

Marine Environments and Resources

Port Sudan, which hosts the largest sea freight terminal in the country, typifies the situation for marine resources in Sudan: economic development is occurring at the expense of the environment, and the surrounding lagoons are suffering from land-based pollution and modification due to the indiscriminate building of infrastructure.



Marine environments and resources

12.1 Introduction and assessment activities

Introduction

The coral reefs of the Sudanese territorial waters in the Red Sea are the best preserved ecosystems in the country. To date, these precious assets have been largely protected by the lack of development, but the economic and shipping boom focused on Port Sudan and the oil export facilities is rapidly changing the environmental situation for the worse.

At present, the state of the coastal environment is mixed: while steady degradation is ongoing in the developed strip from Port Sudan to Suakin, good conditions prevail elsewhere along the coast. On and above the tideline, the symptoms of overgrazing and land degradation are as omnipresent in Red Sea state as elsewhere in dryland Sudan.

The preservation and sustainable development of the marine resources of Sudan will require an integrated approach. For this reason, all of the

issues specifically related to marine and coastal environments are collated and discussed here, though several cut across sectors covered in other chapters of this report.

Assessment activities

For this assessment, UNEP drew upon a significant available databank on the marine resources of Sudan [12.1, 12.2, 12.3, 12.4, 12.5]. In addition, a UNEP field mission covered the coastal strip from 100 km north of Port Sudan to the Tokar delta. Fieldwork included an extensive investigation of the Port Sudan area.

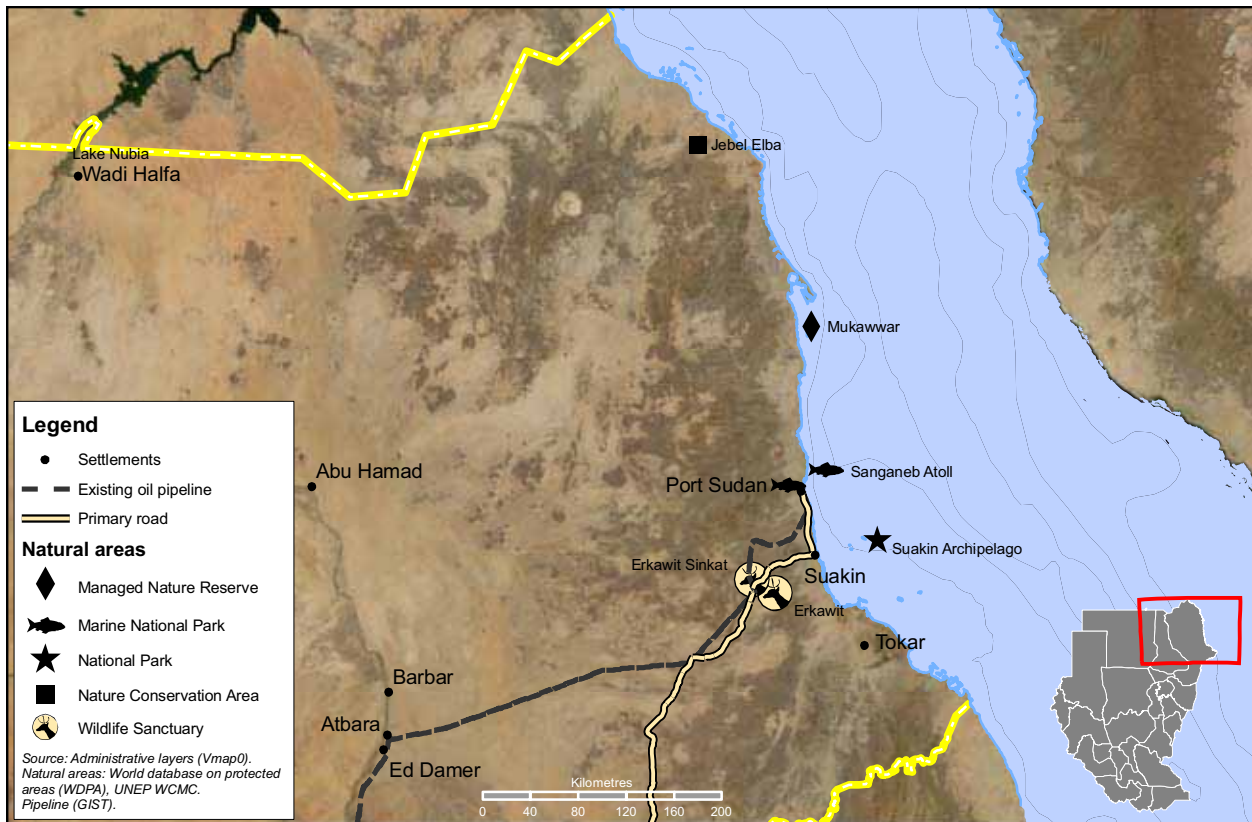
UNEP has been involved in the assessment and management of the natural resources of the Red Sea since the 1980s in its role as a supporter and participant in the Regional Organization for the Conservation of the Environment of the Red Sea and the Gulf of Aden (PERSGA). PERSGA-sponsored projects have included surveys of the coral reefs and other important marine habitats of Sudan.

While it did not extend to the habitat's condition, UNEP's assessment of the marine environment of Sudan was considered adequate to cover and provide an update on the main environmental issues.



A typical shoreline north of Port Sudan, with sparse vegetation on a sandy-silty beach, a sheltered zone and the fringing reef (indicated by the breaking waves in the distance)

Figure 12.1 Sudan coastline



12.2 Overview of marine and coastal environments and resources

The Red Sea

The Sudanese Red Sea is famous for its attractive and mostly pristine habitats, particularly its coral reefs. Three distinct depth zones are recognized: shallow reef-studded shelves less than 50 m deep, deep shelves 500 to 1,000 m deep, and a central trench more than 1,000 m deep, reaching a maximum of 3,000 m off the city of Port Sudan. The Red Sea is home to a variety of pelagic fish including tuna, but the overall fish density is relatively low due to limited nutrient input. The sea hosts important populations of seabirds and turtles, as well as mammals such as dugong, dolphins and whales.

Coastline and islands

The coastline of Sudan on the Red Sea is some 750 km long, not including all the embayments

and inlets [12.2]. Numerous islands are scattered along the coast, the majority of which have no water or vegetation. The dominant coastal forms are silty beaches, rocky headlands and salt marshes, commonly bordered with mangroves. Fringing coral reefs are very common and water clarity is generally high due to the lack of sedimentation.

Average precipitation in the coastal areas is extremely low, ranging from 36 mm per year at Halaib to 164 mm per year at Suakin, so that the desert extends right to the tide mark. The only exception is the Tokar delta, which receives substantial run-off from seasonal streams originating in the Ethiopian and Eritrean highlands.

The islands and most of the coastline are relatively undisturbed and host important feeding and nesting sites for a variety of seabirds. The three most ecologically important habitats are coral reefs, mangroves and seagrass beds.

Coral reefs

Three types of coral reefs are found in Sudanese waters:

- fringing reefs, which lie 1-3 km offshore;
- patch reefs, which lie up to 15 km offshore, separated from the fringing reef by deep and wide channels; and
- pillar reefs or atolls, found 20 km or more offshore, such as the Sanganeb atoll.

The coral reefs of Sudan are considered to be in moderate to good health, despite an extensive cover of algae over some fringing reefs. Some die-back/coral bleaching has occurred, particularly in the upper ten metres [12.3, 12.7].

Mangroves

Mangrove stands are a key coastal habitat, which provide forage, wood products and breeding grounds for fish. Extensive stands were originally found in areas where the seasonal streams (*khors*) reach the coast, as these produce the brackish and sediment-rich conditions necessary for mangroves to thrive. Mangroves stands are currently under severe pressure along the entire coastline from a combination of overgrazing and over-cutting, and in some regions, wholesale destruction due to coastal industrial development.

Seagrass beds

Seagrass beds are found in shallow coastal waters, around mangroves and between the low tide line and fringing reefs. They are highly productive habitats that provide grazing for dugong, and support fish and trochus shellfish.

12.3 Environmental impacts and issues

A high quality environment under pressure

The Sudanese marine and coastal environment is in relatively good condition overall, with isolated badly degraded areas. The region, however, is subject to a mounting list of environmental impacts linked to urban and industrial development, and to overgrazing. The principal environmental issues are:

- coastal habitat destruction by development;
- oil industry spill risks;
- passing ship pollution;
- pollution from land-based sources;
- risk of importing invasive species in ballast water;
- fisheries management;
- mangrove cutting and overgrazing; and
- marine protected areas and tourism.



Soft coral at Sanganeb. The coral reefs of Sudan are in very good to moderate condition away from the major urban areas. They are partly protected by their isolation and the lack of run-off from the desert



A major extension to the Port Sudan harbour, known as the Green Port, is going ahead in an area surrounded by seagrass beds and coral reefs. It is now necessary to focus on planning port operations to minimize ongoing impacts

Coastal habitat destruction by development

Development along the Red Sea coast is largely limited to a 70 km strip extending from Port Sudan to Suakin. This zone includes the two cities, the major ports, the oil terminals, saltworks, a shrimp farm and the new Red Sea Economic Free Trade Zone.

The damage to coastal habitats due to construction within this strip is extensive and in some cases both completely unnecessary and probably uneconomic in the long term. In some areas such as the main commercial port of Port Sudan, habitat destruction is unavoidable: though regrettable, local environmental damage is outweighed by the scale of the economic benefit. In other

cases, however, the benefits of development are questionable.

Twenty kilometres south of Port Sudan, productive mangroves have been destroyed by saltworks construction; saltwater access canals and banks have cut through mangrove stands, disrupted groundwater flows and sediment deposition patterns. Approximately eight kilometres south of Port Sudan at Kilo Tammania, mangroves have been destroyed by the poor design of an outfall access road and recreation area [12.2].

As discussed in Chapters 7 and 13, industrial development in Sudan occurs in the absence of an effective environmental impact and management culture. This is clearly apparent in the Port Sudan region.

Figure 12.2 Port Sudan and coral reef



The boundaries and names shown and the designations used on this map do not imply official endorsement or acceptance by the United Nations.

Oil industry spill risks

The risk of oil spills from the relatively new Bashir crude oil export terminal is discussed in detail in Chapter 7. The risks are considered to be moderate and the reported response measures close to international standards. The new Alkheir petroleum and gas export terminal is also considered to represent a moderate risk.

However, the loaded crude oil and product tanker traffic leaving the two terminals and traveling east to the Indian Ocean remains a considerable risk, due to the navigational hazard presented by the numerous fringing and patch reefs. In 2004, a freight vessel, the MV *Irens*, grounded on the reef at the Wingate anchorage area some 10 km east of the Alkheir terminal [12.2].

Passing and docked ship bilge water and oil pollution

The Red Sea is a major shipping transit route, connecting the Indian Ocean with the Suez Canal. The ports of Sudan host a range of vessels, from



Ships passing and entering ports in Sudan currently have no place to deposit oily waste, such as that generated by clearing bilges and fuel tanks. In the absence of facilities and controls, the risk is that ships jettison this oil at sea

small coastal tenders to bulk grain carriers. In the absence of controls and facilities for receiving oily waste from bilges, ships discharge this effluent into the sea. This results in chronic oil pollution around the ports, but also along the coast, as discharges from passing ships drift landwards.



The Port Sudan landfill is located at the head of a seasonal watercourse. Every wet season, the run-off draws pollution from the site to the coastal lagoons

Pollution from land-based sources

The industrial facilities and utilities of Port Sudan are a major source of land-based pollution for the Red Sea. They include two power stations, a desalination plant and the harbour dockyard. Other facilities in the area, such as a tire factory, a tannery, and an oil seed factory, are now closed down.

Electrical power stations A and C were found to be dumping substantial quantities of waste oil onto open ground in adjacent vacant land (station C is described in more detail in Case Study 7.1). In addition, the desalination plant was found to be at the origin of a significant pollution by hypersaline effluent (see Case Study 12.1). The harbour dockyard, which has no oily water treatment facility, was another expected source of pollution, but was not inspected. Other parts of the harbour, including the main warehouse, were investigated and found to be relatively clean, except for one open warehouse filled with unwanted pesticides and other chemicals.

Figure 12.3 Port Sudan power station and salt flats



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UNEP also visited a small oil refinery located five kilometres south of Port Sudan (see Figure 12.3). Site personnel reported that an oil-water separator was used for water treatment, and that the treated effluent and cooling water were discharged to sea, although this could not be verified by UNEP due to access restrictions. The refinery grounds and surrounds were markedly cleaner than the adjacent electrical power station C.

Additionally, the harbour lagoons are polluted by litter, waste oil and sewage from wet season run-off from the *khor* Kilab, which borders the old industrial area of Port Sudan. This area contains numerous small factories and vehicle repair workshops that dump used oil and other waste into the stream bed throughout the year.

Finally, the main Port Sudan landfill, which is located in the head of the *khor*, is a source of surface and groundwater contamination. The run-off from the dump also eventually ends up in the harbour. The landfill is covered in detail in Case Study 6.4.

Risk of importing invasive species in ballast water

No port in Sudan has facilities for receiving ballast water, which is instead discharged by the ships either in the harbour or in the approaches. This practice carries the risk of importing invasive species (larvae, parasites and infectious agents) from where the ship last docked and took in the ballast.

Fisheries management

Marine fisheries and mariculture industries in Sudan are currently underdeveloped. They are also poorly controlled and subject to repeated proposals for expansion from foreign investors.

The artisanal fleet on Sudanese waters is comprised exclusively of locally made wooden boats and small fiberglass tenders. Fishing methods include hand lines, and bottom set and pelagic gill nets, with 80 percent of the catch coming from hand lines. Prior to 2005, an Egyptian shrimp trawling fleet operated offshore of the Tokar delta, but it was



Cargo ships carry seawater as ballast, which is drawn in or discharged when cargos are loaded and unloaded. When this occurs thousands of kilometres away from the intake point, there is a risk of introducing alien species into the local marine environment



This lagoon in the centre of the city of Port Sudan is already burdened with urban pollution and shoreline development. Unless a solution for the saline effluent is found, the lagoon is expected to become a biologically dead zone

Reverse osmosis units separate seawater into two streams: freshwater for consumption and a high salinity effluent which needs to be disposed of in an appropriate manner to avoid environmental damage

CS 12.1 The impact of pollution from the Port Sudan desalination plant

This desalination-based freshwater production plant in Port Sudan provides an unfortunate case study in the importance of locating industrial facilities correctly in order to optimize benefits to local citizens and minimize environmental impacts.

The plant, which was built in 2004, plays a vital role in the provision of freshwater to the city. Based on a reverse osmosis process that is powered by diesel, it has a combined freshwater output of 7,500 m³ per day and an effluent discharge of 2,500 m³.

The facility is located on the shoreline of a shallow and moderately polluted saltwater lagoon that was an important if declining fishing ground until 2004, but is now surrounded by urban development. The original plant design envisaged extracting water from the lagoon, but health concerns forced a late revision in the form of a 4 km pipeline to convey seawater in from the coastline. The effluent from the plant, however, is currently discharged directly into the lagoon as per the original design.

The salinity of the effluent is approximately four times that of seawater, and it contains traces of chlorine and anti-scaling agent. The local authority reported that a major fish kill occurred during plant commissioning and there are current complaints from local residents regarding skin rashes, although the link between this public health problem and the increased salinity is unclear at this stage.

What is clear is that the combination of a nearly closed system and ongoing saline inputs will in time result in a hypersaline and ecologically dead (and most probably anaerobic) lagoon in an urban area. While the local authorities were very much aware of this problem at the time of UNEP's visit, there was no agreement on the solution due to the high cost of all options proposed to date.

banned by the Red Sea State Governor during the 2005-2006 season, apparently due to a licensing dispute. At present, no legal offshore fishing is conducted by foreign vessels, though the potential for illegal fishing is high as there is effectively no monitoring.

The fisheries industry is constrained by a lack of investment in facilities to handle the catch, as well as by a limited domestic market. The daily fish catch is monitored by the local fisheries authority and estimated to be approximately 1,100 tonnes per year [12.2, 12.8]. Most of the fish is consumed locally. There is a small export market to Saudi Arabia and Egypt for fresh coral fish and shark, and some 200 to 300 tonnes of trochus shellfish are exported – mainly to Europe – per year.

Though historically significant, mariculture and the collection of wild pearl oysters in the Red Sea region ended in the 1990s. It may or may not be revived. Shrimp farming has just commenced, with one farm located 35 km south of Port Sudan, but this venture is struggling to establish local and export markets.

The key environmental issue for the fisheries and mariculture industries is the lack of effective governance. This leaves the environment highly vulnerable to overfishing and uncontrolled mariculture expansion.



At present, the domestic marine fisheries industry is very limited. Most of the catch is consumed locally. A small volume of high-quality fish is exported to other Gulf countries



Camels grazing on mangroves 20 km south of Suakin. The impact of such grazing can be seen in the absence of foliage below three metres. This stand also shows signs of extensive timber-cutting



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Spinner dolphins offshore of Suakin. The marine tourism industry in Sudan still operates on a small scale, catering mainly to scuba divers, but the quality and quantity of marine life holds promise for the long-term growth of the industry. Protection and control measures need to be improved to ensure that this growth occurs without harm to the environment

Mangrove cutting and overgrazing

Mangrove leaves are edible for camels and are thus vulnerable to grazing damage in periods of scarcity. Most of the accessible mangrove stands visited by UNEP had the characteristic clipped look resulting from overgrazing. Mangroves can also supply wood for fuel and construction, and unsustainable cutting has clearly been a problem in the accessible stands.

Marine protected areas and tourism

There are two declared marine protected areas in Sudan: Sanganeb Marine National Park and Dongonab Bay (with Mukawar Island). Sanganeb Marine National Park is described in detail in Case Study 12.2.

Dongonab Bay National Park lies 125 km north of Port Sudan and covers 60 km of coastline and

a shallow bay with a wide diversity of marine habitats, including coral reefs and seagrass beds that support a large population of endangered dugong. The park also has a significant resident human population in a number of small fishing villages, and hosts a salt plant.

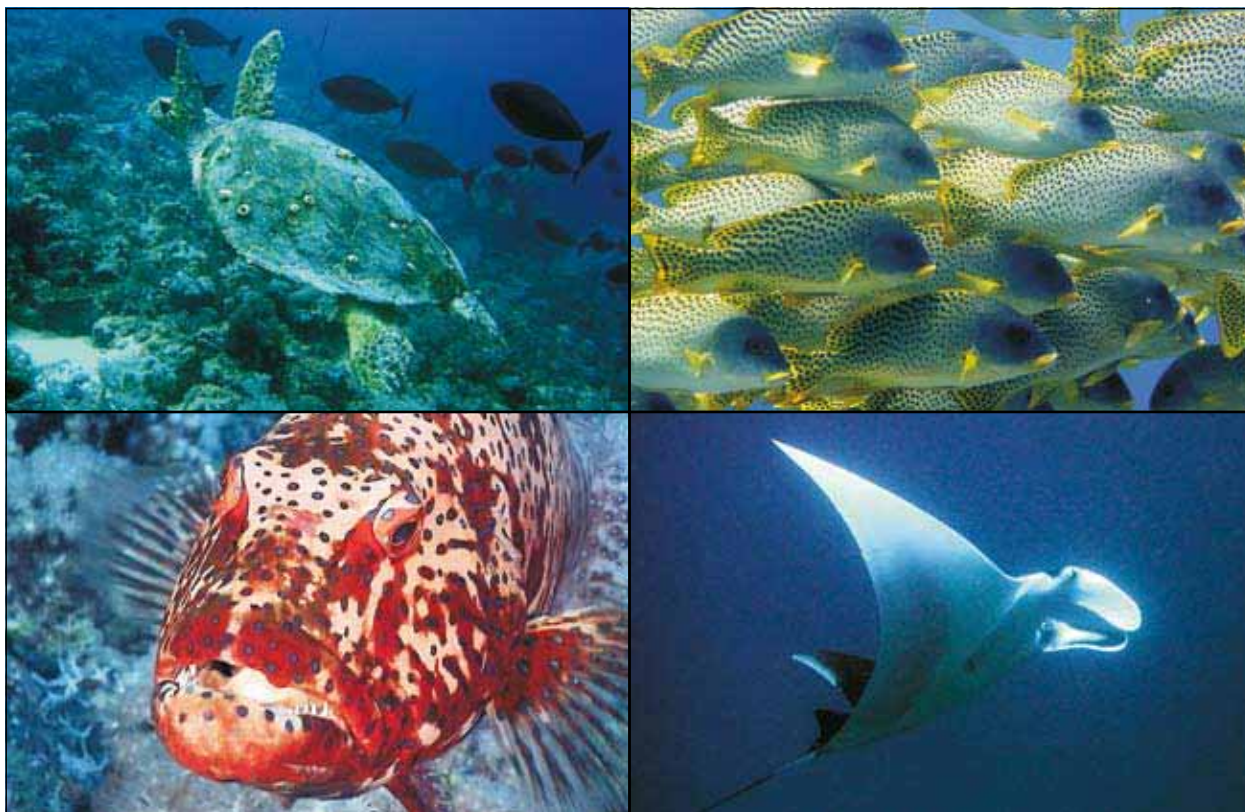
In addition, four high-value habitats have been proposed as marine protected areas:

- Suakin Archipelago, which comprises coral reefs surrounding a number of sandy islands approximately 20 km south-east of Suakin; these are important nesting sites for marine turtles and sea birds;
- Khor Kilab Bird Sanctuary, a 2 km² estuarine area on the south side of Port Sudan harbour;
- the Abu Hashish area, a 5 km² area on the eastern side of the new Green port, containing numerous coral reefs; and
- Shuab Rumi, a 4 km² area of coral reefs 50 km north of Port Sudan.

To this list, UNEP would add **all** of the remaining mangrove stands along the Sudanese Red Sea coastline, as this habitat is now under severe pressure and disappearing rapidly in some areas.

At present, the marine tourism industry is centred mainly on Sanganeb and to a lesser extent on Shuab Rumi. The Dongonab area is relatively remote and rarely visited. For the most part, tourism consists of international diving holidays, with visitors flying to Port Sudan and residing on large hotel boats, which travel to anchor at the various diving sites for a few days at a time. There is also some limited local recreation along the coastline.

The major environmental issue related to marine tourism is the lack of handling facilities at the dive sites and ports. For example, dive boats are forced to anchor on the reefs, causing damage, because they do not have mooring buoys. Tourism operators are highly aware of this problem, but do not have the legal mandate to install the necessary equipment, as that rests with the Sea Ports Corporation. An additional issue is the limited capacity for governance of the parks and tourism in all places.



CS 12.2 Sanganeb National Park: a microcosm of high reef biodiversity

The Sudanese coast harbours the most diverse coral reefs in the Red Sea. The small Sanganeb Atoll, arguably the only true atoll in the Red Sea, is situated approximately 30 km north-east of Port Sudan. It lies close to the centre of Red Sea marine biodiversity, where conditions are optimal for coral growth and reef development.

Sanganeb's physical features include an outer rim that encloses three central lagoons, areas of back reefs, and shallow water reef flats dominated by massive colonies of porites, goniatrea and montipora. Outside this outer rim, the reef drops vertically, interrupted by terraces, to the seabed some 800 m below. The drop from the reef flats to the reef slopes hosts a spectacular diversity of coral and fish species.

The coral fauna of the Sanganeb Atoll, which may well prove to be among the richest in the Red Sea, inhabits a number of different bio-physiographic reef zones. To date, a total of 124 cnidarians have been recorded. The atoll also hosts significant populations of *Trochus dentatus* (giant spider conch) and sea-cucumbers, which are commercially exploited elsewhere in Sudan.

Over 251 coral reef fish species have so far been recorded and this number may rise to more than 300. Populations of larger species such as bumphead parrotfish (*Bolbometopon muricatum*), bumphead wrasse (*Cheilinus undulatus*), and groupers, which are vulnerable to overfishing throughout their ranges, appear healthy in Sanganeb. The open waters around the atoll include a large number of pelagic fish species such as tuna, barracuda, sailfish, manta rays and sharks. Sailfish are reported to spawn in the Sanganeb lagoon.

The atoll was declared a National Park in 1993 and is currently one of two marine protected areas in Sudan (the other is the Dongonab Bay and Mukawar Island National Park, gazetted in 2005). Management plans for both sites were developed by the Regional Organization for the Conservation of the Environment of the Red Sea and Gulf of Aden (PERSGA) in 2003. Sanganeb additionally lies within one of two proposed Ramsar sites along the Sudanese coast, and is on Sudan's tentative list for UNESCO World Heritage status. At present, the park covers an area of approximately 22 km², but there are proposals to create an additional buffer zone that would increase the area to approximately 260 km².

Sudan's Wildlife Conservation General Administration signed an agreement with the international NGO the African Parks Foundation to implement the existing management plans for both Sanganeb and Dongonab Bay National Parks [12.6]. In June 2006, the Foundation and IUCN undertook a baseline biodiversity survey of both parks.

The atoll has considerable potential as a major destination for diving tourism, but the infrastructure to support and manage increased tourism has yet to be put in place.

12.4 Marine and coastal environmental governance

Governance structure

The governance structure for the Sudanese Red Sea coastline, territorial seas, islands and associated marine protected areas is very complex and in consequence, fragmented.

Sudanese ports are managed by the Sea Ports Corporation, which is part of the federal Ministry of Transport. The important exception is the arrangement at the Bashir Oil Terminal port facilities, which also come under the management of the Ministry of Energy and Mining. Marine fisheries are governed by the Marine Fisheries Administration, which is part of the federal Ministry of Agriculture and Forestry. The marine protected areas are under the responsibility of the Headquarter of Wildlife Conservation in the federal Ministry of Interior, and wildlife conservation services staff are actually managed by the Ministry of Interior, as they are part of the country's united police force.

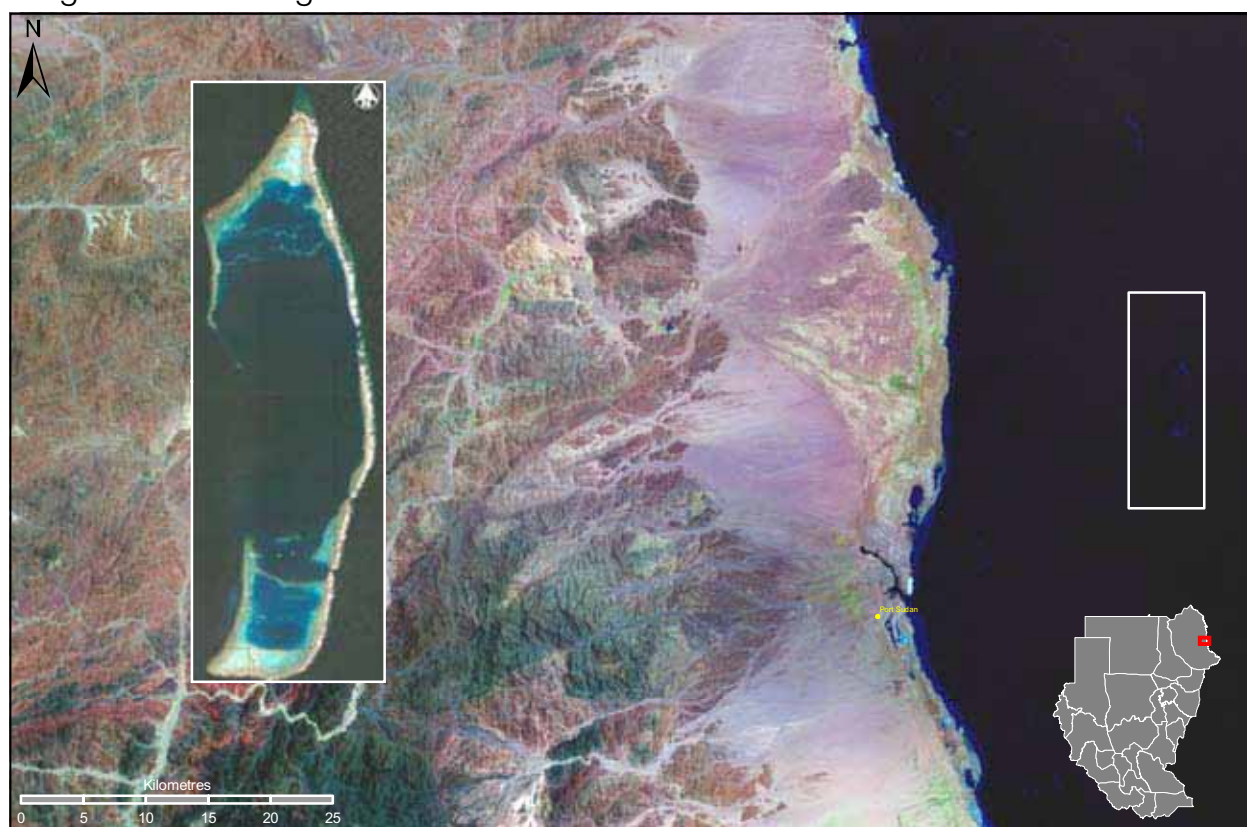
At the state level, the governor and the local government of ministers and advisors have significant and broad-reaching authority, which overlaps with the federal mandate to a large extent.

Red Sea state is unusual in that it has a working body specifically for marine environment protection – the newly formed Marine Environmental Protection Authority (MEPA). In addition, the State Council for Environment (SCE) provides an oversight and coordination role. Finally, the NGO sector is also active in Port Sudan.

Legislation and coordination

Appropriate and up to date legislation and guidance is lacking for the direction of the various authorities. Fisheries legislation, for example, is based largely upon acts drafted by the British in the 1930s. A number of important legal documents have been developed more recently, but have yet to be ratified or implemented by the federal authorities. The new state-sponsored SCE is anticipated to improve coordination between the various actors, though it is constrained by legislation to be largely advisory.

Figure 12.4 Sanganeb National Park



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Governance performance

While the Red Sea region has a number of interested and responsible parties for environmental protection, the complex governance structure and ensuing fragmentation of responsibility hamper practical performance by the authorities.

In addition, a severe lack of financial resources affects all governance operations (except for the Bashir Oil Terminal and the Sea Ports Corporation), and legislative deficiencies hinder both the authorities and civil society. For instance, many of the major facilities are managed at the federal level, which makes enforcement of legislation at the state level problematic.

12.5 Conclusions and recommendations

Conclusion

Compared to many parts of Sudan, the coastal and marine environments are still in very good condition. The marine habitats have global as well

as national significance and are currently the most important foreign tourist attractions in Sudan.

The environmental issues faced by the region will require an integrated approach to have any chance of successful resolution. The multiple competing uses and threats for shared resources such as shipping channels, estuaries, coral reefs and pelagic fisheries cannot be addressed in isolation.

The general level of environmental awareness and interest among Red Sea state stakeholders is impressive and higher than that seen in many other parts of Sudan. However, this interest needs to be converted into practical action, in the first instance by transferring more authority to the local level.

Background to the recommendations

The two key themes for the recommendations are: integration, based on the concept of Integrated Coastal Zone Management (ICZM), and devolution of responsibility to the Red Sea state level.



Young men on duty on national service picking up litter from the tidal lagoons of Port Sudan. The level of interest in the environment in Red Sea state is among the highest in all of Sudan

The objective of Integrated Coastal Zone Management (ICZM) is to establish sustainable levels of economic and social activity in coastal areas while protecting the coastal environment. It brings all those involved in the development, management and use of the coast together in a framework that facilitates the integration of their interests and responsibilities.

In support of the devolution of powers, the 2005 Interim Constitution grants states the authority to manage their natural resources. This general clause needs to be strengthened for the unique coastal and marine environment, with more detail on the division of powers for a range of issues such as fisheries, coastal development, land-based marine pollution sources and tourism. This process would correct the current imbalance due to the fact that much of the interest in environmental management resides in Red Sea state while the mandate for management resides largely at the federal level.

Recommendations for the Government of National Unity

R12.1 Ratify and enforce existing prepared legal instruments for the marine environment. Documents that are ready but not yet translated into law or firm standards include the Sudanese Maritime Law and the National Oil Spill Contingency Plan.

CA: GROL; PB: GONU Assembly; UNP: UNEP; CE: 0.1M; DU: 2 years

R12.2 Develop legislation and statutory guidance covering offshore fisheries. This should cover issues such as prohibited areas and the granting of licenses to both domestic and international operators.

CA: GROL; PB: MAF; UNP: FAO; CE: 0.3M; DU: 2 years

R12.3 Adequately fund the marine fisheries inspection and data collection services operating out of the Red Sea ports to enable monitoring of catches and offshore fisheries including foreign vessels.

CA: GI; PB: MAF; UNP: FAO; CE: 3M; DU: 2 years

R12.4 Adequately fund the two marine protected areas of the Red Sea that have existing management plans and follow through with those plans to develop self-sustaining revenue streams for those areas. Sanganeb Marine National Park is the priority site.

CA: GI; PB: MI, UNP: UNEP; CE: 5M; DU: 5 years

Recommendations for the Red Sea State Government

R12.5 Enforce existing EIA legislation on planned developments on the coastline, including the Red Sea Free Trade Zone. This will require more direct involvement of the Red Sea State Government in support of the Marine Environment Protection Authority.

CA: GROL; PB: RSS MEPA; UNP: UNEP; CE: 0.1M; DU: 2 years

R12.6 Enforce existing water pollution legislation on industrial and utilities plant discharges into the Red Sea. This will require more direct involvement of the Red Sea State Government in support of the Marine Environment Protection Authority.

CA: GROL; PB: RSS MEPA; UNP: UNEP; CE: 0.1M; DU: 2 years

R12.7 Advocate and progress federal/state power-sharing on marine environmental issues. Set out and restructure the power-sharing arrangements for coastal and marine natural resources management to allow direct liaison and resolution at the state level.

CA: GROL; PB: RSS MEPA; UNP: UNEP; CE: 0.1M; DU: 3 years

R12.8 Introduce the concept of Integrated Coastal Zone Management through revised master-planning for the whole coast with a focus on the areas of Port Sudan, Suakin and Tokar.

CA: GROL; PB: RSS MEPA; UNP: UNEP; CE: 0.4M; DU: 3 years