



Figure 1. A GIS assistant seen assisting with map processing at the KeNODC office.

Coastal Geomorphology: The coastal belt of Kenya may be divided into four physiographical units which are almost parallel to one another. These are from the coast to inland: the coastal plain, the foot plateau, the coastal range, and the Nyika. The width of the coastal plain varies between 4 km in the south to 40 km in the north and is generally under 50 metres altitude. Kenya has a narrow continental shelf with depths dropping below 200 metres within less than 4 km in most places. However, the shelf widens significantly at the mouths of rivers Tana and Sabaki, exceeding 15 km off the northern end of Ungwana Bay. The shoreline is protected by fringing reefs running along the coast with gaps at the areas adjacent to the mouths of the main rivers.

Coastal Habitats: The main coastal habitat types found in Kenya are: coral reefs, estuaries, mangroves and sea grass meadows.

Coastal Currents and Tides: During the South West monsoon season (March-August) the swift northerly “East African Coastal Current” flows along the entire Kenyan coast. The current is enhanced by the momentum from local winds and reaches velocities of up to 4 knots. However, during the north eastern monsoon season (November - February) the flow is southward along the coast to about 2° South, just south of Lamu, where the Somali current meets the East African

Coastal Current. The velocity of the current is reduced to about 2 knots during the season. The Kenyan coast experiences semidiurnal tides with the spring range of up to 4 metres and neap range of about 1.8 metres.

Coastal Observations: Tide gauges are installed and operational at Lamu, Malindi, Mombasa and Shimoni. Meteorological stations exist at Mombasa, Lamu, Malindi.

Ports and Harbours: The second major economic resource in the Kenyan coast after tourism is the Kilindini harbour in Mombasa. It derives its viability from its strategic position as a natural harbour serving Kenya as well as Rwanda, Uganda, Burundi, and parts of Tanzania, DR Congo, and Sudan. Other ports and harbours are located in Lamu, Malindi and Shimoni.

Coastal Tourism: Coastal tourism accounts for 60 - 70% of the national tourism industry. There are six marine national parks/reserves along the Kenyan coast located at: Kiunga, Malindi, Watamu, Mombasa, Kisite and Mpunguti. In addition there are several terrestrial parks and reserves along the coast. Other attractions include the museums at Fort Jesus in Mombasa and Lamu Fort in Lamu and several ruins and old settlements dating back to the seventh century scattered along the coastline.

Coastal Industries: The location of the port has attracted many industries of Mombasa. The main industries include cement manufacture, petroleum refinery and motor vehicle assembly.

Fisheries: Marine fisheries are an important source of protein for the coastal populations. The main fishery along the Kenyan coast is artisanal. Most of the fishing is done in the creeks, on the reefs and in shallow inshore waters. While there has been a big increase in the quantity and value of freshwater fish landed in Kenya (more



Figure 2. Sea Observations – A GLOSS tide gauge station at Lamu.

than 200,000 tonnes/year), the marine fisheries sector has continued to perform poorly, with less than 20,000 tonnes/year landed, due to some extent to the inability to fully exploit this resource.

Mineral Resources: There are several minerals being extracted along the Kenyan coast. These include: salt, gypsum, iron ore, lead, barite, lime, stone, coral stone for building, clay and apatite. A major discovery of titanium deposits, described as one of the largest and highest grade undeveloped resources of rutile and zircon in the world, is yet to be extracted.

Agricultural products: Most of the land in the coastal areas is of low agricultural potential. The following agricultural products are important in the coastal region: horticultural products, especially vegetables and tropical fruits, sisal, cotton, coconuts, cashew nuts and bixa.

Other marine resources: The mangrove forests along the coast provide local communities with fuel wood, timber for house construction, fences and furniture. In recent years the mangrove forests have been cleared to make way for agriculture, fish ponds, prawn farms, salt pans, residential houses, industries and dumpsites.

Figure 3. KMFRI mariculture activities – seaweed experimental farm at Shimoni.



ADDRESSING KEY COASTAL ISSUES

Experts taking part in a national assessment of environmental and social issues and impacts identified a number of hot spots (currently suffering measurable degradation), sensitive areas (likely to be subjected to some degradation in the future, and major issues of concern. These are reproduced in Table 1 (ACOPS 2002a).

Table 1. Results of the Integrated Problem Analysis undertaken for Kenya (ACOPS 2002a).

Major issue of concern overall for the country
Over-exploitation of fisheries and other living resources.
Modification of ecosystems or ecotones, including community structure and/or species composition.
Destructive fishing practices.
Hot spots
<i>Mombasa Inshore Water Areas:</i> Issues included microbiological pollution, chemical pollution, eutrophication, suspended solids, solid wastes, spills, over-exploitation of fisheries and mangrove resources and destructive fishing practices.
<i>Lamu Inshore Water Areas:</i> Issues include microbiological pollution, suspended solids, solid wastes and modification of ecosystems or ecotones.
<i>Ungwana Bay:</i> Issues include destructive fishing practices, excessive by-catch and discards from trawling activities (98% of which is for foreign export), suspended solids and modification of ecosystems, and threats to endangered species such as the Green Turtle.
<i>Malindi Bay:</i> Threats include suspended solids (especially silt deposition from River Sabaki), over-exploitation of fisheries resources (trawling and artisanal fishing), modification of ecosystems and threats to endangered species.
<i>Diani Reefs:</i> Threats include destructive fishing practices, over-exploitation of fisheries resources and modification of ecosystems and accelerate coastal erosion.

Sensitive areas
<i>Vanga Creek</i> : threats include destructive fishing practices, over-exploitation of fisheries resources, microbiological pollution, and modification of ecosystems.
<i>Wasini Channel</i> : threats include destructive fishing (especially by foreign fishermen using dynamite and beach seines), over-exploitation of fisheries resources, and loss and modification of ecosystems.
<i>Gazi Bay</i> : threats include over-exploitation of fisheries resources, destructive fishing (both local and foreign), and modification of ecosystems including over-harvesting of mangroves and coastal erosion.
<i>Ngomeni Mangrove Swamps</i> : threats includes: modification of ecosystems including complete clearing of mangroves for the salt works.
<i>Malindi/Watamu Marine National Park and Reserves</i> : threats include suspended solids impacting coral gardens, modification of ecosystems from over-harvesting of mangroves and trampling on corals, and microbiological pollution from domestic sewage.

A high load of suspended solids discharged through the river Sabaki has made this estuary devoid of mangrove vegetation unlike other estuaries. The sediments have similarly impacted the coral system, including those extending into the Malindi Marine Park and Reserve. Sea-grass communities have suffered a loss of biodiversity. Beach accretion has led to loss of frontage for some beach hotels impacting on their aesthetic value and becoming less attractive for the development of tourism in the Malindi Bay. Variations of freshwater discharges are thought to have impact on fish biodiversity in the estuaries, though indicator information is lacking.

The fisheries resources along the Kenyan coast are of two types, artisanal or subsistence fisheries and commercial fisheries. The artisanal fishery is concentrated between the coral reef and the shore, while the commercial fishery is composed of demersal fish, shrimp and lobster in the Bays of Malindi and Ungwana. The artisanal fishery is considered fully exploited with over-fishing now taking place in the reefs with ensuing changes in community structures.

The Kenyan coast is part of the main marine highway used by oil tankers, offloading at the port of Mombasa and destined for the Kenyan mainland and the landlocked countries of Uganda, Rwanda and Burundi. There are therefore the possibility of oil spills that can have major repercussions on the marine life and the thriving coastal tourism industry.

Pollution from industrial and domestic sources are limited to the coastal cities of Mombasa, Malindi and Lamu. These are likely to increase with the growing coastal populations.

Figure 4. Litter collection – World Environment Day.



DEVELOPMENT AND ACHIEVEMENTS OF THE NODC

The Kenya National Oceanographic Data and Information Centre (KeNODC) is hosted at KMFRI with the support of UNESCO/IOC through the Ocean Data and Information Network for Africa (ODINAFRICA) and has been in existence for 10 years.

The main objectives of the Centre are to:

- Provide marine scientists in the region with the necessary scientific information
- Enhance the use of indigenous scientific information in the region
- Promote and facilitate communication between the scientists, both intra - and inter - regionally
- Disseminate information on marine scientific research activities in the country

The centre has provided training in data and information management to staff from collaborating institutions in the country. KMFRI is an input centre for the Aquatic Sciences and Fisheries Abstracts (ASFA) database and has been designated to provide training in ASFA methodologies to other input centres in Africa.

KeNODC has accumulated a wealth of data and information, the majority held in CDs which are utilized to develop a wide range of products and services in support of various communities involved in coastal management. KeNODC collection covers oceanographic, freshwater, and related terrestrial data. In the case of oceanographic data, an area of interest, bounded by the following latitudes and longitudes has been defined: 0.5°S, 6°S and 39°E, 50°E from the World Ocean Database 2005 produced by the US-NODC. Quality controlled ocean profile data for this area has been extracted from the World Ocean Database 2005 produced by the US-NODC. These depth profile data span several years and include measurements of temperature, salinity, oxygen, phosphate, nitrate, silicate, chlorophyll, alkalinity and pH.

The centre has actively sought to present various sets of data in GIS, providing an opportunity to visualize the Indian Ocean basin

in progressive colors that may show variations in chlorophyll, sea surface temperatures, etc. The centre is set to avail more information on coastal terrestrial environment following the implementation of the Nairobi Convention Clearinghouse and Information Exchange System. This will be implemented through national institutional networks with each institution acting as a node for particular categories of data.

KeNODC has contributed to the development of the African Marine Atlas (www.africanmarineatlas.net) and the electronic repository of marine related publications (www.oceandocs.net).

The following are some of the products and services available at KeNODC:

- Catalogue of marine related datasets, which provides information on types, quantity, geographic coverage, sensors used, institutions/individuals holding the data, and conditions for access
- Library catalogue (the SAMAKI database has more than 7 000 records)
- Directory of marine and freshwater scientists within the country
- Computer software tools for quality control, analysis and sub setting of data
- Provision of datasets and meta data from ocean observing programmes, including sea level data
- Tide predictions for Mombasa and Lamu (high and low waters, as well as hourly heights)
- Development of products such as maps, graphs and statistical analysis
- GIS services for scientists and coastal management practitioners
- Provision of bibliographic search and delivery services to the scientific community in the institute

These products and services are available through the KeNODC website (www.nodc-kenya.org). The beneficiaries include coastal communities, resource managers, students, researchers and policy makers.

MARINE RELATED PROGRAMMES AND ORGANIZATIONS

The following are organizations that work in collaboration with the KeNODC:

- Kenya Marine and Fisheries Research Institute (<http://www.kmfri.co.ke>)
- National Museum of Kenya (<http://www.museums.or.ke>)
- Oil Spill Mutual Aid Group
- Forest Department
- Kenya Association of Hotelkeepers & Caterers (<http://www.kahc.co.ke>)
- Fisheries Department Coast Region
- Kenya Meteorological Department
- Kenya News Agency
- Department of Resource Surveys and Remote Sensing (<http://www.drsrcs.go.ke>)
- Kenya Sea Turtle Conservation Committee
- Kenya National Chamber of Commerce and Industry (<http://www.kenyachambers.com>)
- Coast Development Authority (<http://www.cdakenya.org>)
- Kenya Association of Tour Operators
- National Environment Management Authority (<http://www.nema.go.ke>)
- Kenya Petroleum Refineries Ltd
- Jomo Kenyatta University of Agriculture & Technology (<http://www.jkuat.ac.ke>)
- Kenya Ports Authority (<http://www.kpa.co.ke>)



Figure 5. The Executive Secretary of IOC Dr Bernal plants a tree to commemorate his visit to KMFRI.

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