

The Coastal Zone of Gaza strip-Palestine Management and Problems

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1. Historical Background

The coastline of the Gaza strip forms only a small section of a larger concave system that extends from Alexandria at the West Side of the Nile Delta, via Port Said, Bardawil Lagoon, El Arish, Gaza, Ashkalon, and Tel Aviv to the Bay of Haifa. This littoral cell forms the eastern corner of the Levantine Basin (Figure 1.1). This entire coastline, including the coastline of the Gaza Strip, has been shaped over by the sedimentation of the Nile River.

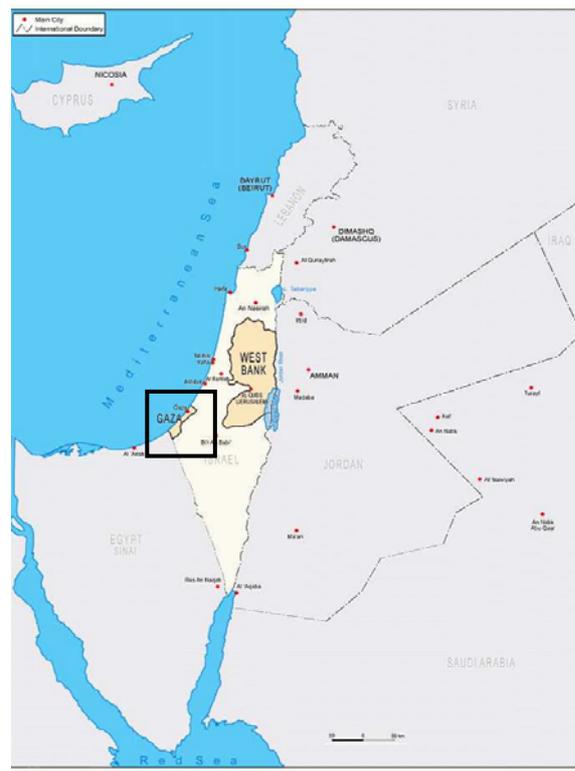


Figure 1.1. Gaza Coastline in the Mediterranean Context

Beach constructions as roads, restaurants, hotels and other buildings have been constructed, very close to and even right on the active part of the shore, thereby constraining the range of free space needed for the seawater dynamics. Recently after the construction of the fishing Port increased the need to protect the coastal zone of Gaza strip.

The coastal erosion is another threat to the coastal zone. The flooding of 'Wadi' Gaza when happens may be increased the erosion rate and therefore effects the structure and the biodiversity of the coast.

Constructions between Rafah at the southern border, and Gaza City there are no major coastal structures, which makes the biodiversity are little threatened. The coastline is sandy in most of the areas forming dunes particularly in the southern part. Kurkar cliffs are found between the mouth of 'Wadi' Gaza a Dier Elbalah.

1.2. Current status of the Coastal Zone

The remaining coastal zone of Palestine is defined in Gaza strip (Figure 1. 1) as a band of water and land along the marine shoreline where different activities interact with each other. The coastal zone includes the sand dunes in the south and north, the coastal cliffs (exposed Kurkar ridges) in the middle to north, the non-urban areas, Gaza valley 'Wadi Gaza' and part of Gaza City.

The coastal zone of Gaza strip (Figure 1.2) is 42 km long, while the width of the strip is between 6 and 12 km covering an area of 365 km². The area is situated in the southern part of Palestine and Southeast Mediterranean Sea and occupied by 1.3 million populations. A number of Israeli settlements are located at different parts, from north to the south, covering a total area of 80 km² and having a population of 3000-5000 inhabitants (Hassanen & Abu Daya, 2000). The coastal zone of Gaza strip is defined as a band of water and a land extended along the seashore of the eastern Mediterranean Sea. The coastal zone includes the sand dunes in the south and north, the coastal cliffs (exposed Kurkar ridges) in the middle to north. The land band of the coastal zone covers about 74 km² of which 2.7 km² are beaches, and in the same time about 48 km² of this area is occupied by Israel settlements (MOPIC, 1996).

Mainly a major valley 'Wadi Gaza' in the centre dissects the coastline. Other two valleys Wadi Beit-Hanoun in the north and Wadi El-Salqa in the south are with little flooding, usually dry throughout the summer and becoming wet in winter. Untreated wastewater discharges in Wadi Gaza and floods may be occurred during winter. The water supply from these valleys appears to be limited or stopped that was after a control system has been established (Goodson, 1999).

In 1999 the American National Oceanic Atmospheric Agency (NOAA) presents the shoreline habitats delineated for the coastline of the Gaza strip. The majority of the coastline consists of upper-medium to coarse-grained (49.41%) and fine to lower-medium grained sand beaches (38.46%). In front of Gaza City part of the coast (6.05%) consists of riprap (shore protection of concrete rubble and rock). Natural, exposed, wave-cut platforms in rock can be found along 3.81% of the coastline. Solid man-made structures can either be sheltered (1.24%) or exposed (0.24%). Finally, 0.74% of the coastline consists of mixed sand and gravel.

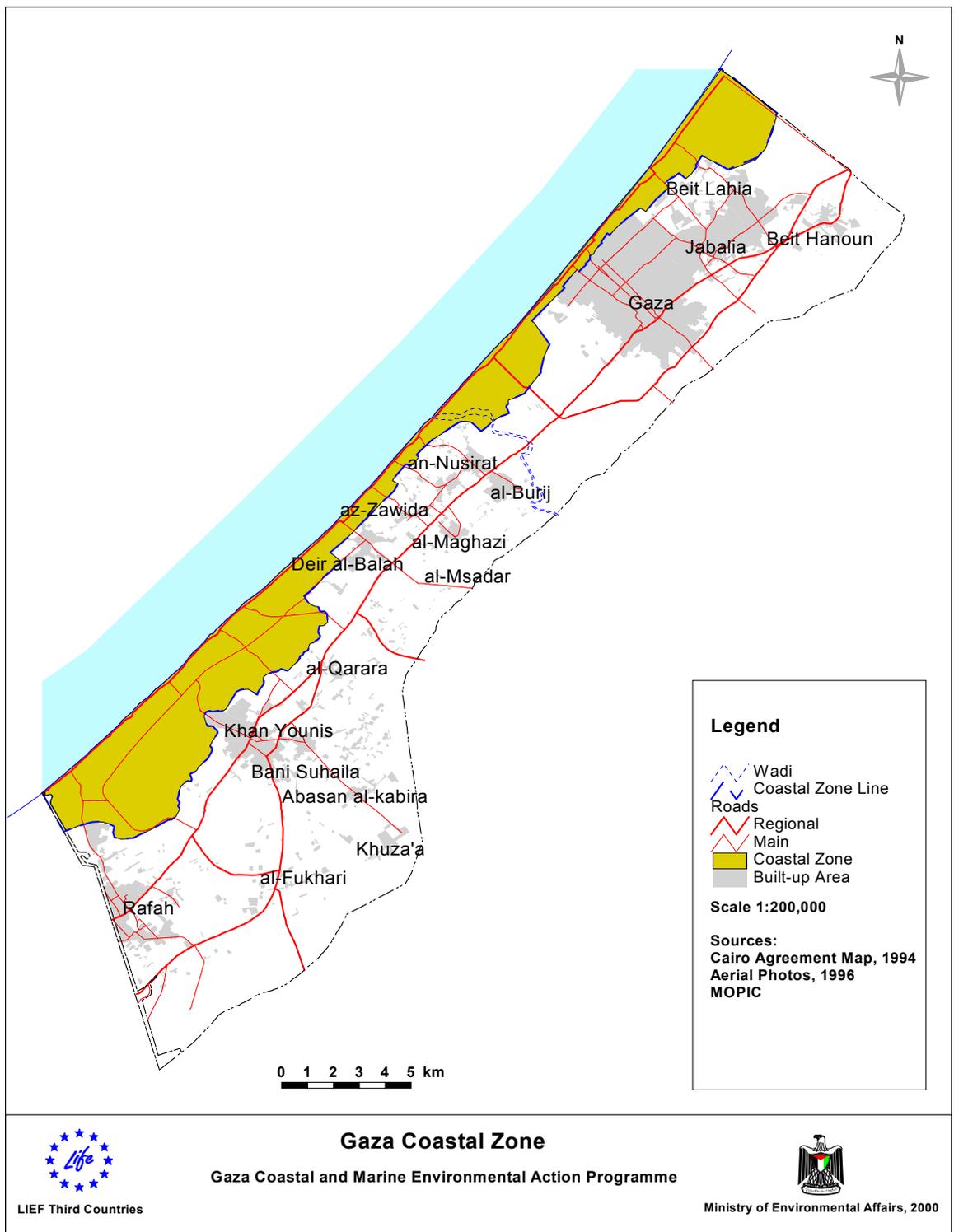


Figure 1. 2. The coastal zone of Gaza strip Palestine.

3. Bathymetry

The bathymetry (geometry of the seabed) off Gaza is given in (Figure 1.3). One finds the 100m depth line off Gaza 28 km away in the south and 14 km in the north. So the average

seabed slope between the coast and the 100m depth line is about 1 in 200. Beyond the 100m depth line, the sea bottom drops quickly to a depth of 1500 m (outside Gaza waters). A detailed bathymetric survey was carried out along an area of 2 by 4 km, at the new port.

The survey revealed that between the shoreline and 10 m depth the seabed is characterised by areas of rock outcrops and linear features of sand bars (Sogreah, 1996).

Recent figures presents a single near-shore coastal profile surveyed in 1986 at a location about 1 km South of the present Fishing Port, where the depth contour lines are relatively straight and parallel to the coastline (Port Consult, 1987). The 20m in depth contour is found some 1600 m seaward of the shoreline, so the average sea bed slope is 1 in 80 (Delft Hydraulics, 1994). The bathymetry of the sea of Gaza strip is presented in Table 1.1.

Table 1.1. Represents the bathymetry of the sea of Gaza strip (Various sources).

Depth (m) below MSL	Distance from shore (m)
0	0
2	100
4	200
6	350
8	500
10	670
12	870
14	1070
16	1260
18	1460
20	1660

Striem (1974) and Goldsmith et al (1982) have described a more complicated coastal profile form, with one or two offshore submerging sandbars. Such sand bar feature is also found along the coast of Gaza, at a depth of MSL (-4 to -5) m. This was revealed during preparations for the UNRWA-initiated coastal protection plan for Beach Camp (Haskoning and Team Palestine, 1998). These bars can also be seen on most aerial photographs. The sandbars are known to play an important role in the sediment transport along the seashore and of the perpendicular.

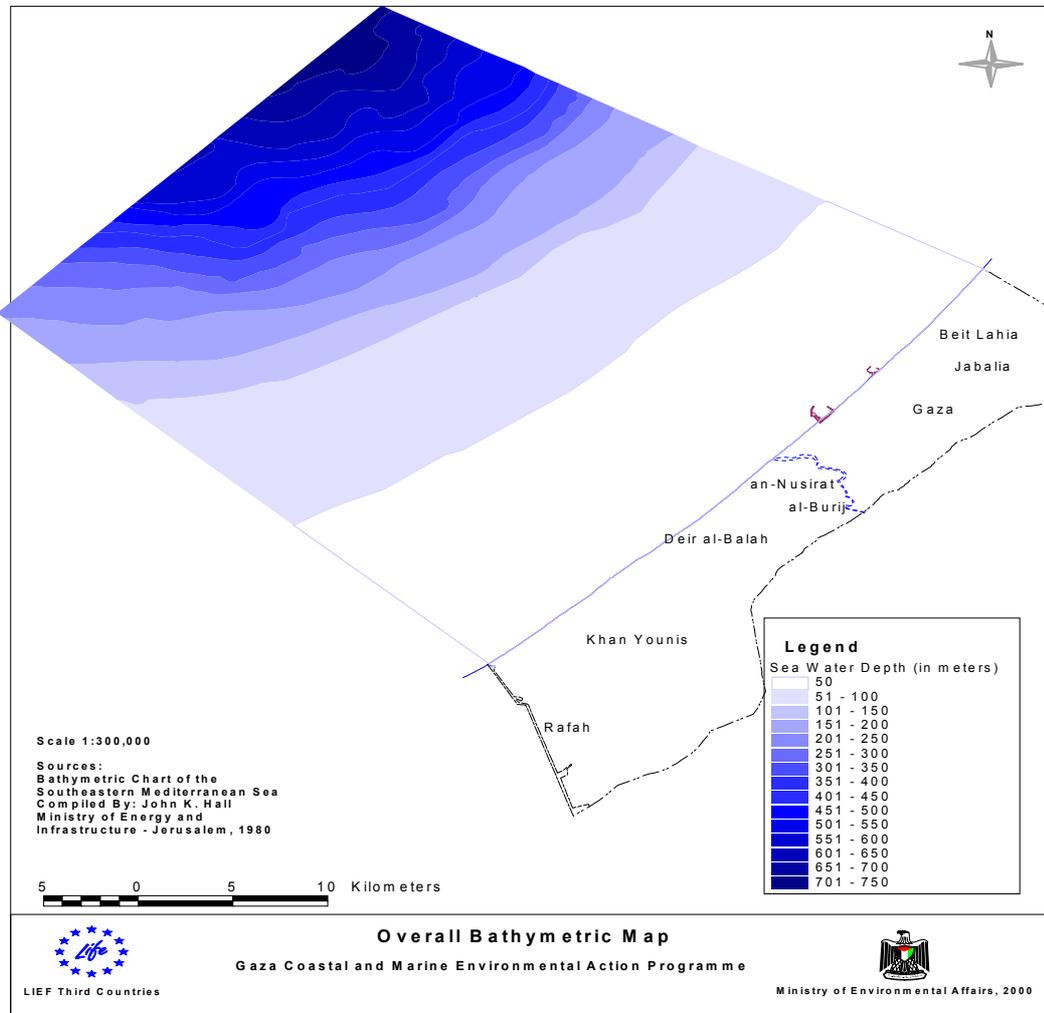


Figure 1. 3. Represents the Bathymetric map of the sea of Gaza strip

1.4. Sea Level Fluctuations

Reference for physical characteristics of the sea as the wind wave climate, the currents and the water levels are provided. The sea level fluctuations is due to the normal astronomical tide with variations due to neap tide and spring tide cycles, storm events piling up water near the coast due to combined wave action and local low barometric pressure, and seasonal effects due to shifts in regional air pressure systems. In Gaza so far no systematic records are available for the sea levels. The tidal levels MHWS was found between 0.0 and 0.4. Records for the wind, wave, climate and the currents appear to be limited or lacking.

1.5. Coastal Geology

Grabowski and Poort (1994) showed that the deposits of the Holocene and the Pleistocene in Gaza terrestrial area are approximately 160 m thick, covering the underlying Pliocene sediments. These deposits consist of marine kurkar formation, shell fragments and quartz sands cemented together. Calcareous sandstone is also found in some areas. It was found that the marine kurkar forms a good ground water aquifer where most of the groundwater of Gaza strip is extracted from this layer. The thickness of the marine kurkar varies between 10 m and 100 m with a tendency thicker near the coast. The formation of the continental kurkar is varied from friable to very hard, depending on the degree of cementation. Alluvial and wind blown sand deposits are found on top of the (Pleistocene) kurkar formations reaching a thickness of 25 m. According Grabowski and Poort (1994) four types of alluvial deposits can be distinguished:

1. Sand dunes are oriented in the south near Rafah, mainly ENE to WSW. The north dunes become sporadic with scattered sand in a zone of 2 to 3 km from the coast.
2. Wadi fillings consisting of sandy loess and gravel beds, which can reach a thickness of 10 to 20 m's".
3. Alluvial and aeolian deposits of varying thickness. In the northern part from the Wadi Gaza aluvial deposits are widely distributed and are dominated by heavy, loamy clay.
4. Beach formation consisting of a fairly thin layer of sand and shell fragments.

1.6. Coast and Seabed Characteristics

The Gaza coastline has a length of 40-45 kilometers and has a straight and sandy shore. The near-coast continental shelf slopes down with a gradient of 1:100. The coastal shelf of Gaza is 28 km wide in the south of Gaza (i.e., to the 100-m depth line) and 14 km in the north. Beyond the 100-m depth line, the sea bottom drops quickly Figure (1. 4).

The sea bottom sediments mainly consists of sand up to 25 metros depth and there are some muddy places near the Wadi Gaza. Down to a depth of 100 metros, the seabed is irregular with rocky grounds. A detailed Bathymetric survey of the area, where the Gaza sea port is planned, revealed that between the shoreline and 10 m depth the seabed is characterized by areas of rock outcrops and linear features of sand bars (Sogreah, 1996).

Hydrographically, the Gaza strip marine area is part of the Southern Levantine basin. This area is characterized by its extreme oligotrophy, high salinity (to 39.5 g/l) and high temperature (29°C) compared to the western parts of the Mediterranean Sea.

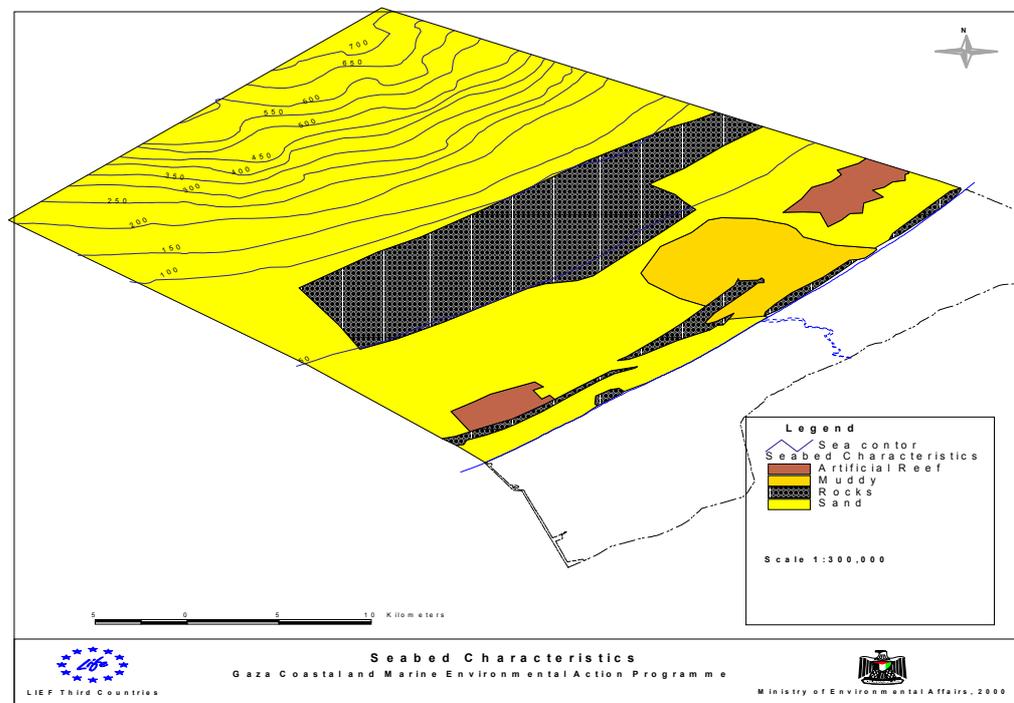


Figure (1.4) shows the characteristics of the seabed of Gaza strip.

2. Fish and fisheries

2.1. Fishing zone

The marine part of Gaza strip is the area along the coast that stretches up to 20 nautical miles off shore. Not all of this area can be used for fishing. This marine area has been divided into three distinct Maritime Activity Zones, named K, L and M, Figure 2.1. Zones K and M extend to 20 nautical miles and form respectively the northern (Israel) and southern (Egypt) border with respective widths of 1.5 nmile and 1.0 nmile. In these zones navigation is restricted. Zone L extends to 20 nautical miles off shore and is opened for fishing according to the Oslo agreement, but because the Israeli navy refuses to implement this agreement, fishing is only allowed in the first 12 nautical miles (Mahdi, 2000). This makes the total area where fishing is allowed about 660 km².

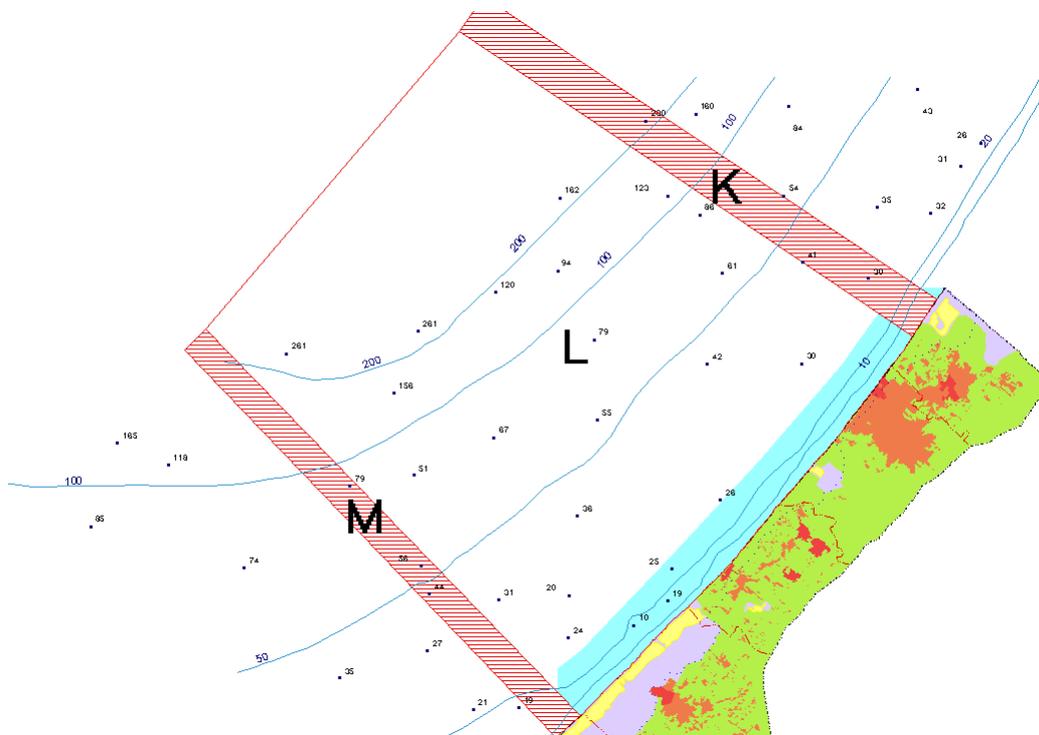


Figure 2.1. Fishing zone of Gaza strip.

2.2. Fishing fleet

The latest count of the fishing fleet (2000) showed that there are 725 vessels involved for a total of 2305 fishermen. The number of fishing-vessels, types, landing sites and the number of the fishermen are presented in Table (2.1). Both the number of vessels and the number of fishermen are illustrated in Figure 2.2.

Fishing vessels and fishermen of the Gaza Strip, Palestine

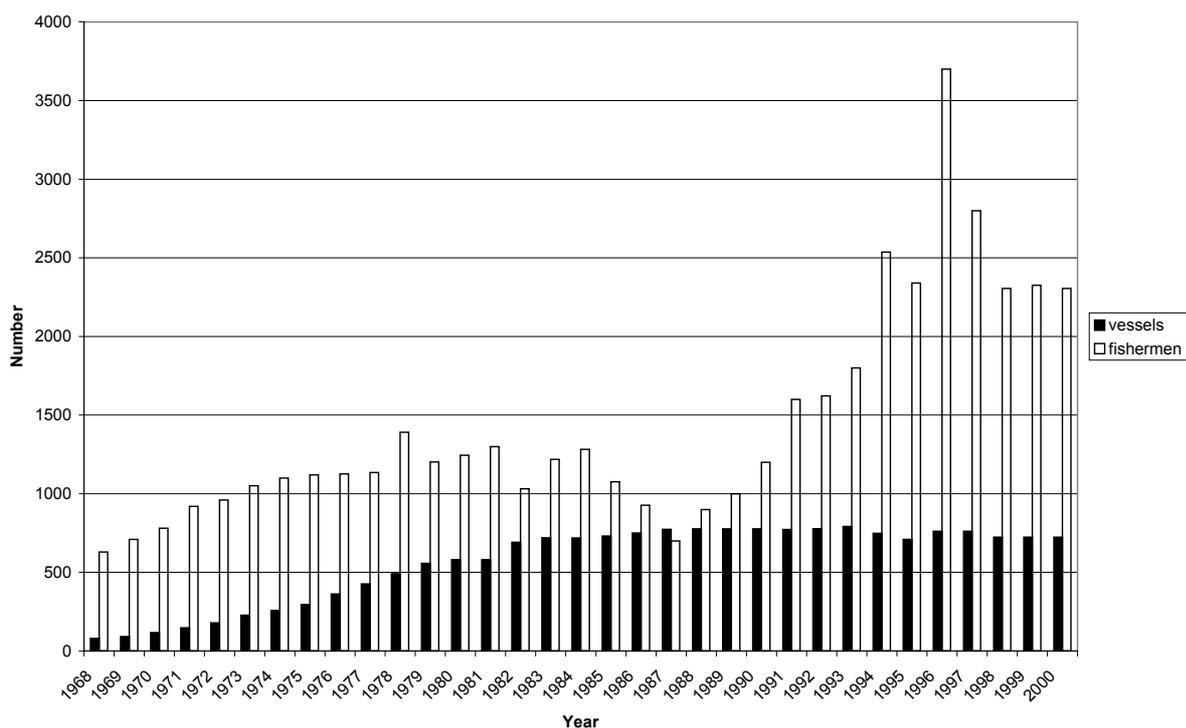


Figure 2.2. Number of fishing vessels and fishermen from 1968-2000.

Table 2.1. Shows the number of fishing vessels and the crew of different types.

Type of vessels	Gaza	Deir el-Balah	Khan Younis	Rafah	Total NO.	Value/vessel (US \$)	Total value (US\$)
Flouka	92	3	37	26	158	2,000	316,000
Unmotorised hasaka	86	8	3	-	97	3,000	291,000
Motorised hasaka	198	46	44	33	321	6,000	1,926,000
Shanshula hasaka	39	19	4	11	73	6,000	438,000
Long-line launch	4	-	-	-	4	40,000	160,000
Shanshula launch	36	-	11	8	55	40,000	2,200,000
Trawler	15	-	-	-	15	100,000	1,500,000
TOTAL	470	76	99	78	723	varied	6,831,000
Number of fishermen *	1170	327	532	276	2305		

* Mahdi(2000)

An Unmotorised hasaka is a small vessel with a closed deck that is handled by oars on the deck. Its length is about 3 meters long. The motorised hasaka is relatively small vessel, with a length of 5.5 to 8 m. A flouka is also a small vessel with an open deck and has a length of 5 - 8 m. The launch vessels are bigger, ranging from 8 to maximum 14 m length. Trawlers are large vessels, between 16-27 m of length.

2.3.Fishing gears

The fishing gears used in Palestine can be divided into three major groups: 1) nets, 2) hooks and lines, 3) other devises. The specifications and the costs of different types of each group of the fishing gears are summarised and presented in Table 2.2. Other devises have been banned are presented in Table 2.3.

Table 2.2. Represents different types of the fishing gears of Palestine- Gaza strip. Costs of the gears are included on the basis of the current prices. Local names are in parentheses.

Fishing gear English Name	History of use	Type of catch	Total No.	Total length (1000m)	Cost USAS\$(1000)	Total costs (USAS\$1000)
1-Fish Trawl (Gar)	After 1971	Benthos & epigenetic	15	Slandered	1,5	22,5
2-Shrimp Trawl (Gar)	After 1971	Shrimps	15	Standard	1,5	22,5
3-Purse seine net (Shanshola) Short seine Long seine Devil seine .Totals	After 1964	Pelagic & Epipelagic	56 120 62 238	14-19,8 42-48 27,9-42 56-67,8	4,5-5(4,75) 5-6(5,5) 5-6(5<5) 15,75	252-280 600-720 310-372 852-1,000
4-Beach seine net (Garafah)	Before 1948	Benthic & Pelagic	7	0.84-1.4	0.25-0.35	1,75-2,45
5-Gillnets A-Zeda 1-Drift zeda 2-Fixed zeda B-Guiter gillnet C-Floating drift net (Maltash)	After 67 Before48 Before48	Benthic, Pelagic& Epipelagic Guiter fish Sardines & flying fish	75 ? ? ?	45-63 ? 70-80	1,5-1,8 2	157,5-189 400
6-Entangling nets 1-ShrimpTrammel net 2-Fish trammel net	After 67 Before48	Shrimp Benthic&Epibenthic	40-50 600- 1000	9-15 27-45	0.15 0.15	6-7,5 90-150
7- Hand cast net (Shabaka)	Before48	Mullet	200- 250	Standard 2-3 radial	0.03	6-7,5
8-Hooks and Lines (Sharak) A-bottom lines B-Entias lines C-Hand lines D-Pole-lines	Before 1948 ? ? ? ?	Benthic &Epibenthic	138- 172 Hooks	690- 860	1.2 dollar/ Hook	165-207,36
Total Cost						1,723, 1850- 2,008,810

*Local names are in parenthesis

Table 2.3. Shows the banned traditional fishing-gear of Palestine

The Nets

1. Bottom trawlers. Two types of bottom trawlers are used. A) Fish trawler used to catch demersal and benthic fish. B) Shrimp trawler is used, mainly at night, to catch shrimps. Both trawlers, Semi-pelagic and midwater are out of use by the fishermen of Gaza strip. Trawlers fish continuously (24 hours) and return once in the morning, to land the catch, get supplies and change crews.
2. Purse seines. Purse seines are divided into two types. A) Beach purse seine, which is known as *Jarafah*, pulled by fishermen on the beach. B) Offshore purse seine, which is known as *Shanshula*. This is a type of one-boat purse seine net used on different depths to catch pelagic and pi-pelagic fish, such as flying fish and sardines. In this fishing method lights are used to attract fishes.
3. Drift nets. Two types of drift nets are used. a) Drift net with a large mesh size (30-50 mm), which is known as *Zida*, to catch tuna and Spanish mackerel at different depths. b) Drift net with a small mesh size (10-20 mm), known as *Maltash*, to catch sardines. This is a traditional net.
4. Gill nets. Two types of gill nets are used. A) *Quta*, to catch shallow water coastal fishes, with a length about 20 to 30 metres, put in the water without a vessel. B) *Bushlela*, which is similar to the quta, but longer and used in deeper water. Both gill nets are fixed at both ends, by anchors or stones.
5. Trammel nets. A trammel net is a three-layered gillnet with an inner net that has a small mesh size (10-44 mm) and two outer nets that have a large mesh size (240 mm). Fish will swim through the outer net into the inner net and will trap themselves by forming pockets. One type of trammel net is used to catch demersal fish and benthic fish and a similar type is also used to catch shrimps. Combinations of gill nets and trammel nets are not used in the Gaza strip.

6. Handcast nets. Type with central line and without pockets, which is used by fishermen, mainly to catch mullets in shallow waters near the coast.

The hooks and lines

Hooks and lines of different sizes are known as *Sharak*, which is used to catch Groupers, demersal and other benthic species, by using baits. Floating or hanging lines are out of use by the fishermen of Gaza strip.

Other devices

In this report other devices are mentioned to show that certain methods are used not only by the fishermen but also by other people. These devices are:

1. Bottles or jars. Plastic bottles with a lateral cut are used to attract fry fish (small fish) near the beach by swimmers. This affects many species of fish usually found during the spawning season near the beach. Striped sea bream (*Lithognathus mormyrus*) is a particular species that is threatened by this method.
2. Poisons. This is the most threatening method used mainly in the past to catch fish. Insecticides are used to kill fish and subsequently catch them. This method threatens different fish populations, and has serious effects on the human health. Recently restriction laws have been issued to prevent the use of this method.
3. Spear gun. The method used by many swimmers to catch fish as a hobby. This method does not affect the fish population very much.
4. Rods. Rod fishing used on the beach as sport or hobby.

2.4. Fish landing statistics

Traditionally the Palestinian fisheries may play a major role in the activities of the national economy. Most of the high value fishes are the demersal species of which are the main exports to foreign markets, whilst the pelagic landings are consumed locally providing an important source of protein in the diet of the inhabitants.

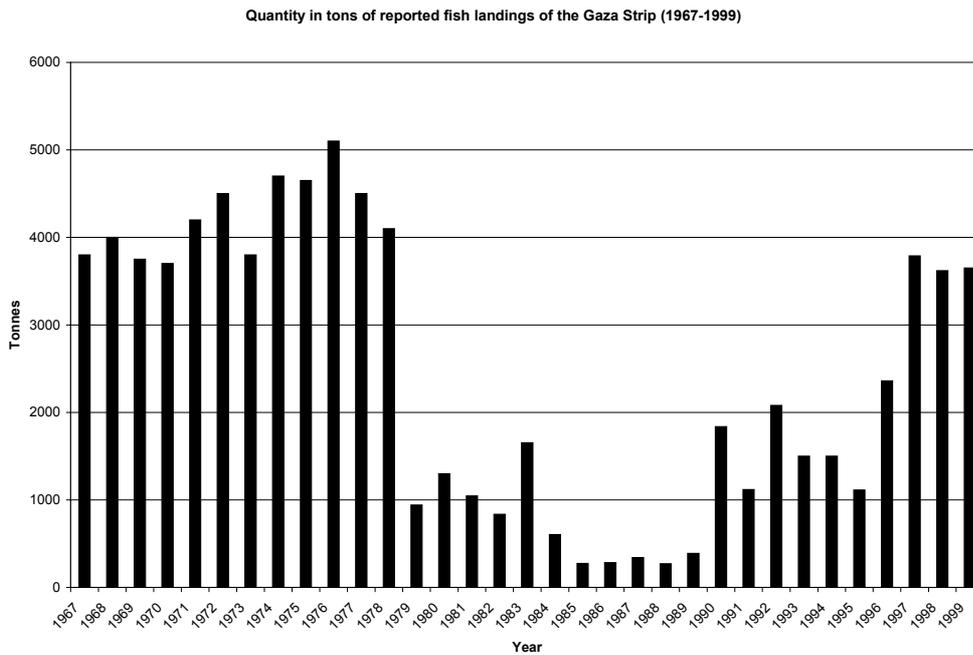


Figure 2.4. Reported fish landings during the period 1967-1999 (Mahdi, 2000; Abu Sada, 1997)

Obviously the fish landings show fluctuations during this period, as a consequence of the political situation. Analyses of the results in Figure (2.4.) shows that six stages can be distinguished and interpreted as following:

- 1) The average production in the first stage, before 1978 (Camp David Treaty), is estimated at 4000 ton/year. In that period the fishing area involved both the Gaza strip and Sinai coasts (total fishing area 75.000 km²).
- 2) After 1978 the catch dropped to approximately 1200 ton/year; this stage was marked by the withdrawal of Israelis from Sinai Peninsula, so the Gaza fishermen were not allowed to fish off the coast of the Sinai anymore.
- 3) In the third stage (1985-1989) the total catch declined to only 400 ton/year, this may be due to the establishment of settlements across Gaza strip and to the uprising situation (*intifada*).
- 4) In the fourth stage (1990-1992) the total production reached 2000 ton/year. This may be due to the growing of the fish population during the previous period.
- 5) In 1994, after the Oslo agreement, the total production declined due to limitation of the fishing area from 20 nautical miles to 12 nautical miles (fishing area 660 km²) and maybe to the Israeli military restrictions.
- 6) Rising stage (1996-1999), the stage marked by 1) better reporting, since the Fisheries Department is responsible, 2) extensive use of seine nets 'shanshula' 3) the use of new equipment (sonar) and 4) the improvement of fishery techniques, supervised by international programs under co-operation of the Ministry of Agriculture.

The species composition of the catches and the percentage of their landings are shown in Figure 2.5. Sardines constitute half of the commercial catch. The cuttlefish and the shrimps are included.

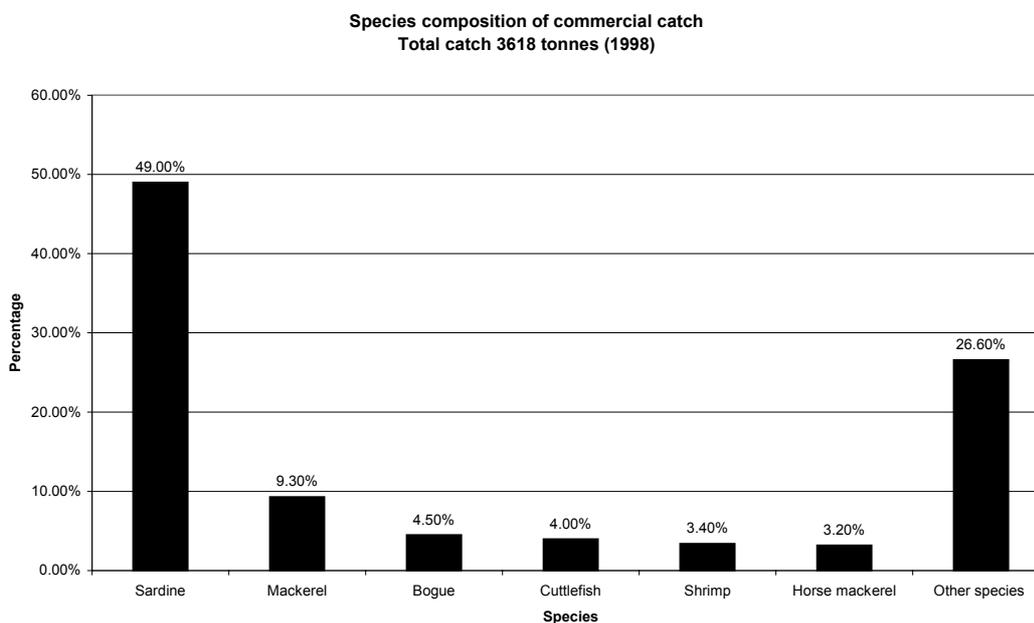


Figure 2.5 Species composition of commercial catches in 1998 (Saqr, 1999).

2.6. Fish species of Gaza strip

From the sea of Gaza strip 201 (163 bony and 38 Cartilaginous) fishes (such as sharks and rays). species were caught and identified, on the bases of different resources. Each fish species is listed with its scientific name, common English name and its local names then categorised according size, depth, abundance, habitats and the migratory status. The result is summarised in Table 2.4.

Table 2.4. Shows the numbers of fish species of different categories (2000).

Categories		Bony fishes	Cartilaginous fishes	Total fishes
Abundance	Common	91	25	116
	Rare	59	9	68
	Very rare	13	4	17
Habitat	Pelagic	53	2	55
	Epipelagic	15	12	27
	Benthic muddy	64	27	91
	Benthic sandy	71	27	98

	Benthic rocky	95	7	102
	Benthic vegetation	19	0	19
Status	Migratory	12	2	14
	Immigrant	24	1	25
	Threatened	56	0	56
	New observation	4	0	4
Total Number of species caught		163	38	201

Abundance and status

In Gaza strip waters 201 fish species have been recorded so far (Table 2.4). The majority of the species are bony fishes (81%). Of the bony fishes 56% is common, 36% is rare and 8.0% is very rare. Of the observed bony fishes 7.4% are migratory species that are not present in Gaza strip waters year-round. About 15% of the Bony fishes are immigrants from the Red Sea, Figure 2.6, among them four new species have been recorded in Gaza strip waters. The record of one specimen of ‘Painted sweet lips’ (*Diagramma pictum*) may be the evidence of a new immigrant for the Mediterranean Sea. About a third of the bony fishes is considered threatened, due to various environmental problems.

The sharks, rays and other cartilaginous fish form 19% of the observed fish fauna. Of these fishes 66% is common, 24% is rare and 10% is very rare. Of the cartilaginous fish 5.3% are migratory, 2.6% have immigrated, Figure 2.6 and 5.3% is considered threatened.

Of the total ichthyofauna of the Gaza strip, 58% is common, 34% is rare and 8.5% is very rare. About 7% are migratory, 13% have immigrated and 26% are considered threatened.

The number of species recorded for Gaza strip is still limited, not reaching the same numbers of the species reported previously by other authors as in the list of Golani (1996). Figure 2.6 presents a general overview on the status of the Bony and Cartilaginous fishes of Gaza strip.

Present status on migratory, immigrant, threatened, new records and commercial species of the fishes of Gaza Strip, Palestine, 2000.

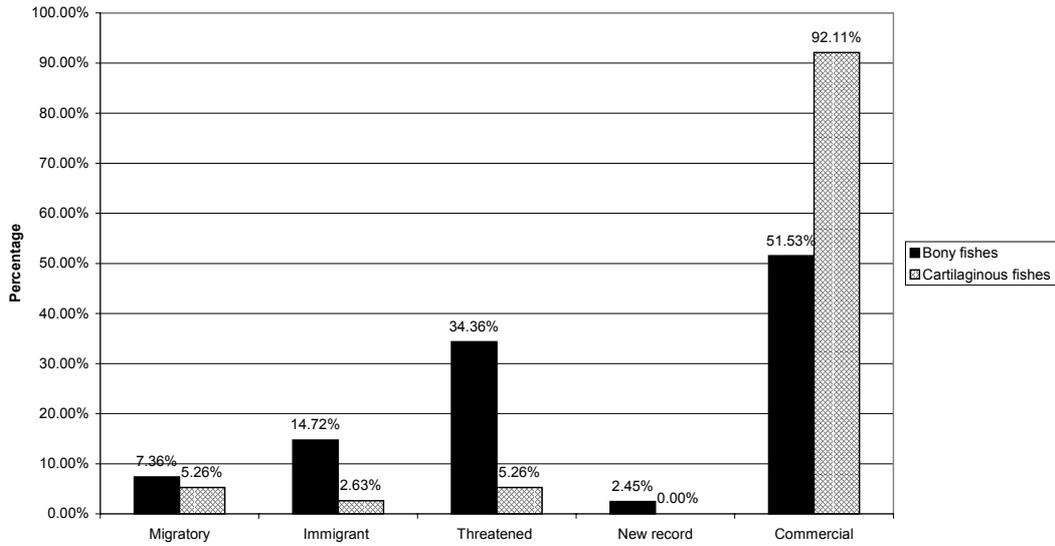


Figure 2.6. Present status of the Bony and Cartilaginous fishes of Gaza strip.

Habitats

The fish of Gaza strip distribute in different types of habitats, Figure 2.7. The use of multiple habitat types is common for many species of fish, for example the golden grey mullet (*Liza aurata*) occurs in many habitats, pelagic, sandy and rocky. This species is listed as pelagic and benthic at the same time, because it is dependent on types of food in the bottom.

The most important habitat for the Bony fish of Gaza strip is the rocky substrate, Figure 2.7. The majority of the cartilaginous fish uses the soft bottom (muddy and sandy) sediment of the seabed of Gaza strip where the sand and mud are dominant, Figure 2.1. Very vulnerable species are those found occupying vegetation habitat (11% of bony fishes), usually on rocks. Because the rocks in the shallow coastal zone are removed for construction, those species become under severe pressure.

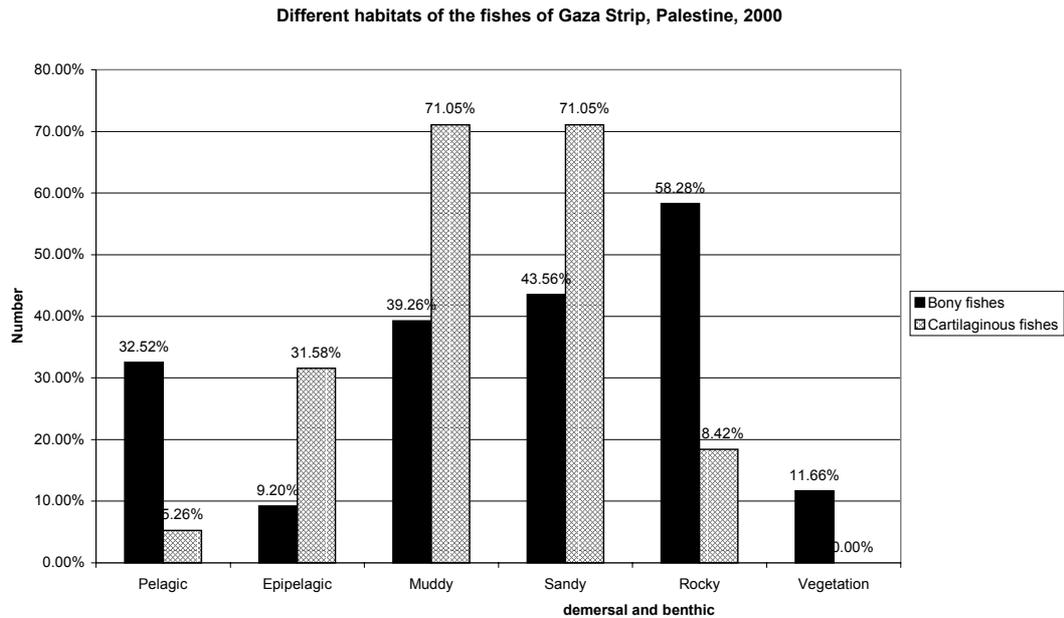


Figure 2.7. Fishes distribution according different habitats.

Depth distribution

The fishes of Gaza strip are distributed according the depth of habitats as shown in Figure 2.8. The figure shows that between 20 and 200 meters most of the fish are found, in particular the highest rate of abundance is between 100 and 200 metros, where the abundance of fish in deep water (>200 metros) becomes declining. The marine area of Gaza strip between 20 and 200 metros is the zone of most of the fishing activities, where the fish become under severe pressure.

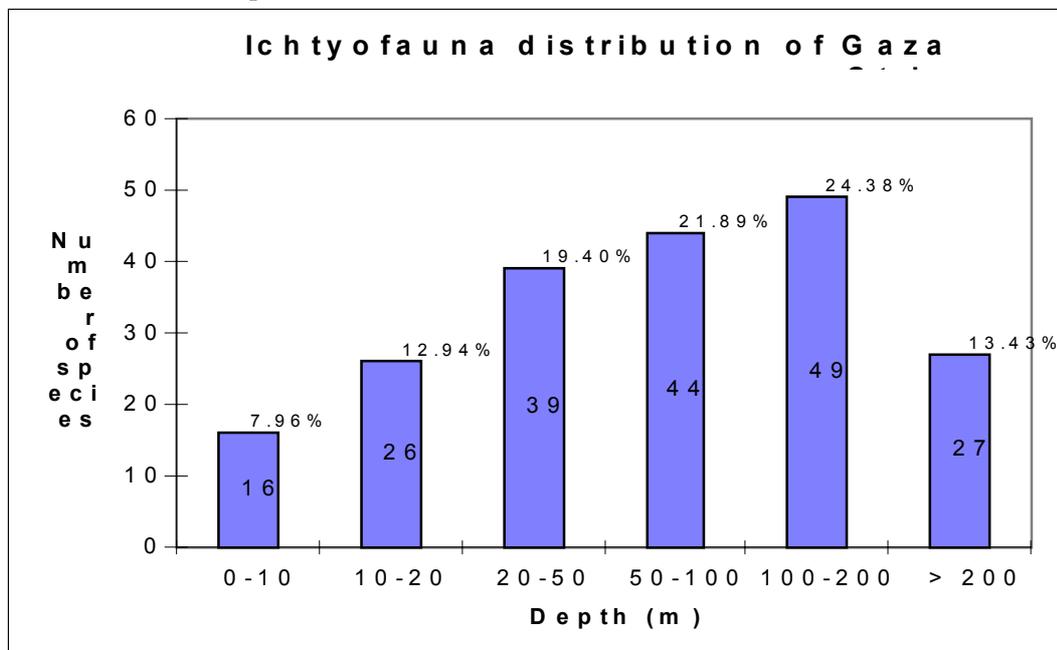


Figure 2.8. Fish distribution according different depths.

3. Marine flora and fauna

Specific Gaza literature on marine flora and fauna is very scarce. More references can be found from Israeli authors (Ben-Eliahu & Poor, 1994; Hebrew University, 1971 and references therein; Golani, 1996).

Immigrant species

The building of the Suez Canal in 1869 has led to the influx of an estimated 300 marine fauna species of Indo-Pacific origin; this is named Lessepsian migration. Some examples of Lessepsian species that nowadays occur in very large quantities include the jellyfish *Rhopilema nomadica*, prawn species *Penaeus japonicus* and *P. monoceris* and the swimming crab *Charybdis longicollis* (Gaza Environmental Profile, 1994). Numerous fish species of the Eastern Mediterranean, including Gaza strip, are immigrants (Golani, 1996). Another important immigrant species is the *Caulerpa taxifolia*, a tropical, toxic, green macro-algae from the Caribbean that was introduced in the Mediterranean in 1984 (Medwaves, 1997), has not been recorded in Gaza waters.

Marine and coastal flora

Each floral species that occurs in the marine area of Gaza strip is listed with its scientific name. The database includes the classes of the Green algae, Brown algae and Red algae as well as the Lichens. Each species is categorized according to its size, depth range, and status of abundance, habitat and the status for 'threatened'. Gaza Environmental Profile (1994) gave an overview of the vegetation types of the coastal zone.

Sea grass species are not present in the sea of Gaza strip, because the seabed of this area is not sheltered, despite the nature of the seabed is suitable for their growth. The status of marine algae and lichens are shown in Figure 3.1.

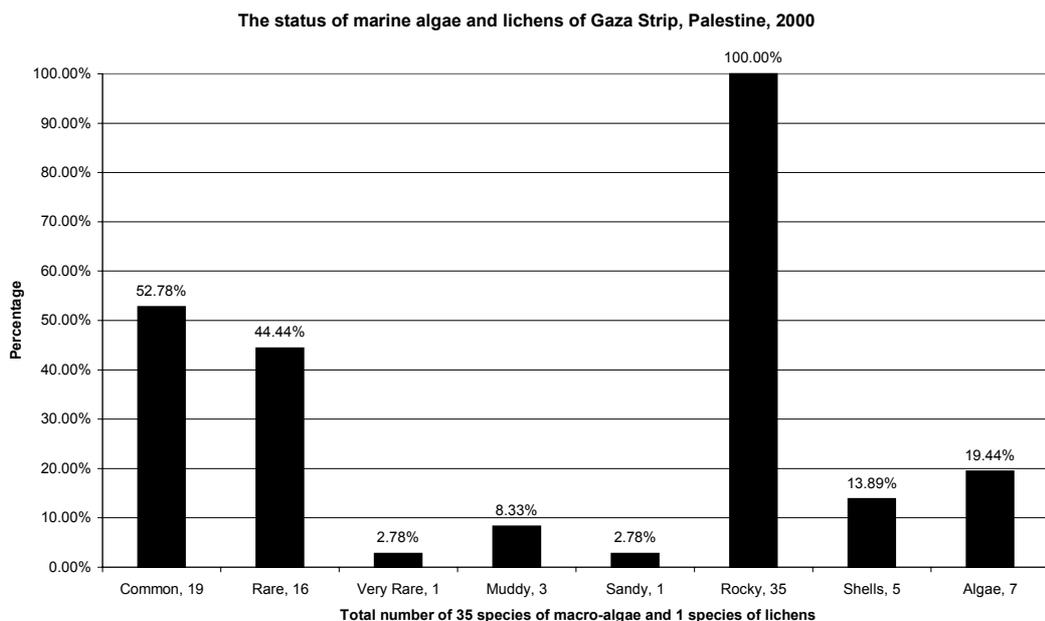


Figure 3.1. The status of marine algae and lichens of Gaza strip, Palestine, 2000.

The marine macro-algae of Gaza are all dependent on the rocky substrate in the shallow coastal waters. This makes them very vulnerable to habitat destruction and marine pollution.

Macrobenthos

Many species of macrobenthos have been identified in the coastal zone of Gaza strip up to a depth of 80 metros. Higher taxa include Mollusca (66 species); Crustacea (61); and Polychaeta (50). Of the 245 identified species, 26 are of Indo-Pacific origin (Gaza Environmental Profile, 1994).

A quick visual inspection of the shells that were washed ashore on the Gaza beach in front of Gaza City and the man-made breakwaters revealed the following species: *Murex trunculus*, *Murex brandaris*, *Glycimeris glycimeris* (in very large quantities), *Cerastoderma paucicostatum*, *Cerastoderma edule*, *Donax trunculus*, *Mytilus galloprovincialis*, *Natica sp.* and *Patella coerulea*.

Marine mammals, reptiles and birds

The Gaza Environmental Profile (Gaza Environmental Profile, 1994) identifies the sea turtle species *Caretta caretta* (Loggerhead turtle) and *Chelonia mydas* (Green turtle) as existing in the coastal region of Gaza. Turtle nesting beaches of Gaza strip are reported by The Coastal Zone Plan for Gaza (MOPIC, 1996). Unfortunately these species and their eggs are under extreme pressure from hunting and collecting. It is not known at present whether the turtles still breed along the beaches of Gaza strip despite regular sightings at sea are reported by fishermen (Department of Fisheries, 2000). Sea turtles are protected species and hunting is prohibited by law (Groombridge, 1990).

Little is documented on the status of marine mammals in the Gaza area, the status of the Monk seals; *Monachus monachus* remains unclear (Gaza Environmental Profile, 1994). Dolphins are regularly reported but are far less common than in the Western Mediterranean. Two species of dolphins have been observed by fishermen of Gaza strip, these are Bottlenose dolphin (*Tursiops truncatus*) and Common dolphin (*Delphinus delphis*).

The Gaza strip is an important stopover on the flyway of many birds. Gaza Environmental Profile (1994) provides an overview of the birds of Gaza strip.

4. Sea water quality

Monitoring the seawater quality of Gaza strip is limited, information on the structure of the seawaters such as hydrocarbons, nitrates, heavy metals and other pollutants appears to be lacking. The seawaters of Gaza strip is highly polluted from the sewage flow into the sea and from the flooding of Gaza valley presenting chemical wastes from the other side of the border. Figure (4.1) shows the outfalls along the coastline of Gaza strip.

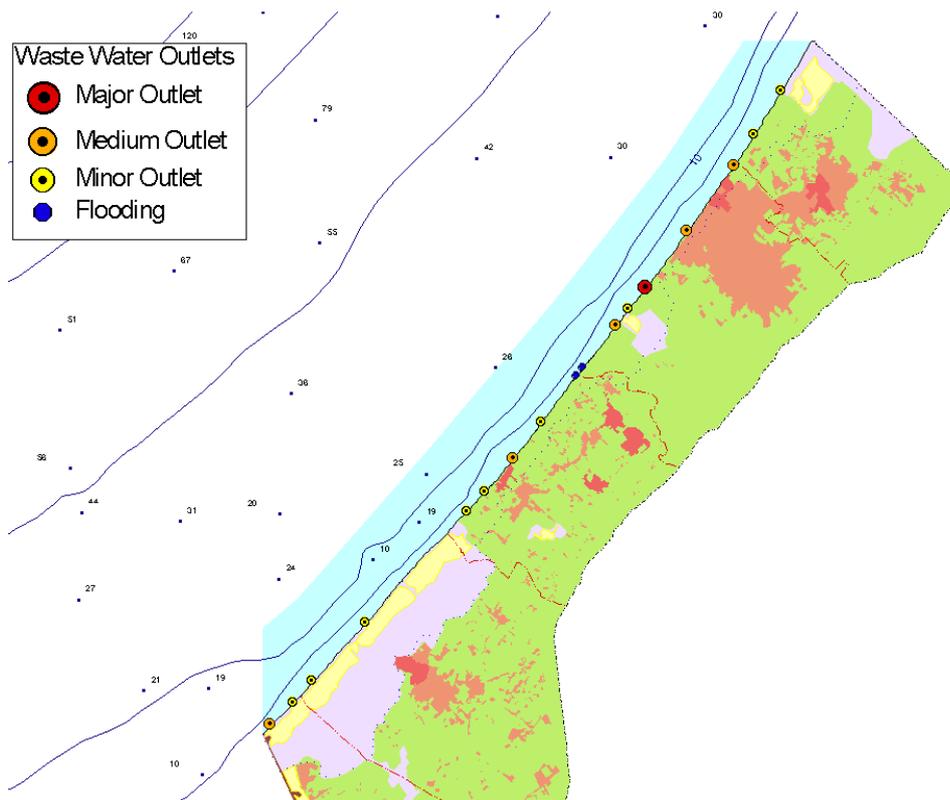


Figure 4.1. Locations of the wastewater outfalls of Gaza strip.

5. Organizations for coastal and marine ecological protection

Different organizations related with the coastal and marine ecology are presented in Table (5.1). However all of these organizations mainly the Ministry of Agriculture, the Ministry of Environmental Affairs and Gaza Municipality may play the major role.

Table (5.1.) represents different organisations related with marine environment.

Organization	Notes	Area of Activities
Ministry of Environmental Affairs	Chairman of the Committee	Environmental issues
Ministry of Agriculture	Member of the Marine Ecosystem and Pollution Taskforce	a) Aquaculture division provides for technical assistance and hatchery. b) Marine fisheries section issue licenses and develops fishing technology. c) Landing site administration includes the collection of fish landings statistics d) Hatchery and fishing activities not yet implemented.
Ministry of Local Governments		Co-ordinates the local municipalities.

Ministry of Industry	Member of the Marine Ecosystem and Pollution Taskforce	Industrial developments, pollution control
Ministry of Transport	Member of the Marine Ecosystem and Pollution Taskforce	Environmental aspects of traffic and infrastructure
Ministry of Public Works	Member of the Marine Ecosystem and Pollution Taskforce	Gaza Corniche road
Ministry of Education	Community participation in Coastal and Marine protection	Education for schools
Ministry of Higher Education	Community participation in Coastal and Marine protection	Education for universities
Ministry of Health		Medical service, public health aspects, control of medical waste
Ministry of Tourism and Antiquities	Member of Sand Exploitation and Coastal Erosion Taskforce	Protection of valuable cultural and archaeological sites
Ministry of Planning and International Co-operation		Gaza seaport management during construction, land-use planning and regional development plans
Palestinian Water Authority	Member of the Marine Ecosystem and Pollution Taskforce	Sewage treatment, drinking water supply
Sea Port Authority		Co-ordination of construction of Sea Port
Naval Police	Member of the Marine Ecosystem and Pollution Taskforce	The role of the naval police in fisheries sector is: a) Controlling the security within the fishing port. b) Checking access to the fishing ports. c) Security approval for the fishermen's licenses
Civil Defense	Member of the Marine Ecosystem and Pollution Taskforce	Emergency response
Gaza Municipality	Member of the Marine Ecosystem and Pollution Taskforce	
Local municipalities		Local governments
El Tawfiq Fishermen Cooperative Society	Tawfiq Co-operative is the only co-operative in the sector. In mid eighties it received a grant from UNDP in the form of infrastructure and fishing gear. This includes the fish market complex, the coop building, stores and ice plant.	a) Services include fuel, ice, fishing gear, and a health/accident insurance scheme. b) The coop is the main unified voice of the fishermen and takes a leading role in the representation of fishermen when dealing with either Palestinian Authority or foreign missions.

Gaza Fishermen's Association	Was established on March 11 1996. The structure consists of an elected chairman who presides over an administrative committee. The administrative committee is chosen from the association committees in each of the four primary local units. The general assembly is the meeting of all members elected to sit on local committees. Member of the Marine Ecosystem and Pollution Taskforce	a) Defends and establishes professional rights of fishermen in relation to national authority as well as developing a legal structure to support fishermen and their families (health insurance, schemes and social benefits). b) The association also promotes practical training and initiatives such as the establishment of housing co-operative.
Internationally Funded Fisheries Project: CARE	CARE in Gaza is supported by funding from IDRC, CIDA and IFAD	CARE has a fisheries conservation project which commenced in October 95.
Internationally Funded Fisheries Project: DANIDA	DANIDA, bilateral Danish project. Commenced project in Gaza during summer 1996.	DANIDA objective: institutional support and infrastructure support, Training and research leading to stock assessment.
Internationally Funded Fisheries Project: (MI)	Marine Institute (MI)- Canadian College and Canadian partners. (Training Project)	MI objectives: periodic workshops for the training of trainees and development of sub-sections such as fish processing.
MA'AN Development Center	MA'AN Development Center was established in 1990 by a group of Palestinian contributors as a non-profit organization. A central activity of the Center is the design and delivery of training programs in various fields, for individuals, institutions and grass roots organizations. It works as a research institution, conducting both applied and basic research in all aspects of national development.	MA'AN participates as a partner with CARE in all aspects of research in fisheries Sector and helps promote new initiatives such as fish data collection and biological analysis and co-management issues such as development of an artificial reef project.
Coastal Aquifer Management Project (CAMP)	US Aid project	Management of the groundwater in the coastal region.
Palestinian Green Party		Environmental protection and conservation
Green peace Association	This Association is not associated with Green peace International.	Environmental protection and conservation

7. Current projects

Current projects that are undertaken in the field of marine and coastal environment are:

1. Comprehensive project for establishing emergency centre for marine disasters.
Suggested by Naval Police.
2. Sewage treatment project for Gaza City, UNDP+USA.
3. Beach camp shore protection. UNRWA
4. Rehabilitation of threatened plants in sand dunes, UNDP.
5. Extended project for research and training on the research vessel. Fisheries Department & Danish Project.
6. Training project for fishermen to stop threats of coastal fishes by beach seine net. GEF & Fishermen Co-operative.
7. Wadi Gaza protection project. GEF.

7. Pressure and Impacts

The pressures and the associated impacts of the marine ecosystem are summarized and presented in Table (7.1.).

Table (7.1.) represents the summary of the pressures and the associated impacts of marine environment of Palestine.

Pressure	Impact
1. Increasing fishing efforts	<ul style="list-style-type: none"> • Deterioration of fish population • Non-sustainable fish population growth • Destruction of fish habitats, i.e. habitats for spawning, nursery, feeding.
2. Waste water discharge	<ul style="list-style-type: none"> • Untreated sewage affects marine life, including phytoplankton, zooplankton, crustaceans, macro-algae and (juvenile) fish. • Oxygen deficiency of water • Eutrophication (the increase of the nutrient concentration) may cause: <ul style="list-style-type: none"> • Algae blooms that may be harmful • Excessive bacterial growth. • Shift in species composition, which encourages the abundance of benthic species rather than pelagic species. • Poisoning of species by toxic substances • Increase in turbidity may affect marine organisms.
3. Removal of rocks for construction	<ul style="list-style-type: none"> • Destruction of fish habitat, shelter, and marine flora • Increases erosion rate
4. Solid waste dumping	<ul style="list-style-type: none"> • Affects respiration of fish • Many solid wastes are toxic • Decrease of habitat availability and quality • Obstruction of fishing activities
5. Unlicensed fishing	<ul style="list-style-type: none"> • Catch of fish including small fish, without control (in spawning season).
6. Agriculture (run-off and discharge of	<ul style="list-style-type: none"> • Toxic effects of pesticides and

pesticides and fertilizers)	eutrophication by fertilizers
7. Pesticide fishing	<ul style="list-style-type: none"> • Affects fish population, affects food chain, may cause serious diseases to humans.
8. Oil spills	<ul style="list-style-type: none"> • Toxic
Coastal structures	<ul style="list-style-type: none"> • Habitat destruction • Changed sedimentation or erosion rates
Wadi Gaza flooding	<ul style="list-style-type: none"> • Pollution of marine water and destruction of marine habitat
Sand mining	<ul style="list-style-type: none"> • Habitat destruction

Overfishing

There are concerns about overfishing of pelagic fish and of demersal fish. In the Gaza marine zone there is a high density of fishermen (723 boats on 660 km²) and there is also evidence of catches of undersized or juvenile fish. In addition, there is the problem of ‘by-catch’, but exact numbers are not known. The large trawlers catch Demersal and benthic fish, and these are the biggest threat to the fishes of Gaza strip.

Especially in the shallow coastal zone, fish species are under severe threat as a result of using extensively the beach purse seine fishing to catch small, juvenile fish. Another method used in shallow waters is the plastic bottles to attract fry fish (small fish). This also affects many species of fish usually found during the spawning season near the beach. Striped sea bream (*Lithognathus mormyrus*) is a particular species that is threatened by this method. Studies, conducted by MI International fishermen in three fishing communities, raised concerns that too much harvesting effort was put on the fish populations with regard to a sustainable fishery. Therefore the PNA continues to put pressure on the Israeli side to increase the fishing zone, which would decrease the fishing pressure in the current zone.

Habitat destruction

The trawlers that are used to fish on demersal fish species are damaging the seabed, affecting the habitats in the marine area. This can in turn affect the populations of benthic fauna, that serve as a food source to demersal fish. Similarly, anchoring of vessels and nets may damage habitats for fish.

Fishing port

The Gaza fishing port that is planned south of Gaza City may have important impacts on the coastal erosion and beach stability. On the other hand the port may well serve as a refuge for (young) fish, which may an opportunity. The port provides more quit conditions (less waves and currents), rocky substrate and shelter as an environment for fish. If the fishing port is kept clean of wastes and oil spills, and fishing is not allowed in or near the fishing port, it may serve as a kind of fish protection zone of the Gaza strip.

In addition, old cars, which have been dumped in the sea by fishermen (near Rafah and Gaza City), also serve as artificial reefs, and apparently help to increase the fish population size. Other Biodiversity as benthic fauna is also protected and allowed to grow.

Waste water discharge

The discharge of untreated wastewater into the shallow waters of Gaza strip is a serious problem for the status of the marine ecological system. The input of raw sewage water into the sea can cause a number of detrimental effects Table (7.1.). About 80% of the wastewater generated in Gaza strip is currently discharged without treatment into the sea (50,000 m³ per day). The untreated sewage discharge affects the complete marine foodchain ranging from phytoplankton, via zooplankton, crustaceans, macrobenthos, and macro-algae to fish and

mammals. An important effect is the decrease of the dissolved oxygen content of the water, due to the breakdown of organic material in the sewage water. Another effect is *eutrophication*, the increase of nutrient concentration. Originally the waters of the Southern Levantine are oligotrophic (low in nutrient levels). An increase in nutrient concentrations can therefore change the ecosystem. High nutrient level, high temperatures and sunlight enhance the growth of phytoplankton species to bloom and increasing the seawater toxicity. Excessive bacterial growth may also occur. The increased nutrient and organic matter concentrations may favor certain species at the expense of others. Macrobenthic species for example that feed on dead organic materials will have more food and their growth may be promoted. As a result the species composition may shift from a pelagic dominated system to a benthic dominated system. The high fishing effort for pelagic fish may stimulate this. Evidence for these shifts have not been found yet, but similar effects have been recorded in for example the North Sea.

The quality of fish caught near the shore is not examined to identify the effects of sewage on fish health. There is also evidence of weakened or poorly looking fish near the sewage outlets at the beaches. More important is that the very young stages of fish (larvae and juveniles) grow up in the nearshore zone, where the water quality is heavily affected by the raw sewage outfalls. This poses a severe threat to the fish populations of Gaza strip where many wastewater outfalls discharge untreated sewage into the sea.

Removal of rocks for construction

In the shallow coastal zone the problem of rock removal for construction is very important to fish habitat. Many of the Gaza fish species are dependent on the rocky substrate and consequently these species become under severe threat. For example all of the Gobi-species are in dangerous status now. Removal of the rocks also affects the flora habitat of shallow waters of the beach. The removal of rocks also increases the seasonal rate of erosion, which affects the fauna and flora of the beach of Gaza strip.

Solid waste dumping

The dumping of solid wastes in the marine environment may affect the marine ecosystem through a number of ways. Small particles, for example plastics, can clog the gills of fish and may therefore affect their respiration. The solid wastes may also contain some toxic substances, such as the remains of oil, paint and pesticides. Furthermore, the large quantities of solid wastes dumped into the coast of Gaza strip are a direct threat to the habitats of the coastal and marine species.

Another effect is the solid waste collection by the nets of fishermen which reduces the rate of fish catch by preventing the fish to enter their nets and consequently the fishermen spend long time to clean their nets and leave the wastes on the beach. Recycling of those solid wastes by wind or by high waves increases the rate of their spread in the sea, which makes trouble to the fish and fishing.

Unlicensed fishing

A small-scale problem is the catch of fish by hobbyists. A possible threat is that mainly young and small fish are caught, which has a negative effect on the fish population growth.

Agriculture

The amount of the agriculture land is about 43% of the coastal area. Agriculture is intense in the coastal zone. This is expressed in the production figures, as 31% of the total agricultural production of Gaza comes from the coastal zone, but the relative share of agricultural land is only 18.5% of the total (MOPIC, 1996). The sand dunes have good water resources. From an environmental point of view it is important to preserve the coastal dunes as a natural habitat.

The use of fertilizers and pesticides in agriculture poses a threat to marine ecology, because these substances can pollute the marine environment via run-off and discharges. Furthermore, intensive use may ultimately lead to groundwater pollution, which is a very

serious problem. Nitrate fertilizers used in agriculture make up 70 % of the nitrate load in the Gaza groundwater resources. Groundwater contamination with nitrate is a most severe problem in the Gaza strip. Most wells used for domestic water supply contain nitrate concentrations far above the WHO-standard for drinking water (MEnA, 1999).

A wide variety of pesticides (some 150 different types) are used in the West Bank and Gaza; WHO, including DDT, linden and parathion has banned several of these. The density of active ingredients that are locally used is exceptionally high compared with figures from other countries (MEnA, 1999).

Oil spills

The environmental impact of oil pollution on the ecosystem necessitates a sub-division in at least three types of oil impact, because different types of impact are associated with different sources of pollution. These are: chronic oil spillage, exposure to an oil spill, chemically dispersed oil

The majority of oil pollution in Gaza waters does not come from major accidents, but from sewer outfalls, ship bilges and possibly oil tanker operations near Ashkelon. Most of these types of spills are small, but they lead to a diffuse and chronic oil spillage that forms a threat to marine ecology. A second type of oil pollution is major oil spill accident. The chance of such an accident in Gaza waters is small but oil tankers are nearby, off the coast of Ashkelon or entering and leaving the Suez Canal. A generalization of the observed damages is complicated because the toxicity of the spilled oil changes in time due to weathering processes and varies with the type of oil. The small volatile, and generally most toxic, compounds will evaporate or dissolve during the first day of the spill. The oil is further dispersed and degraded by spreading on the surface, dissolution, and dispersion of small droplets in the water column, sedimentation, biodegradation and oxidation. Emulsification (formation of so-called 'chocolate-mousse' by wave action) causes an oil spill to persist for some longer time. The fate of the oil in the sea depends to some extent on the oil's molecular weight. The lower molecular-weight fraction is more easily emulsified. The heavier fractions tend to settle and degrade much more slowly, and eventually may end up as tar balls deposited on the beach.

NOAA (1999) presents Environmental Sensitivity Index (ESI) maps on oil pollution for the coastal zone of Gaza strip.

Coastal structures

The construction of ports, breakwaters and other coastal structures has a direct impact on habitats that are used by coastal and marine species. An indirect impact may occur as a result of the presence of the coastal structure, through changed sedimentation and erosion rates.

Wadi Gaza flooding

A Wadi Gaza flooding in winter, caused by intense rainfall, will bring large amounts of heavily polluted water into the marine environment. The Wadi Gaza catchment area covers about 3500 km² of the Negev desert. Its length from origin to mouth is about 105 km, and only the last 7 km are located in the Gaza strip (Goodson, 1999). The status of the water quality on the Israeli side is not known, but the Gaza part collects raw sewage from adjacent refugee camps and has a very poor water quality. Wadi Gaza does not flood every winter, but when it happens large-scale fish mortality is observed.

Sand mining

Sand mining leads to habitat destruction of both the benthic and demersal species. In the past period a large quantities of the beach have been mined.

8. Identification of coastal and marine ecological themes

From the list of threats on the marine environment, five major themes can be identified Figure (8.1.).

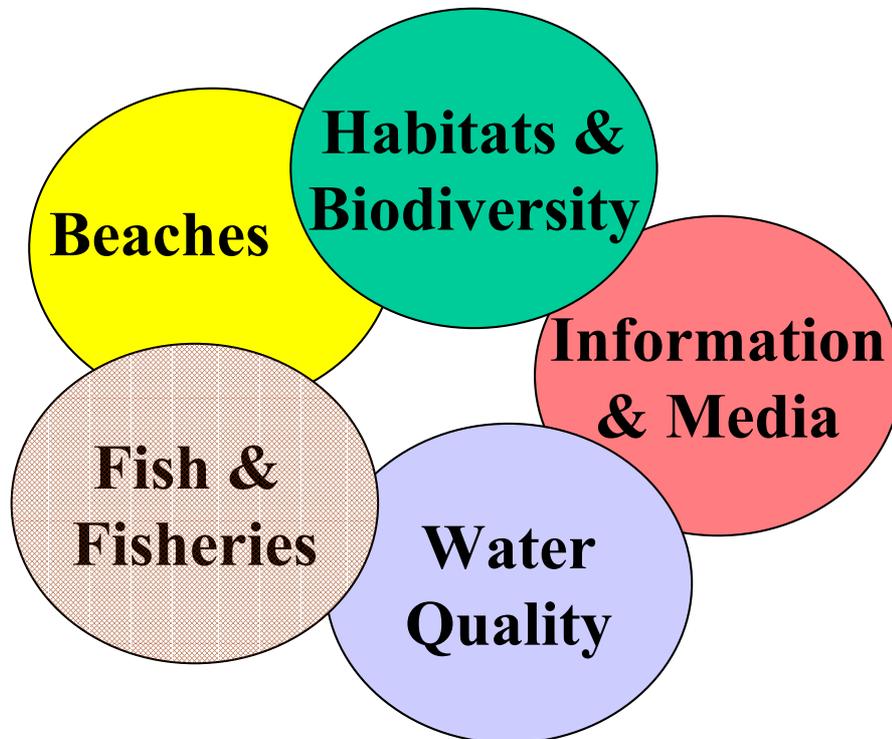


Figure 8.1 Marine ecosystem themes of Gaza Strip, Palestine.

Fish & Fisheries

The fishing efforts in the Gaza strip are high. The largest threat comes from the bottom-trawlers that fish for demersal and benthic species. These trawlers fish daily and year-round and their fishing methodology is detrimental to the soft-bottom habitats, but even to the hard substrate when the trawlers come too close. A second most important threat is the beach purse seine fishing for small and juvenile fish in the shallow coastal zone.

Water quality

It is widely acknowledged that the pollution of the sea must be cut back or stopped. The primary focus is the untreated wastewater outfalls on the beaches. Already, working programs and groups are into action to solve this urgent problem. Wastewater treatment plants are under construction and within a few years, 60% of the wastewater of Gaza strip will be treated. This means that another 40% of the sewage will still be discharged in the sea. Furthermore, future emissions of pollutants should already be prevented by issuing laws on possible effluents and by preventing the use of pollutants.

Habitats & Biodiversity

The shallow coastal zone is the most important marine habitat for fish and other flora and fauna of the Gaza strip. Destruction of habitats in this zone, caused either by fisheries activities, rock removal, the construction of coastal structures or other disturbances must be

prevented. Conservation of nature and biodiversity are the main concerns of the Palestinian Biodiversity Strategy (PBS) which is now under formulation by MEnA.

Beaches

The beaches of Gaza strip are selected as a separate theme. These beaches are subject to a lot of human activity and therefore the habitats of the beaches, shallow waters and dunes are under threat of destruction and disturbance. Also the problem of solid wastes is visible on the beaches. A new threat arises from the construction of the Gaza Sea Port. It is expected that measures must be taken to reduce erosion of the shore. These measures may include the construction of groins or sand nourishment techniques. Some of these techniques are a direct threat to marine life; some others however may even be beneficial

Information and Media

The issues of public awareness, training and education together define the fifth theme. This includes education at a young age, community participation and the awareness campaigns on the importance of the coastal and marine ecosystem.

9. Targets and indicators

Targets and indicators are defined to measure the ecosystem's health and to have a goal for improvement.

Fish & Fisheries

With regard to fisheries the target is a sustainable fishery sector. This means that commercial fishery is possible without the deterioration of commercial and non-commercial fish populations. Indicators for sustainable fisheries are the stability of fish catches, and a balance between young juvenile fishes and larger adults.

Water quality

With regard to marine pollution and seawater quality, international guidelines on water quality objectives and indicators exist. Water quality monitoring is necessary to check whether the Gaza waters comply with these standards. Studies may be carried out to establish the maximum allowable discharge quantities that can be allowed without exceeding of the water quality objectives.

Habitats & Biodiversity

With regard to habitat destruction, general targets are (in this sequence):

1. to prevent destruction when possible;
2. to mitigate effects when (partial) destruction cannot be prevented;
3. To compensate for habitat losses in another place.

10. Interventions for improving the marine and coastal ecosystem

Prioritisation of interventions

To improve the marine ecosystem of Palestine a number of interventions must be taken to meet the themes and impacts (Figure 8.1). However, each intervention is prioritised and evaluated according to the following criteria:

1. Environmental aspects:
2. Technical aspects:
3. Cost / Financial aspects:
4. Socio-economic aspects:
5. Legal / Institutional aspects:

List of interventions

For each theme a number of interventions are defined and summarised with each theme (Figure 10.1).

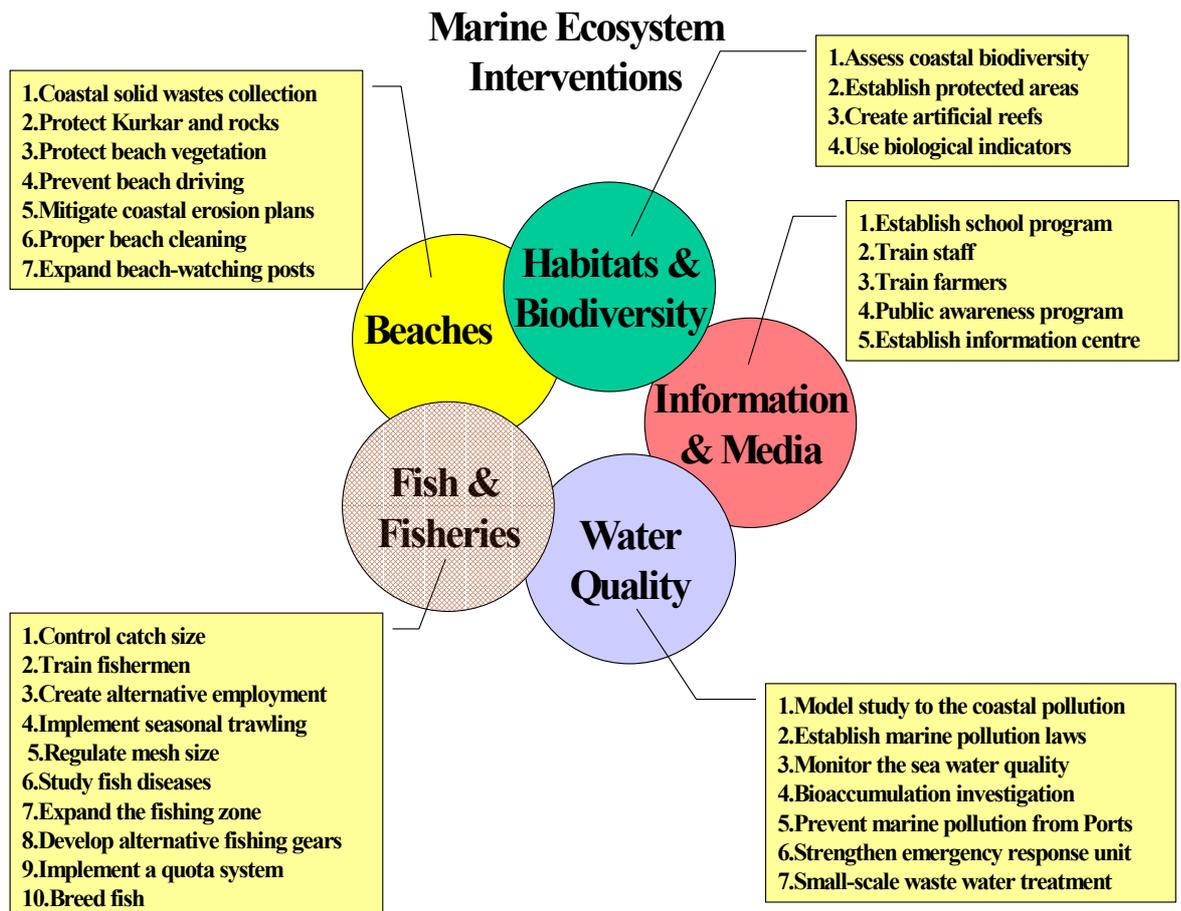


Figure (10.1) shows the themes and the related interventions for the marine ecosystem of Palestine

References

- *Abu Sada, A., 1997. Development prospective of a fishery port in Gaza / Palestine. International Institute for Infrastructure Hydraulic and Environmental Engineering (IHE), Delft, Netherlands. MSc thesis.
- *Barrett, J. & C.M. Yonge, 1980. Collins Pocket Guide to the Sea Shore.
- *Delft Hydraulics, 1994. Port of Gaza, basic engineering study, Final report, Part 11, Coastal impact study, prepared for the Palestinian National Authority and the Ministry of Economic affairs, the Netherlands, Sep. 1994
- *Grabowski & Poort, 1994. Port of Gaza. Basic Engineering Study, Part 10, Environmental study, Final, Nov. 1994.
- *Gaza Environmental Profile, 1994. Gaza Environmental Profile, Part One Inventory of Resources. Prepared for the Palestinian Environmental Protection Authority by Euroconsult and Iwaco.
- *Gaza Environmental Profile, 1995. Gaza Environmental Profile, Part Two Interactions between Man and Environment & Part Three Towards a Sustainable Use of Resources. Prepared for the Palestinian Environmental Protection Authority by Euroconsult and Iwaco.
- *Golani, D., 1996. The Marine Ichthyofauna of the Eastern Levant; History, Inventory and Characterization. Israel Journal of Zoology, 42, 15-55.
- Goodson, J., 1999. Reuse of RO Concentrate to Improve Water Quality at Wadi Gaza. US Agency for International Development, Bureau for Asia and the Near East.
- Groombridge, B., 1996. Marine turtles in the Mediterranean: distribution, population status, conservation. Council of Europe, Environment Conservation and Management Division.
- *Hassanen, M. & Abu Daya, M., 2000. Coastal Zone of Gaza strip. Palestinian National Authority, Ministry of Environmental Affairs, General Directorate of Natural Resources Protection.
- Italconsult S.p.A., 1994. Feasibility study for the coastal defence in Beach Camp, December 1994.
- Jennings, G.H., 1979. Mediterranean Fishes.
- *Khalaf, A.M. & M.A. Disi, 1997. Fishes of the Gulf of Aqaba.
- *Mahdi, A.N., 2000. Information about fisheries sector. Ministry of Agriculture, Fisheries Directorate.
- Medwaves, 1997. The latest on the spread of the *Caulerpa taxifolia* algae in the Mediterranean. In: Medwaves 34, spring 1997.
- *MEEnA, 1999. Palestinian Environmental Strategy. Palestinian National Authority, Ministry of Environmental Affairs.

*MOPIC, 1996. Coastal Zone Plan, regional plans for Gaza and West Bank governorates. Palestinian National Authority, Ministry of Planning and International Cooperation, Directorate for Urban and Rural Planning.

NOAA, 1999. Gaza strip, a coastal atlas; sensitivity of coastal environments and wildlife to spilled oil. Seattle, Washington, National Oceanic and Atmospheric Administration, National Ocean Service, Office of Response and Restoration, Hazardous Materials Response Division. Prepared for the Middle East Peace Process, Multilateral Working Group on Environment.

Muus, J.B. & Dahlstrom, P., 1981. Collins Guide to the Fishes of Britain and North-Western Europe.

Nir, Y., 1982. Asia, Middle east, Coastal Morphology: Israel and Sinai. The Encyclopedia of beaches and environments (edited by M.L. Schwartz)

Nir, Y., 1985. The world's coastline, Israel (edited by E.C.F. Bird and M.L. Schwartz)

*Port Consult, 1987. Assistance to the fishermen, Gaza Strip. Final report of study on fishery port - Gaza, Sept. 1987. Portconsult, Consulting Engineers A/S, Copenhagen.

Rosen 1998a (to be checked at DH, Toms)

*Sogreah, 1996. Gaza Port- Part II Layout Report, Section II Site Conditions Study. Sogreah Ingenieri.

Saqr, M., 1999. Description of the fishery. Ministry of Agriculture, Directorate General of Fisheries.

*Scott, P., 1983. Red Sea Reef Fishes.

Witteveen + Bos and Team Palestine, 1996. Environmental Impact Statement for the Gaza Seaport; January 1996.

*Wheeler, A., 1978. Key to the Fishes of Northern Europe.

*References in the Text, others may be useful for further studies.