOTY FALCON: FALCO CONCOLOR
PINK-BACKED PELICAN: PELECANUS RUFESCENS
Source : Field surveys by the ECMIB
Sea Birds Conservation Team
2004/2005
ECMIB
This map must not be considered an authority
on the delimitation of international boundaries
MASSAWA
ASSAB
40°0'0"E
41°0'0"E
42°0'0"E
43°0'0"E
17°0'0"N
16°0'0"N
15°0'0"N
13°0'0"N


ERITREA
ISLANDS WITH MARINE TURTLE NESTING BEACHES
Turtle nesting islands only are named
Source : Field surveys by the ECMIB Turtles Conservation Team 2004/2005
ECMIB
Dahlak Islands
North of Assab
Difnein
Romiya
Hermil
Awali Hutub
Hermil, Seil
Awali-Shaura
Isratu
Anber, Seil
Ghabbi-hu
Harat
Umm Ali
Betta, Seil
Baradu
Dhu-l-fidol
Martabdn
Dergoman Seghir
Auatib, Seghir
Derom
Auatib, Kebir
Dahret Bulke
Dhu-l-kuff
Sarad
Gharib
Bilha
Segala
Senach
MASSAWA
Sheik Seid
Entean
Zauber
Madote
Erfan
Salima
Assarca White
Aucan
Dilemmi
Mojeidi
Disse
Dhu-Kurush
Umm Namus
Adjuz
Howakil
Dergamman Kebir
Umm en Nayim
Askoma
ADI-KEYH
Selafi
Sanahor
R. Fatuma
ASSAB
Urukia
1:800,000
Kilometers
0 10 20 40 60 80
1:800,000
40°0'0"E
41°0'0"E
42°0'0"E
42°30'0"E
43°0'0"E
16°0'0"N
15°0'0"N
13°30'0"N
13°0'0"N
N
W
E
S


ERITREA
INCIDENTAL CATCH OF MARINE TURTLES BY TRAWLERS 1994 - 2004
Species
Green
Hawksbill
Olive Ridley
Leatherback
Loggerhead
Unidentified
Source Data : Collected by on-board monitors from the Ministry of Fisheries
This map must not be considered an authority on the delimitation of international boundaries
Nora
Dehil
Wokiro
Emberemi
Dasko melil
Selit
Debelo
Debushet
MASSAWA
Dahlak Kebir
Hirgigo
Dessel
Angel
Dululu
ASMARA
Meka'lile
Zula
Harena
Abdur
Gel'alo
Arafile
DEKEMHARE
Akelo
Mersa Fatma
Mutl
Mombat
Haresan
Me'dr
Tio
MENDEFERA
ADI-KEYH
Saroyta
Kurum
Edi
Obel
Barasole
Bihta
Adubaro
Beilul
Airori
ASSAB
Harsile
Kiloma
Beahro
Rahaita
GREEN 1520
HAWKSBILL 81
LEATHERBACK 36
LOGGERHEAD 4
OLIVE RIDLEY 2
UNIDENTIFIED 970
Total Number of Turtles Caught
1:1,700,000
Kilometers
0 15 30 60 90 120


ERITREA
DISTRIBUTION OF MANGROVE FORESTS
Source : supervised and unsupervised classifications of Landsat TM imagery combined with ground verification by the ECMIB GIS Unit
Scale of inset maps:
1:400,000
This map must not be considered an authority on the delimitation of international boundaries
1:6,000,000
N
W
E
S
Mersa Gulbub
Selit
Debelo
Derbushet
Desse
Adgofaito
Angel
Gonforor
Dekikai
Duluh
Meka'lile
Harena
Garsatebi
Abdur
Barasob
Aluli
Bededa
Mersa Fatma
Dewelo
Haresan
Me'dr
Sahel
Ras Terma
Assab
Harsile
Abo
Kiloma
ECMIB
Coastal, Marine & Island Biodiversity Conservation Project
Kilometers



ERITREA

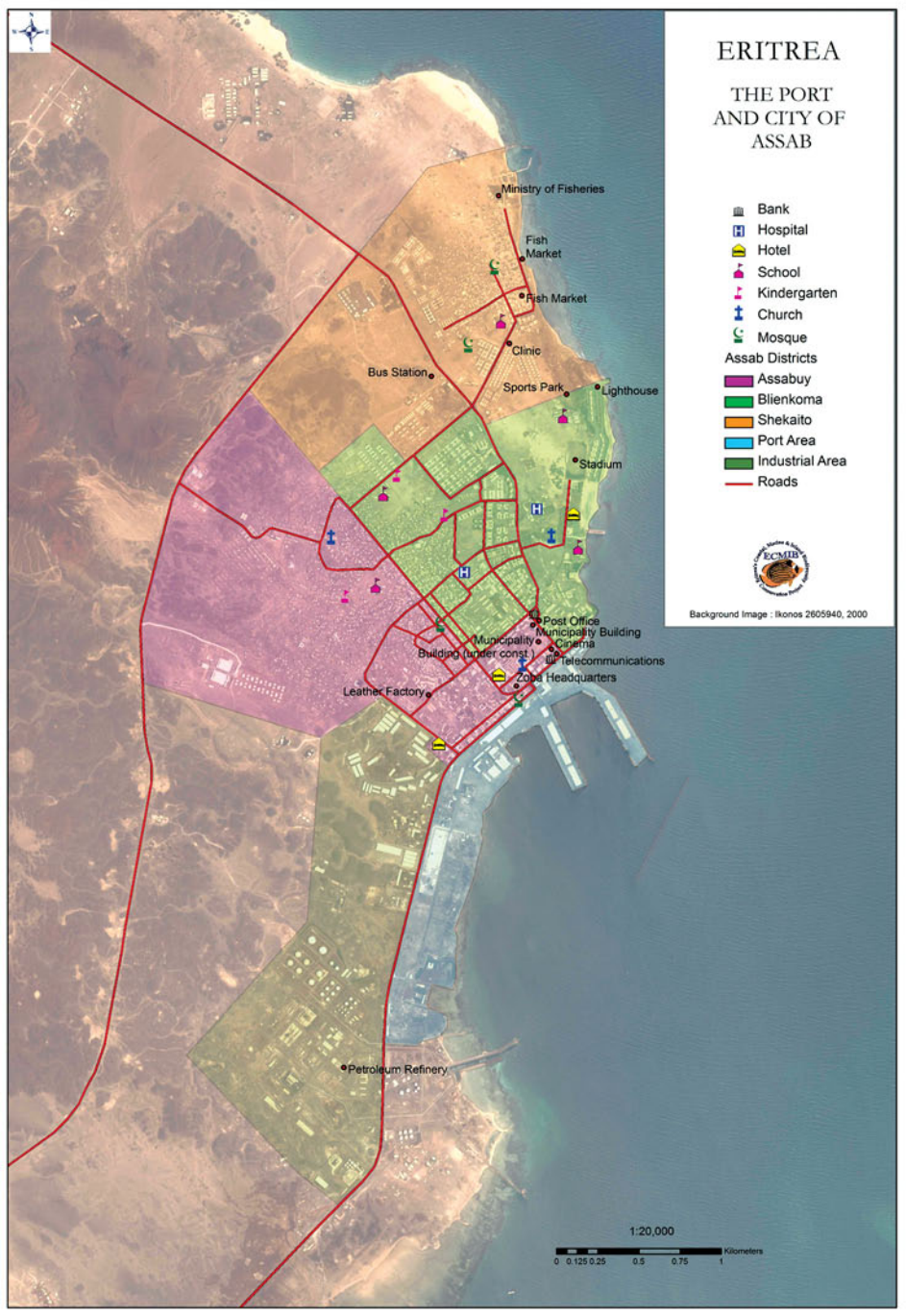
THE PORT AND CITY OF MASSAWA

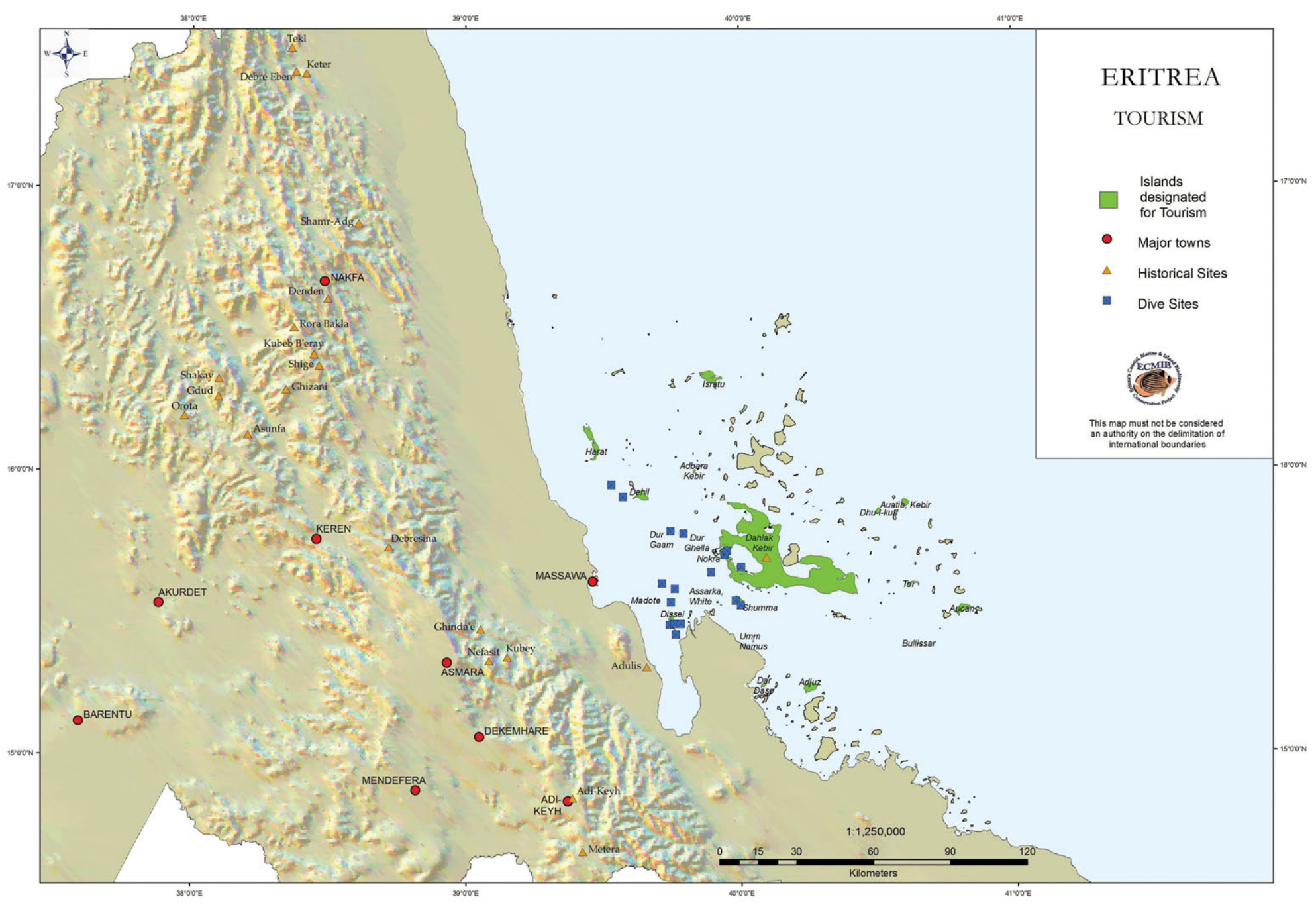
- Hospital
- Hotel
- Bank
- School
- Church
- Mosque
- Market
- Roads
- Railway
- Port Area
- Saltpans
- Mangroves

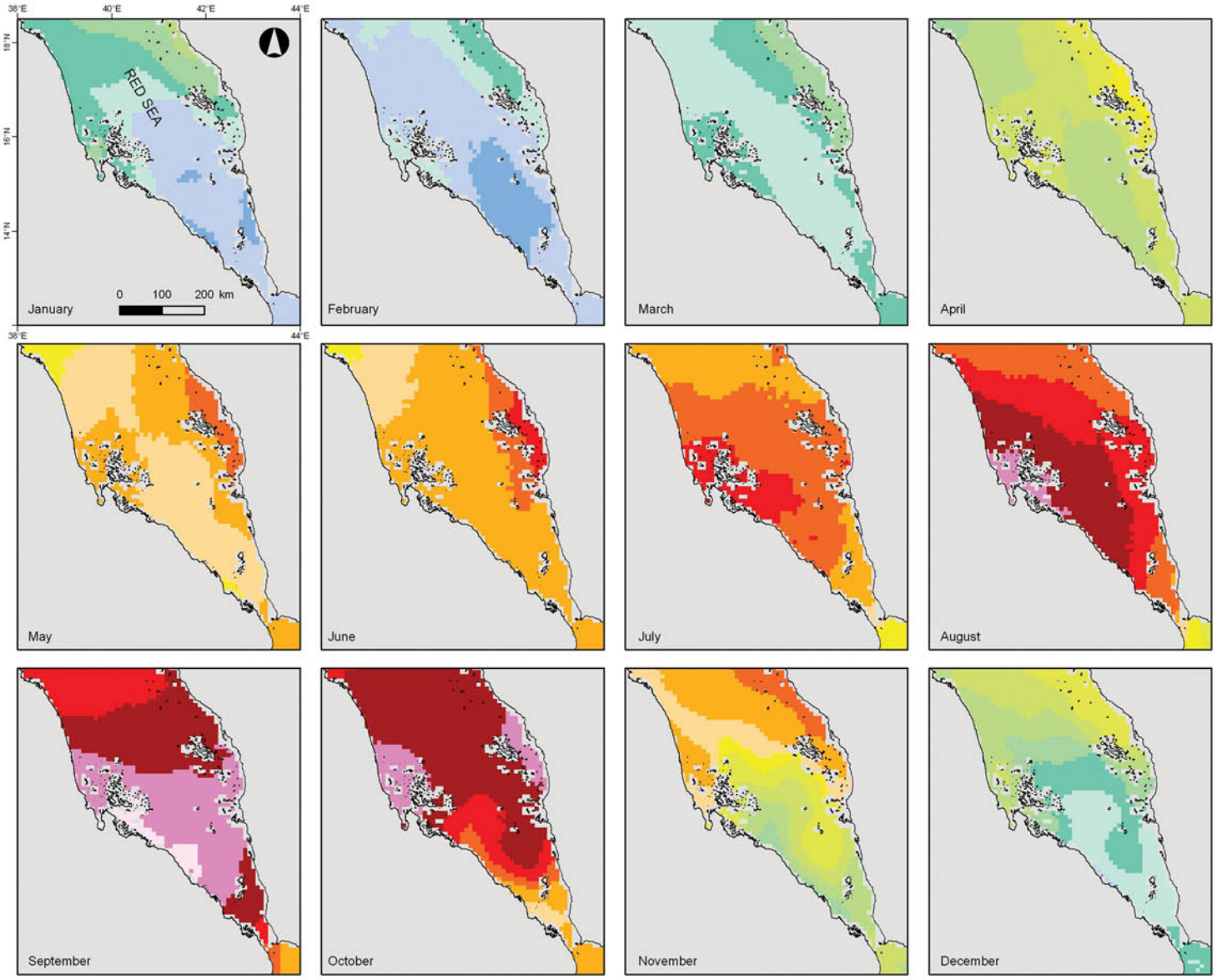
Massawa Districts

- Abd El Kadr
- Adis Alem
- Amatere
- Batsii
- Edaga
- Grar
- Hutumlo
- Kapo Marta
- Kutmia
- New Residential
- Tualud

Background image : Ikonos 166138, 2004


ERITREA
THE PORT AND CITY OF ASSAB
Bank
Hospital
Hotel
School
Kindergarten
Church
Mosque
Assab Districts
Assabuy
Blienkoma
Shekaito
Port Area
Industrial Area
Roads
Background Image : Ikonos 2605940, 2000
Ministry of Fisheries
Fish Market
Fish Market
Clinic
Bus Station
Sports Park
Lighthouse
Stadium
Post Office
Municipality Building
Municipality
Cinema
Building (under const.)
Telecommunications
Zoba Headquarters
Leather Factory
Petroleum Refinery
1:20,000
0 0.125 0.25 0.5 0.75 1
Kilometers


ERITREA
TOURISM
Islands designated for Tourism
Major towns
Historical Sites
Dive Sites
ECMIB
This map must not be considered an authority on the delimitation of international boundaries
1:1,250,000
0 15 30 60 90 120
Kilometers
38°0'0"E
39°0'0"E
40°0'0"E
41°0'0"E
17°0'0"N
16°0'0"N
15°0'0"N
Tekl
Keter
Debre Eben
Shamr-Adg
NAKFA
Denden
Rora Bakla
Kubeb B'eray
Shige
Shakay
Gdud
Ghizani
Orota
Asunfa
KEREN
Debresina
AKURDET
MASSAWA
Ghinda'e
Nefasit
Kubey
ASMARA
BARENTU
DEKEMHARE
MENDEFERA
ADI-KEYH
Adi-Keyh
Metera
Adulis
Isratu
Harat
Adbara Kebir
Dehil
Dur Gaam
Dur Ghella
Nokra
Dahlak Kebir
Auatib, Kebir
Dhul-kuff
Ter
Auloam
Bullissar
Assarka, White
Madote
Dissei
Shumma
Umm Namus
Dal Dase
Adiuz



ERITREA

SEA SURFACE TEMPERATURE

Sst

- No data
- <23
- 23.1 - 23.5
- 23.6 - 24
- 24.1 - 24.5
- 24.6 - 25
- 25.1 - 25.5
- 25.6 - 26
- 26.1 - 26.5
- 26.6 - 27
- 27.1 - 27.5
- 27.6 - 28
- 28.1 - 28.5
- 28.6 - 29
- 29.1 - 29.5
- 29.6 - 30
- 30.1 - 30.5
- 30.6 - 31
- 31.1 - 31.5
- 31.6 - 32
- 32.1 - 32.5

Source : Long term mean monthly sea surface temperature (SST) data for Eritrean waters, in southern Red Sea, between 1985 and 1997. Data from the Advanced Very High Resolution Radiometer (AVHRR) Pathfinder 9km SST dataset from the U.S. National Oceanographic & Atmospheric Administration (NOAA), Jet Propulsion Laboratories (JPL), provided to ECMIB by Dr R. Klaus

This map must not be considered an authority on the delimitation of international boundaries