Marine Environment

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I. INTRODUCTION

The sustainable use of coastal and ocean resources is linked to public health, food security, and economic and social benefits, including cultural values and traditional livelihoods. More broadly, these elements are understood as decisive elements for the alleviation of poverty. Activities from industrial and agricultural production to daily domestic routines all generate impacts that cumulatively affect the health of these critical marine ecosystems and ultimately their economic development.

The major threats to the health, productivity and biodiversity of the marine environment result from human activities on land and in coastal areas. Most of the pollution load of the oceans, including municipal, industrial and agricultural wastes and run-off, as well as atmospheric deposition, arises from land-based activities (LBA) and affects the most productive areas of the marine and coastal environments.

II. ARAB MARINE ENVIRONMENT: POLLUTION CAUSES AND REMEDIAL ACTIONS

Three of the UNEP Regional Seas Programme regions – the Mediterranean Region (MAP), the Red Sea and Gulf of Aden Region (PERSGA) and the ROPME Sea Area (RSA) – encompass twenty Arab States out of the twenty-two member countries of the Arab League. Some of these countries (Egypt, Morocco, Saudi Arabia) straddle more than a region, for example Egypt's coastlines extend on both the Mediterranean and the Red Sea, and Saudi Arabia's coastlines extend on both the Red Sea and the Gulf.

THE UNEP REGIONAL SEAS PROGRAMME

UNEP Regional Seas Programme has emerged over the last quarter century as an inspiring example of how to craft a regional approach to protecting the environment and managing natural resources. The Regional Seas Conventions and Action Plans cover issues ranging from chemical wastes and coastal development to the conservation of marine animals and ecosystems.

Basic information on the coastal and marine environment of the Arab countries is presented in Table 1.

Arab Environment of the Mediterranean Region

The Mediterranean basin, a semi-enclosed sea, is situated at the centre of a complex mosaic formed by tectonic plates, and is subject to heavy seismic and volcanic activity. With the exception of the southeast and some 3,000 km along the Libyan and Egyptian coasts where the Saharan platform directly meets the sea, there are mountains everywhere (Jeftic *et al*, 1989).

There are a number of large alluvial plains associated with the deltas of major rivers (Ebro, Rhone, Po and Nile) and with those of numerous smaller rivers of the basin, as in Tunisia. These rivers drain soils far removed from the coastline and carry very large volumes of sediment to the sea (Batisse & Grissac, 2003).

Seven Arab countries (Algeria, Egypt, Lebanon, Libya, Morocco, Syria, Tunisia) are Signatory States to the Barcelona Convention (1976), that include 22 Mediterranean counties.

TABLE 1 **BASIC INFORMATION ON THE COASTAL AND MARINE ARAB ENVIRONMENT**

COASTAL & SHELF EXTENSION & AREA

Region	Arab Countries	Coastline km	Cont. shelf km²	Territorial Sea km²
MED Region	**Morocco**	2,008**	70,365	37,481
	Algeria	1,557**	9,688	27,863
	Tunisia	1,927**	65,347	36,773
	Lybia	2,025**	63,595	38,131
	Egypt#	2,450**	(Med+RS) 50,060	(Med+RS) 82,048
	Lebanon	294**	1,169	4,702
	Syria	212**	852	3,866
PERSGA Red Sea & Gulf of Aden Region	**Djibouti**	443***	3,406	4,853
	Egypt	1,800***	X	X
	Jordan	27***	82	87
	Saudi Arabia	1,840***	(RS+RSA) 95,580	(RS+RSA) 95,580
	Somalia	3,898***	40,392	68,849
	Sudan	2,245***	15,861	32,645
	Yemen	3,149***	65,341	82,359
ROPME Sea Area (GULF Region)	**Bahrain**	255#	7,967	4,006
	Iraq	105#	1,034	716
	Kuwait	756#	6,526	5,362
	Oman	3,165#	46,670	51,821
	Qatar	909#	31,156	11,373
	Saudi Arabia	790#	(RS+RSA) 95,580	(RS+RSA) 95,580
	UAE	735#	51,394	30,962
Other Regions	**Mauritania**	1,268	28,370	19,455
	Comoros	469	1,426	12,684

Main source: World resource Institution. Earth trends: The Environmental Information Portal (2006)
** EEAA (2006)
*** PERSGA (1998)
# ROPME (2003)
Med: Mediterranean Sea
RS: Red Sea
ROPME Sea Area: RSA

Around 150 million people (in 2000) are concentrated along the 46,000 km of the Mediterranean coastline, 54 million people of which are from the 7 Mediterranean Arab countries. Some 200 million tourists descend on the Mediterranean region every year, of which 17 million are tourists visiting the Arab countries of the region (Benoit & Comeau, 2005). More than 200 petrochemical and energy installations, chemical industries and chlorine plants are located along the Mediterranean coast. These figures represent the major challenge for the preservation of the environment of the Mediterranean owing to the transboundary nature of the pollution that originates from land-based sources around the whole basin. The Mediterranean countries have been devoting specific attention over the past decades to prevent, halt, reduce and ultimately eliminate the main sources of pollution for the marine environment.

The major sources of pollution in the Mediterranean include:

- Municipal wastewater treatment and disposal;
- Urban solid waste disposal;
- Activities contributing to air pollution from mobile sources;
- Release of harmful concentrations of nutrients into the marine environment;
- Storage, transportation and disposal of radioactive and hazardous waste; and
- Activities contributing to the destruction of the coastline and coastal habitats.

Arab Environment of the Red Sea and Gulf of Aden Region (PERSGA)

The Red Sea and Gulf of Aden (RSGA) is recognized as one of the world's most unique coastal and marine environments, in its role as an important repository of marine biodiversity, largely through its complex systems of coral reefs, interspersed with mangroves, seagrass beds and other diverse coastal habitats. The relative physical isolation of the sea has given rise to high levels of species endemism, especially among some groups of reef fishes and reef-associated invertebrates. The Gulf of Aden presents a very different situation: its cold, nutrient rich upwelling water may inhibit coral development but gives rise to prodigious fisheries production (PERSGA, 2004a).

The marine resources of this region have sustained human cultures for centuries. Until relatively recently, the RSGA region remained comparatively unaffected by the changes being wrought worldwide, especially in neighbouring areas such as the Mediterranean Sea. The environment and resources of the RSGA are threatened by a variety of human activities such as dredging and filling operations, the disposal of domestic and industrial effluent, the non-sustainable use of non-living resources and the expansion of the tourism industry. Yet the present transboundary and region-wide concerns are far-reaching and require actions to minimize loss of vital ecological and economic services to the people of this region (PERSGA, 2004a).

The Member States to PERSGA (Regional Organization for the Conservation of the Environment of the Red Sea and Gulf of Aden) are: Djibouti, Egypt, Jordan, Saudi Arabia, Somalia, Sudan and Yemen.

Arab Environment of the ROPME Sea Area (Gulf Region)

ROPME (Regional Organization for the Protection of the Marine Environment) Sea Area (RSA), is the sea area located at the most northwestern part of the Indian Ocean. The RSA is made up of three parts. These include the inner RSA which extends over 1,000 km along the NW-SW axis from the Strait of Hormuz to the northern coast of Iran; the middle RSA, which consists of the deep basin of the Gulf of Oman, with depths exceeding 2,500 m along its central channel; and the outer RSA, which extends to the southern border of Oman, and is an integral part of the Indian Ocean.

The ROPME area is surrounded by eight Member States, seven of whom are Arab countries: Bahrain, Iraq, Kuwait, Oman, Qatar, Saudi Arabia and the United Arab Emirates.

The RSA is considered to have one of the greatest pollution risks in the world due to the large number of offshore installations, tanker loading terminals, and the high volume and density of marine transportation of oil (UNEP/GPA, 2006). Roughly two million barrels of oil are spilled annually from routine discharges of ballast, tanker slops and from 800 oil and gas platforms (GESAMP, 2001).

The most pressing current and emerging environmental issues in the RSA include: the introduction of various pollutants, physical alteration and destruction of habitats, the use of destructive fishing techniques and overexploitation of marine biological resources, and the introduction of invasive species (ROPME, 2003).

III. ALGAE CONCENTRATION IN COASTAL WATERS (EUTROPHICATION)

Eutrophication is a process by which waters enriched with nutrients (nitrogen and phosphorus) stimulates primary aquatic production. This leads to an increase in phytoplankton biomass associated with excessive algal blooms, including seaweed, 'red tides', seaweed scum, the growth of benthic algae and sometimes a massive growth of immersed and floating microphytes; oxygen depletion and fish kills.

The sources of excessive amounts of nutrients in the marine environment are diverse and include industry, agriculture, river run-off and sewage discharges.

The Mediterranean Region

Eutrophication has become a chronic problem in shallow waters near deltas such as the Nile in Egypt and major urban areas, because of the diffuse agricultural and industrial discharges. Agricultural projections in the Mediterranean indicate that the use of fertilizers could increase between 2000 and 2025 by as much as 70% in the east and 50% in the south.

The discharge of non-treated wastewater from industry and cities contributes 10% of the total input of phosphorus and 20% of nitrogen. This can intensify eutrophication locally. Examples are the hot spots associated with eutrophication in Egypt and Tunisia (UNEP / MAP / MEDPOL, 2005).

The Red Sea and Gulf of Aden Region

All Red Sea and Gulf of Aden countries have identified nutrients (particularly nitrogen, phosphorus and their compounds) as a primary area of concern (PERSGA, 2005).

The nutrients' principal sources in the region include:

- Fertilizer factories in Jordan and Egypt;
- Agricultural run-off;
- Discharge of untreated sewage. This appears to be a drastic problem in Djibouti, Somalia and Yemen (PERSGA, 1997).

Eutrophication is recognized in the Arab Marine Environment of the Mediterranean, RSGA and RSA Regions. However, eutrophication has become a chronic problem in shallow waters near deltas such as the Nile in Egypt and major urban areas. Rational agriculture – making more efficient use of fertilizers – could limit the risks of excessive soil additives, and thus the diffuse discharges of agricultural origin that are a primary cause of eutrophication. Along with waste treatment, this will minimize the eutrophication.

Some areas, particularly on the west coast of the Red Sea south of Suez, still receive a considerable load of nutrients and Biochemical Oxygen Demand (BOD) discharges from domestic sewage. This contributes to eutrophication of the coastal waters around selected population centres, major ports and tourist facilities (Gerges, 2002).

The ROPME Sea Area

Dense mats of filamentous green algae grew in the intertidal zone of the northern coast of Bahrain, indicating eutrophication. Similarly, sewage and agro-based industries have caused increased growth of benthic algae in the northwest RSA off Shatt Al-Arab. Signs of eutrophication were observed in Kuwait Bay and in the coastal waters of Muscat (Oman), Dhahran (Saudi Arabia) and Abu Dhabi (UAE). Oxygen depletion associated with high levels of H_2S, ammonia and the discharge of large quantities of wastewater in Kuwait Bay have led to several major incidents of fish mortality, such as the incident of 1999 which was the result of anoxic conditions caused by massive algal blooms. Red tides were recorded in Bahrain and Saudi Arabia; this may be taken as a result of eutrophication (ROPME, 2003).

IV. COASTAL AND MARINE POLLUTION

The Mediterranean Region

Land-based sources of pollution

Pollution from land-based sources consists of untreated sewage discharge, agricultural runoffs containing pesticides, nitrates and phosphates,

ill-managed coastal development and emissions of contaminants directly from the ever-expanding industries around the Mediterranean or through rivers. Industrial pollution mainly comes from the chemical/petrochemical and metallurgy sectors.

Direct impacts of effluents from industry cause pollution problems at the site level and create 'hot spot' areas. Pollution Hot Spots in the Arab Mediterranean Environment are shown in Table 2.

Sea-based sources of pollution

The Mediterranean Sea is the major route for transportation of crude oil from the oil fields in the Middle East and North Africa, and oil ports in the Black Sea towards major consumption centres in Europe and North America. The most important oil traffic lane (90% of total oil tanker traffic) connects the Suez Canal and the Sidi Kerir terminal of the SUMED pipeline in Egypt with Gibraltar, passing between Sicily and Malta and then following the coasts of Tunisia, Algeria

TABLE 2 **PRIORITY POLLUTION HOT SPOTS IN THE ARAB MEDITERRANEAN ENVIRONMENT AND ESTIMATES OF BOD DISCHARGED FROM THEIR HOT SPOTS**

Country	Hot Spot	Effluent Type	BOD t/y (UNEP/MAP, 2004)
Algeria	Oran	Domestic +industrial	113,600
	Rouiba-Peghaia	Domestic +industrial	
	Ghazaouet	Domestic +industrial	
	Alger	Domestic +industrial	
	Mostaganem	Domestic +industrial	
	Bejaia	Domestic +industrial	
	Annaba	Domestic +industrial	
	Skikda	Domestic +industrial	
Egypt	El-Manzala	Mixed (Wastewater)	213,160
	Abu-Qir Bay	Mixed	
	El-Mex Bay	Mixed (Wastewater)	
	Alexandria	Domestic	
	Damietta	Mixed (River)	
Lebanon	Greater Beirut area	Municipal +industrial	4,090
	Jounieh	Municipal +industrial	
	Saida-Ghaziye	Municipal +industrial	
	Tripoli	Municipal	
	Batroun-Selaata	Municipal +industrial	
Libya	Zawia	Domestic	2,160
	Tripoli	Domestic	
	Zanzur	Industrial	
	Benghazi	Domestic	
	Tobruk	Domestic	
Morocco	Tangier	Domestic +industrial	5,180
	Tetouan	Domestic+ industrial	
	Nador	Domestic+ industrial	
Syria	Tartous	Municipal +industrial	580
	Lattakia	Municipal +industrial	
	Banias	Municipal +industrial	
	Jableh	Municipal +industrial	
Tunisia	Gabes	Municipal +industrial	7,250
	Lake of Tunis	Municipal +industrial	
	Lake of Bizerte	Municipal +industrial	
	Sfax-South	Municipal +industrial	

Sources: UNEP/WHO, 1999 ; UNEP/MAP, 2004

and Morocco (REMPEC, 2002). Naturally, such heavy naval traffic brings with it many risks of marine pollution.

The Red Sea & Gulf of Aden Region

Land-based Sources of Pollution

The main land-based sources of pollution are:

Municipal wastewater discharges: The discharge of municipal wastewaters continues to present significant management problems in the Region. Although the levels of sewage discharge in the Red Sea are not particularly severe compared to other areas, due to the relatively limited coastal population and general lack of major population centres in its catchments area, the results of discharges are cumulative.

Industrial effluents: Impacts of industrial effluents, in the form of thermal pollution or brine water from power and desalinization plants, particulate matter and mineral dust from fertilizer and cement factories, and chemicals and organic wastes from food and textile processing factories, contribute to the land-based sources of pollution affecting coastal waters in the RSGA region (Gerges, 2002).

Sea-based Sources of Pollution

Although approximately 11% of the world's seaborne oil is transported through the RSGA region, there have been no major spills (>5,000 tonnes) resulting from shipping accidents. Most spills in this region have been the result of operational discharges, equipment failures and groundings (ITOPF, 2003).

Despite the low occurrence of major accidents within the region, the high volume of shipping results in chronic pollution in the form of tarballs arriving on the shorelines. Studies of water quality suggest that the Red Sea environment receives more oil/km^2 than any other regional sea. The coast of Saudi Arabia between Jeddah and Yemen is tarred in several places. The Egyptian coast near the offshore oil fields of the Gulf of Suez is similarly affected by oil discharges (ITOPF, 2003).

Plans to increase the volume of oil transported via the Yanbu Petroline and the SUMED Pipeline, along with the possibility of expanding the capacity of the Suez Canal to accommodate fully laden vessels of 250,000 tonnes create increased risks of major oil spills. Other potential sea-based sources of pollution in the region are the risks of spills and other production accidents associated with the offshore oil activities and operations (Gerges, 2002).

Pollution from land-based sources (mainly untreated domestic sewage and industrial wastes) is a common marine environmental issue in the Arab countries, while sea- based pollution is more acute in the RSA.

The ROPME Sea Area

Land-based Sources of Pollution

The impacts of municipal sewage and industrial effluents, particularly those of petroleum refineries and the petrochemical industry, are significant. Power plants cause thermal pollution and desalination plants release chlorine, brine and thermal loads into the seawater (ROPME, 2003).

Sea-based Sources of Pollution

The RSA has one of the highest oil pollution risks in the world because of the concentration of offshore installations, tanker loading terminals and the huge volume and density of marine transportation of oil. Out of twenty cases of oil spills greater than ten million gallons worldwide, six cases have taken place in the RSA. Smaller scale oil pollution incidents such as submarine pipeline rupture and well blowout are more frequent in the RSA (ROPME, 2003).

V. MARINE FISHERIES & ANNUAL CATCH

The Mediterranean Region

In the Mediterranean, 540 species of fish have been recorded (Batisse & Jeudy de Grissac, 2003). The yield of Mediterranean fisheries, in general, is relatively low compared to other oceans, probably as a result of the relatively low primary productivity and generally narrow continental shelves. There is some evidence of a gradi-

ent in the yield, decreasing from west to east and from north to south.

Exploitation of Resources

Approximately 1.5 million tons of fish are caught in the whole Mediterranean Sea each year (WWF, 2004), and fishing from the Levant Basin during 2000 was 80,915 tonnes (Benoit & Comeau, 2005). Overfishing is becoming an increasing problem in the Mediterranean waters, and is being driven by the rising prices and demand in the past decades. This is resulting in unsustainable exploitation of many fish stocks, and the destruction of their natural habitats. With 22 Mediterranean countries plus Asian fishing fleets competing for the same fish resources, there has been a dramatic decline in fish stocks which have already fallen to 20% of natural levels in some areas. Destructive and often illegal fishing methods have contributed to depleting fish stocks.

Data on the Capture Fishes of the Mediterranean region are shown in Table 3.

The Red Sea & Gulf of Aden Region

The fisheries of the RSGA are of considerable socio-economic importance in terms of national food security and income generation for rural communities. Fisheries resources are exploited by artisanal fishermen, local commercial fisheries and foreign industrial fisheries targeting invertebrates, demersal finfish and pelagic finfish. The shark resources in the region are heavily fished, especially in Djibouti, Somalia, Sudan and Yemen. Fish and shellfish stocks of the RSGA support artisanal, semi-industrial and industrial fisheries fleets of Djibouti, Egypt, Saudi Arabia, Somalia, Sudan and Yemen (PERSGA, 2004a).

A large number of fish stocks are exploited. Of the vast number of species of fish in the region, only around 65 species are presently considered to be of economic importance, in addition to sharks, rays, shrimps, lobsters, crabs, molluscs and sea cucumber.

Very few large-scale resource surveys and stock assessments have been conducted on major species on a regional basis. The total potential yield of fisheries resources for the Red Sea has been calculated at 360,000 mt (megatons) and 267,000 to 414,000 mt for the Gulf of Aden.

Unsustainable exploitation of living marine resources

According to PERSGA (2000), Egypt's trawl, purse-seine and reef-associated fisheries are all considered over-exploited. Severe fishing pressure, coupled with water pollution in the Gulf of Suez and the Red Sea have been indicated as negative impacts on fisheries.

In Sudan, stocks are fully exploited in waters adjacent to Suakin in the south and Mohammed Qol in the north; a steady decline in finfish catches of certain species of snapper is observed. Production from Suakin dropped from 163 mt in 1990/91 to 26.3 mt in 1992/93 and exports as a whole declined from 485 mt in 1991/92 to 432.7 mt in 1994/95. Shark resources have also shown rapid decline to only 163 mt in 1990/91 to 26.3 mt in 1993/94.

In Djibouti, parts of the coasts and territorial waters are still in a largely pristine state. However, some studies shown that in several areas there are alarming signs of degradation and threats. Djibouti has only traditional fisheries.

In Yemen, the lucrative industrial fishery for cuttlefish in the Gulf of Aden illustrates a clear example of overfishing and resultant decline of the fishery. The stock today has still not recovered and is still far below its biological potential. Similarly the deep-sea lobster was also over-fished. Reasonable data for landings by the Gulf of Aden rock lobster fishery off the coast of Yemen indicate that landings have declined since 1990 and the average size of rock lobster has decreased. Declines in the landings of sharks by fishermen operating in the Yemen's Red Sea waters and in Sudan is an indication of overfishing (PERSGA, 2000).

Data on the Capture Fishes of the RSGA are shown in Table 3.

The ROPME Sea Area

There is a generally low diversity of fish species in the RSA. The fisheries sector plays only a minor role in the national economies in the Region. The inner part of the RSA supports more than

TABLE 3 **CAPTURE FISHES FROM THE ARAB COUNTRIES OF THE MED, RSGA AND RSA**

		1000 tons					
Region	**Countries**	**Demersal mar. fish**	**Pelagic mar. fish**	**#Marine fish NEI**	**Crustacean**	**Molluscs**	**Cephalopod**
MED Region	**Morocco**	68	749	37	10	2	29
	Algeria	12	115	9	3	0	1
	Tunisia	31	54	6	7	1	12
	Libya	-	-	-	-	-	-
	***Egypt MED+RS**	216	35	19	14	4	3
	Lebanon	1	2		0		0
	Syria	1	1		0	0	
PERSGA Red Sea & Gulf of Aden Region	**Djibouti**	-	-	-	-	-	-
	Jordan	0	0	0	-	-	-
	***Saudi Arabia RS+RSA**	26	18	1	18	-	1
	Somalia	-	-	-	-	-	-
	Sudan	0	0	5	-	-	-
	Yemen	56	183		3	-	13
ROPME Sea Area	**Bahrain**	6	1	1	6		0
	Iraq	-	-	-	-	-	-
	Kuwait	2	1	0	2	-	-
	Qatar	7	3	1	0		0
	Oman	50	97	6	1	0	12
	UAE	57	31	2	0	-	0

#NEI not elsewhere included
*Egypt and Saudi Arabia data are for their total production from different regional seas.
Source: FAO, 2004

500 fish species, most of which live in pelagic or soft substrate demersal habitats: at least 125 species are found on the reefs; about 130 fish species are known to occur in Kuwait; 71 species in Bahrain; and 106 species from reefs in Saudi Arabia. Environmental extremes in the inner RSA have restricted the distribution of many species of fish (ROPME, 2003).

The commercial fisheries of the region are supported by over 1,000 species of finfish and shellfish, including six species of shrimp, two species of spiny lobster, one species of shovel nose lobster, one species of cuttlefish, one species of abalone and one species of crab. Considering the Arab countries of the RSA, the highest fish landings have been reported in Oman and UAE. Qatar had the lowest quantities during the period 1995–1999. Bahrain and Kuwait had similar volumes of landings.

The fisheries of the region are affected by environmental degradation caused by coastal zone activities which have led to the elimination of nursery areas for commercially important species of fin and shellfish. The reduction of outflow from Shatt Al-Arab has had significant negative effects on the reproduction of certain marine species. Bottom trawling has severely destroyed the benthic communities of the region. Several countries have taken remedial measures to protect shrimp stocks. Data on the Capture Fishes of the RSA are shown in Table 3.

In the Mediterranean and the RSGA, overfishing is becoming an increasingly severe problem as a result of unsustainable exploitation of many fish stocks. The fisheries of the RSA are affected by environmental degradation caused by coastal zone activities that eliminate nursery areas for important species. Inadequate Fisheries management is a result of the:

- lack of information on transboundary stocks and cooperation in management of shared stocks;
- inadequate baseline data on benthic and demersal stocks;
- lack of surveillance and enforcement of existing fishing regulations.

VI. CORAL REEFS

Coral reefs represent an important resource, both in terms of global biological diversity and with respect to the well-being of the people who live near or depend upon them. Reefs are an essential supplier of protein to subsistence communities; a valuable currency earner through exploitation of their resources and through tourism; and a naturalist's paradise (UNEP/IUCN, 1993).

Coral reefs exist only in the PERSGA and ROPME regions.

The Red Sea & Gulf of Aden Region

The Red Sea is most famous for its extensive fringing coral reefs. These reefs are composed of approximately 200 species of stony corals (belonging to more than 50 genera, Table 4). The warm water and absence of freshwater input provide very suitable conditions for coral reef formation adjacent to the coastline. This beautiful environment is extremely attractive as a tourist resource and is currently visited by hundreds of thousands of people each year particularly in Egypt, who dive and swim in the waters adjacent to the reefs. Further south the coastal shelf becomes much broader and shallower and the fringing reefs gradually disappear to be replaced by shallow, sandy shorelines and mangroves.

Reef development varies from north to south in the Red Sea, with well-developed, narrow fringing reefs north of 20°N with steep slopes dropping into very deep water. In the northern Red Sea the coast is fringed by an almost continuous band of coral reef, which physically protects the nearby shoreline. A longitudinal series of coral reefs exists within the Red Sea, effectively forming a series of barrier reefs. These barrier reefs are 10-40 km offshore of the Saudi Arabian coastline and extend southward for 400 km. Similar systems of reefs occur on the African side of the Red Sea. There are also isolated patch reefs and atoll-like structures, the most famous of which is Sanganeb Atoll in Sudan (PERSGA, 2002).

Corals require a range of physical conditions for healthy growth and reproduction, all of which are influenced by human activities. Physical destruction, changes in water quality, such as raised nutrient levels, and changes in salinity and temperature, high levels of sedimentation, and changes in water currents can all damage coral reefs. Recovery, through new growth and larval settlement, requires a considerable amount of time and freedom from chronic stress (PERSGA, 1998).

The ROPME Sea Area

There are numerous patch reefs in the RSA, with coral islands representing the peak of their development. Because of scouring by loose sand in the water column, patch reefs support fewer and less dense communities than island coral reefs, which have extensive reef flats and extend to depths of 10-20 meters. About 55-60 coral species have been identified in the RSA. This compares to about 200 species in the Red Sea (ROPME, 2003).

The coral reefs in the RSA are subject to a wide range of natural environmental stresses and human influences. Coral bleaching has been reported on some reefs in Bahrain, Oman, Saudi Arabia and the UAE over the past few years. Coral reefs are extensively destroyed by Crown of Thorns Starfish (COTS) in Oman and UAE.

Although the region contains only about 8% of the world's mapped coral reefs, almost two-thirds of them are classified as being at risk.

Most fishing activities in the **RSGA** occur in shallow waters in the vicinity of coral reefs.
Corals are largely destroyed in areas affected by "uncontrolled" urban and tourism development and tourism. Sedimentation from these operations has an adverse effect on the surrounding ecosystems (e.g coral reefs). The coral reefs in the **RSA** are subject to a wide range of natural environmental stress and human influences. Coral bleaching has been reported on some reefs.

VII. BIOCHEMICAL OXYGEN DEMAND (BOD) IN MARINE WATERS

The Mediterranean Region

Algeria and Egypt are the highest BOD contributors among all Mediterranean countries including the Arab states of the south Mediterranean. The BOD discharged from industrial sources in Algeria was estimated at

113,600 tons/year. This value is about 28% of the total industrial BOD discharged to the Mediterranean. The Egyptian Mediterranean coastal waters receive the pollution load of the major part of the country's population, agricultural and industrial activities. Accordingly, the BOD discharged from industrial sources in Egypt was estimated at 213,160 tons/year; this contributes about 52% of the total industrial BOD discharged to the Mediterranean.

BOD discharged from Hot Spots of the Arab Mediterranean countries is presented in Table 2.

The Red Sea & Gulf of Aden Region

Some areas, particularly on the west coast of the Red Sea south of Suez still receive a considerable load of nutrients and BOD discharges from domestic sewage (Gerges, 2002). According to PERSGA (2001), estimated total BOD generated by Saudi Arabia's municipal sewage treatment along the Red Sea coast is 122,000 t/y.

The ROPME Sea Area

Desalination and power plants discharge around 48% of the total industrial effluent volume which contribute to the BOD, COD (Chemical Oxygen Demand) and SS (Suspended Solids) load in the marine environment of the RSA (ROPME, 2003).

The liquid industrial discharge from Saudi Arabia is mainly from sewage treatment plants, and includes domestic and industrial wastes. In 1999, the quantity of waste discharged on the Saudi Arabian coast of the RSA was 600,000 m^3/d. The contaminant load of the discharged waste indicated that the BOD load was 6,622 t/y.

Levels of industrial liquid waste produced in the UAE were estimated at $37x10^6m^3$ in 1998, and BOD estimated as 11,082 t/y. In Abu Dhabi, the BOD is estimated at 3,018 t/y.

VIII. IMPACT OF COASTAL DEVELOPMENTS

The Mediterranean Region

The coasts of the Mediterranean Arab states supported a population of approximately 53 million inhabitants in 2000, a figure which is rapidly increasing, and is projected to rise to 77 million inhabitants in 2025 (Benoit & Comeau, 2005). Associated with this urban spread is the threat to species and habitats from land reclamation, waste water discharges and construction disturbance.

Tourism is flourishing at present in the southern Mediterranean (Morocco, Algeria, Tunisia, Egypt and Lebanon). The Arab Mediterranean countries received about 17 million tourists in 2005, with a projection of about 48 million in 2025 (Benoit & Comeau, 2005). The negative impact of tourism is the environmental degradation through extensive development, added pressure to the coastal areas, and stress on the marine environment.

The Red Sea & Gulf of Aden Region

The physical alteration and destruction of habitats as a result of dredging and filling operations associated with urban expansion, tourism and industrial developments are among the main sources of environmental degradation in the RSGA region. This is particularly witnessed in Egypt and Saudi Arabia (Gerges, 2002). Sedimentation from these operations has an adverse effect on the surrounding ecosystems (mangroves, seagrass beds, and coral reefs) and, as a consequence, a decline in the productivity of the sea. In addition, uncontrolled tourism has resulted in significant damage and destruction of key habitats. Although the environmental impact of tourism in the southern RSGA is not as prominent as in the northern and central areas, the growing tourism investment plans in various parts of these countries will ultimately induce environmental impacts on a regional scale (PERSGA, 2005).

The ROPME Sea Area

The coastline of the RSA is under increasing pressure from the high pace of development and extensive economic activities. By the early 1990s, some countries had already developed more than 40% of their coastlines (ROPME, 2003). Several coastal development projects have been or are being implemented in the region's countries. In Bahrain such activities considerably increased in the 1970s, due to industrial and residential pressures such as the construction of industrial complexes and to build the King Fahd Causeway. The reclaimed land in Bahrain increased the surface area of Bahrain from 661.87 km^2 in 1975 to 700 km^2 in 1994. Recently, urbanization has encroached on significant parts of the coastal areas of Bahrain.

Considerable stretches of the intertidal areas along the Kuwait City coast and some sections along the southern coast of Kuwait have been reclaimed. As a result, significant erosion problems have developed along most of the fill edge of the reclaimed areas.

Reclamation and particularly dredging for port, harbour and seafront development contributed to changes in coastal environments in the Sultanate of Oman in 2002.

Commercial and residential development has taken place along the coastal areas of Saudi Arabia, particularly around Jubail, and further south around Tarut Bay, Dammam and Khobar.

Industrial complexes and desalination plants were established in the UAE. Significant urban development is taking place along the coasts and their surrounding areas in Abu Dhabi and Dubai.

ROPME (2003) concluded that although dredging and land reclamation are also permanent features in many coastal areas of the region with significant damaging effects on the environment, the alarming magnitude of the physical alteration of the coastline of the RSA has had several adverse environmental effects on the coastal environment.

The negative impact of tourism and uncontrolled urban development is the environmental degradation which has generated several adverse environmental effects on the coastal environment of the three regions.
The lack of proper land use planning, ineffective zoning and environmental audit procedures in some countries, particularly with regard to urban development and industrial expansion are growing problems in different areas.

IX. MARINE AND COASTAL PROTECTED AREAS (MPAS)

A Marine Protected Area *(MPA)* is

> *Any area of the intertidal or subtidal terrain, together with its overlying water and associated flora, fauna, historical and cultural features, which has been reserved by law or other effective means to protect part or all of the enclosed environment (IUCN, 1988).*

TABLE 4 THE COASTAL AND MARINE PROTECTED AREAS IN THE ARAB COUNTRIES

Region	Arab Countries	Number Mar & Coast Protected Areas	*Protected Areas % of total land areas (2003)	Number of Scleractinia Coral Genera
MED Region	**Morocco**	10	1.2	X
	Algeria	8	5.1	X
	Tunisia	7	1.5	X
	Libya	X	0.1	X
	Egypt	4	(Med + RS) 9.42**	X
	Lebanon	1	0.7	X
	Syria	X	1.9	X
PERSGA Red Sea & Gulf of Aden Region	**Djibouti**	2	0.5	55
	Egypt	7	(Med + RS) 9.42**	57
	Jordan	1	3.02**	44
	Saudi Arabia	4	(RS+RSA) 2.8	54
	Somalia	2	0.3	50
	Sudan	2	4.9	56
	Yemen	X	X	51
ROPME Sea Area (GULF Region)	**Bahrain**	1	1.3	29
	Iraq	X	X	X
	Kuwait	4	0.0	23
	Oman	2	13.74**	40
	Qatar	4	1.1	27
	Saudi Arabia	(RS+RSA) 4	(RS+RSA) 2.8	54
	UAE	4	0.3	28

Main source: World Resource Institute. Earth trends: The Environmental Information Portal (2006)
*Protected Areas (all types and categories, and not restricted to coastal and marine only) % of total land areas as in 2003
**EEAA (2006)

MPAs can provide a range of benefits to local communities and national development through the sustainable use of living marine resources and biodiversity conservation.

The coastal and marine protected areas in the Arab countries are listed in Table 4.

Significant efforts were recognized in the three regional seas to develop marine and coastal protected areas as a rational management tool for the coastal area and within the strategy of the sustainable development.

The Mediterranean Region

As part of the Mediterranean Action Plan, a protocol concerning specially protected areas and biological diversity in the Mediterranean was adopted by the contracting parties in June 1995. The protocol calls for the establishment of a list of Specially Protected Areas of Mediterranean Importance (SPAMI), with the objectives of biodiversity conservation and protection of specific Mediterranean ecosystems.

MEDPAN (the Mediterranean Protected Areas Network) was established in 1991 to facilitate the exchange of experience between protected areas managers.

The Red Sea & Gulf of Aden Region

PERSGA (2004b) found that although all countries in the region had designated MPAs, they were few in number and only one or two were adequately managed. Many of the current and/or proposed protected areas were under high pressure from fishing and/or tourism. Others were at risk from navigation and development activities in adjacent areas.

MPAs have been established in many parts of the RSGA. This has been initiated through the inte-

Although the Arab countries have designated MPAs, issues of their adequate and efficient management remain. Several of the current and/or proposed protected areas, particularly in the RSGA, are under high pressure from fishing and tourism. Others are at risk from navigation and development activities in adjacent areas. Designation of MPAs that can be adequately managed should be associated with efficient institutional and capacity building, including resource mobilization.

gration of 12 MPAs from throughout the region into a Regional Network of MPAs for the RSGA.

Twelve declared and proposed MPAs, representing different ecosystem types and biodiversity richness and uniqueness, were identified as regionally or globally important (PERSGA, 2004b)

The ROPME Sea Area

In the RSA there are eight parks and reserves already established along the coasts of the region, and over 85 sites have been recommended for protection (ROPME, 2003)

Of the protected areas, some areas are also covered by international conventions and programmes. In Iraq, most of the important nature conservation areas in the country are unprotected although many have been recommended for future protection as national parks or reserves. The coastline of Iraq is restricted to an area next to Faw by the mouth of the Shatt Al-Arab. Little-developed areas recommended for protection include the mudflats near Al-Faw and Khor Zubair/Khor Abdullah.

Table 4 shows the numbers of Marine and Coastal protected areas as well as the percentage (%) of protected areas to the total land areas in the three regional seas in the Arab world.

X. MARINE REGULATORY PROGRAMMES, REGIONAL AND INTERNATIONAL AGREEMENTS

The Mediterranean Region

The environmental policy of the Mediterranean countries is becoming progressively aligned with the requirements of the Barcelona Convention of 1976 and its Protocols, formally known as "The Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean.

The Barcelona Convention was adopted in 1976 and entered into force in 1978. The following are the Protocols related to this Convention:

- Protocol for the Prevention of Pollution of the Mediterranean Sea by Dumping from Ships and Aircraft *(1976).*
- The Protocol concerning Co-operation in Combating Pollution of the Mediterranean Sea by Oil and other Harmful Substances in cases of Emergency (Emergency Protocol) *(1976).*
- The Protocol concerning Co-operation in Preventing Pollution from Ships and, in cases of Emergency, Combating Pollution of the Mediterranean Sea *(1976).*
- The Protocol for the protection of the Mediterranean Sea against Pollution from Land-based Sources (LBS Protocol) *(1980).*
- Protocol for the Protection of the Mediterranean Sea against Pollution resulting from Exploration and Exploitation (Offshore Protocol) of the Continental Shelf and the Seabed and its Subsoil *(1994).*
- The Protocol concerning Specially Protected Areas and Biological Diversity in the Mediterranean (SPA & Biodiversity Protocol) *(1995).*
- Protocol on the Prevention of Pollution of the Mediterranean Sea by Transboundary Movements of Hazardous Wastes and their Disposal (Hazardous Wastes Protocol) *(1996).*

THE RED SEA & GULF OF ADEN REGION

The Jeddah Convention of 1982, formally titled Regional Convention for the Conservation of the Red Sea and Gulf of Aden Environment, and its two Protocols Concerning Regional Cooperation in Combating Pollution by Oil and Other Harmful Substances in Cases of Emergency (1982) and the Protocol for the Protection of the Marine Environment in the Red Sea and Gulf of Aden from Land-based Sources of Pollution and Activities (2005), provide an important basis for environmental cooperation in the region. In addition, another supportive instrument was developed, namely the Action Plan for the

Conservation of the Marine Environment and Coastal Areas in the Red Sea and Gulf of Aden.

The ROPME Sea Area

The Kuwait Regional Convention for Cooperation on the Protection of the Marine Environment from Pollution (1978) has four related protocols that were developed in accordance with the recommendations of the Legal Component of the Kuwait Action Plan. These protocols are:

- Protocol concerning Regional Cooperation in Combating Pollution by Oil and other Harmful Substances in Cases of Emergency *(1978).*
- Protocol concerning Marine Pollution resulting from Exploration and
- Exploitation of the Continental Shelf *(1989).*
- Protocol for the Protection of the Marine Environment against Pollution from Land-Based Sources *(1990).*
- Protocol on the Control of Marine Transboundary Movements and Disposal of Hazardous Wastes and Other Wastes *(1998).*

The status of the ratification of the regional and international conventions and protocols by the Arab states in the three regional seas is presented in Table 5 (UNEP, 1991; PERSGA, 2003, ROPME, 2003; EEAA, 2006).

XI. EMERGING ISSUES; THE IMPLICATIONS OF CLIMATE CHANGE

According to UNEP (1992), a substantial rise in the sea level would eventually invade wetlands and lowlands, accelerate coastal erosion, aggravate coastal flooding and salinisation of fertile lands and increase the salinity of estuaries and aquifers. Global climate change would play a role in the increase of coral bleaching events, and could cause the destruction of major reef tracts and the extinction of many coral species (GIWA, 2006). Climate changes would also affect the productivity and fisheries in the marine environment.

In the Mediterranean Arab Region, the Nile delta in Egypt and the deltaic plain of the River Medjerda in Tunis are examples of areas vulnerable to a rising sea level.

Although regional and national legislation concerning the coastal and marine environments were developed in the Arab countries of the three regions, the following are shared problems in most countries:

- Lack of enforcement of the existing laws and regulations
- Inefficient monitoring for compliance
- The need to standardise terms and identifications related to definitions, ecosystem, biodiversity and integrated management
- The need to consider regional/interregional transboundary issues (cooperation mechanism and dispute resolution)

In the RSGA no bleaching has been observed to date in the Gulf of Aqaba, the Gulf of Suez or along the Egyptian coast of the main basin. Bleaching was patchy along the Saudi Arabian coast, being more severe to the south. In Sudan, bleaching occurred at several locations, above all south of Port Sudan. Along the Red Sea coastline of Yemen, where reefs are already under considerable human-induced stress, effects of coral bleaching were severe. However, no quantitative data is available. Many areas of the Gulf of Aden were affected by bleaching. In Somalia, almost all corals in an area east of Berbera were killed, whereas further west, corals were only slightly affected. In Yemen, many corals along the shoreline died, and more than half of the corals of the Socotra Archipelago were affected by the bleaching (GIWA, 2006).

In the RSA coral bleaching has been reported in Bahrain, Oman, Saudi Arabia and UAE because of high temperatures over the past few years.

XII. PRIORITY ENVIRONMENTAL ISSUES, IMMEDIATE & ROOT CAUSES AND PROPOSED REMEDIAL MEASURES

Although located in different regional seas, the marine and coastal Arab environments share common priority issues. Some of these issues are transboundary in nature (e.g. pollution, overfishing).

Priority environmental issues, immediate and root causes and remedial measures in the Arab environment of the Mediterranean, PERSGA and ROPME regions are presented in Table 6.

TABLE 5 **THE STATUS OF SIGNATURE/AND OR RATIFICATION OF THE REGIONAL AND INTERNATIONAL CONVENTIONS AND PROTOCOLS BY THE ARAB STATES**

Region	Countries	Regional Conventions			International Conventions & Protocols							
		Barcelona Convention 1976	Jeddah Convention 1982	Kuwait Convention 1978	London Convention 1954	RAMSAR Convention 1971	MARPOL 73/78	UNCLOS 1982	Basel Convention 1989	CBD 1992	UNFCCC 1992	LBA Protocol 1995
MED Region	**Morocco**	Y			Y	Y		Y				Y
	Algeria	Y			Y	Y	Y	Y				Y
	Tunisia	Y			Y	Y						Y
	Libya	Y			Y			Y				Y
	Egypt	Y	Y		Y	Y	Y	Y	Y	Y	Y	Y
	Lebanon	Y			Y	Y		Y	Y			Y
	Syria	Y			Y				Y			Y
PERSGA Red Sea & Gulf of Aden Region	**Djibouti**		Y		Y		Y	Y	Y	Y	Y	Y
	Egypt		Y		Y	Y	Y	Y	Y	Y	Y	Y
	Jordan		Y		Y	Y	Y		Y	Y	Y	Y
	KSA		Y	Y	Y			Y	Y		Y	Y
	Somalia		Y								Y	Y
	Sudan		Y			Y		Y	Y		Y	Y
	Yemen		Y		Y			Y	Y		Y	Y
ROPME Sea Area	**Bahrain**			Y	Y	Y		Y	Y	Y	Y	Y
	Iraq			Y				Y	Y	Y	Y	Y
	Kuwait			Y	Y			Y	Y	Y	Y	Y
	Qatar			Y	Y				Y	Y	Y	Y
	KSA			Y	Y			Y	Y	Y	Y	Y
	Oman			Y	Y		Y	Y	Y	Y	Y	Y
	UAE			Y	Y				Y	Y	Y	Y

Sources: UNEP, 1991; PERSGA, 2003, ROPME, 2003 and EEAA, 2006

TABLE 6 **PRIORITY ENVIRONMENTAL ISSUES, IMMEDIATE & ROOT CAUSES AND PROPOSED REMEDIAL MEASURES**

Region	Priority Envir. Issues	Immediate Causes	Root Causes	Proposed Remedial Measures
MED Region	Land-Based Activities	Discharge of Industrial waste Discharge of untreated or partially treated sewage	Lack of regulation and enforcement Inadequate monitoring Inadequate technology	Develop/ implement NAP on LBA Reduce BOD by 50% by the year 2010 (UNEP/MAP/RAC/CP (2004) Establish WWTP Prevent/Reduce discharge of waste Apply Clean Production & BAT Enhancement of Awareness Enforce Laws and regulations
	Urban and Tourism Development	Large scale urban and tourism development Coastal modification Population pressure and mobilization	Lack of awareness, lack of enforcement	Develop/implement ICZM Prevent/Reduce landfill and dredge in the coastal areas Determine the carrying capacity of coastal development & Tourism
	Destruction of Habitats	Destruction of seagrass meadows, coastal habitats Release of untreated waste	Lack of enforcement, limited awareness, poor navigational control	Prevent/Reduce landfill and dredge in the coastal areas Prevent/Reduce discharge of solid and wastewater Enhancement of awareness
	Exploitation of LMR (Living marine Resources)	Overfishing Decline in landings Increased fishing efforts Landing beyond Maximum Sustainable Yield. Destructive fishing technique	Lack of stock assessment Lack of monitoring Lack of regulation enforcement	Enforcement of regulations Prevent destructive fishing techniques Assessment & Monitoring
	Sea-based Activities	Accidental oil spill, sand mining	Inadequate control. Lack of reception facilities	Navigational control Establish reception facilities Enhancement of REMPEC
PERSGA Red Sea & Gulf of Aden Region	Land-Based Activities	Discharge of Industrial waste. Discharge of untreated or partially treated sewage	Lack of regulation and enforcement Inadequate monitoring Inadequate technology	Develop NAP on LBA Establish WWTP Prevent/Reduce discharge of waste Apply Clean Production & BAT Enhancement of Awareness & Enforce Laws and regulations
	Destruction of Habitats	Destruction of coral reefs by anchoring, trawling and landfill, and mangrove	Lack of regulations and enforcement, limited awareness	Prevent/Reduce landfill and dredge in the coastal areas.Prevent or reduce discharge of solid and wastewater Carrying capacity for diving in coral reef areas/ NAP for coral reef management Protection of mangrove/ NAP for mangrove management. Prevent curio trade. Enhancement of awareness

TABLE 6 CONTINUED

Region	Priority Envir. Issues	Immediate Causes	Root Causes	Proposed Remedial Measures
	Urban and Tourism Development	Large scale urban and tourism development Extensive dredging and filling	Lack of awareness, lack of regulations and enforcement	Develop/implement ICZM Prevent/Reduce landfill and dredge in the coastal areas Determine the carrying capacity of coastal development & Tourism
	Sea-Based Activities	Exploitation of oil Tar balls and slicks on beaches and water Discharge of ballast and bilge water Discharge from Pipe lines	Inadequate control Lack of reception facilities	Navigational control Establish reception facilities Enhancement of MEMAC
	Exploitation of LMR (Living marine Resources)	Overfishing Decline in landings Increased fishing efforts Landing beyond Maximum Sustainable Yield Destructive fishing technique	Lack of stock assessment Lack of monitoring Lack of regulation & enforcement	Enforcement of regulations Prevent/Reduce destructive fishing techniques Assessment and monitoring
ROPME Sea Area	Sea-Based Activities	Oil spill (2 million b/y) Exploitation of oil Tar balls and slicks on beaches and water Discharge of ballast and bilge water Discharge from Pipe lines	Inadequate control Lack of reception facilities	Navigational control Establish reception facilities Enhancement of MEMAC

TABLE 6 CONTINUED

Region	Priority Envir. Issues	Immediate Causes	Root Causes	Proposed Remedial Measures
	Land-Based Activities	Discharge of Industrial waste Discharge of untreated or partially treated sewage	Lack of regulation and enforcement Inadequate monitoring Inadequate technology	Develop NAP on LBA Establish WWTP Prevent/Reduce discharge of waste Apply Clean Production & BAT Increase Awareness & Enforce Laws and regulations
	Urban and Tourism Development	Large scale urban and tourism development Extensive dredging and filling	Lack of awareness, lack of enforcement	Develop/implement ICZM Prevent/Reduce landfill and dredge in the coastal areas Determine the carrying capacity of coastal development & Tourism
	Destruction of Habitats	Destruction of seagrass, coral reefs by anchoring, trawling and landfill	Lack of enforcement, limited awareness, poor navigational control	Prevent/Reduce landfill and dredge in the coastal areas Prevent or reduce discharge of solid and wastewater Carrying capacity for diving in coral reef areas/ NAP for coral reef management Prevent curio trade Enhancement of awareness
	Exploitation of LMR (Living marine Resources)	Overfishing Decline in landings Increased fishing efforts Landing beyond Maximum Sustainable Yield. Destructive fishing technique	Lack of stock assessment Lack of monitoring Lack of regulation & enforcement	Enforcement of regulations Prevent/Reduce destructive fishing techniques Assessment and monitoring

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