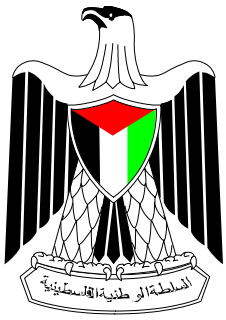


Palestinian National Authority
Ministry of Environmental affairs

Gaza Coastal and Marine Environmental Protection and Management Action Plan

LIFE Third Countries

In Association with

DHV Consultant BV

1 Introduction

1.1 Background

The Gaza coastal and marine environment is facing large and serious threats. The small Gaza strip contains a rapidly growing population that already counts at about one million persons. The limited land resources, the physical isolation of the area and the underdeveloped environmental management system has caused various serious problems. These problems relate to pollution of the coastal zone and seawater, deterioration of natural resources and natural habitats and diminishing fish populations. The fishery and tourist sectors as well as the domestic and agricultural sectors are directly faced by the negative impacts.

The Ministry of Environmental Affairs (MEnA) is well aware of these urgent environmental problems. A ten-year Palestinian Environmental Strategy Plan, covering both the West Bank and Gaza, has recently been completed by MEnA. Directions for solving the coastal and marine environmental problems have been given in the strategy plan. Parts of the required actions have already been initiated by different authorities and donor organisations, such as the preparation of wastewater and solid waste management plans. Other urgent coastal and marine environmental actions have not been initiated yet. These actions relate to the establishment of a Coastal and Marine Environmental Protection Committee that will deal with local as well, as trans-national, environmental co-ordination; formulation of a sand exploitation and erosion protection plan; a coastal and marine ecological protection plan and the establishment of a coastal and marine environmental information system.

One of the key elements of this project is to mobilise the stakeholders in order to find consensus and support for the proposed actions. Another key element is organisation of the coastal and marine environmental information into a dedicated information system. This system will support the Ministry of Environmental Affairs and key stakeholders in evaluating coastal and marine actions and their outcomes

This project is designed to fit to the conditions of the LIFE Third Countries programme. It is also consistent with the EC Environmental Policies and European Agreements, such as the Mediterranean Action Plan and the Barcelona Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean. It corresponds to the Agreement on the Conservation of the ACCOBAMS (including the Mediterranean) and the priorities agrees upon within the Short and Medium Term Environment Priority Action Programme (SMAP) under the Euro-Mediterranean Partnership.

1.2 Problem Identification

The coastal land and sea zone of Gaza is subject to serious environmental threats. Limited land resources, large and rapidly growing population numbers, long term isolation as result of the regional political circumstances and an underdeveloped environmental protection system have caused serious deterioration of land and water resources as well as pollution of various compartments of the coastal environment. Meanwhile, the coastal zone is very

important from marine ecological, land resources, fishery, transport, recreation and tourist perspectives.

Figure 1.1- Coast Area of Gaza City

1.2.1 Depletion of Sand Resources

The sand resources in Gaza, especially the coastal sand dunes, represent important environmental values. These dunes traditionally protect the coastal areas against the sea. The sand dunes have a natural water cleaning capacity. They are the habitat for flora and fauna. They also represent certain natural landscape values. Meanwhile a total amount of at least 25 Million cubic meter of sand is estimated to have been excavated - mainly for building purposes - in the last 20 years, from an area of about 520 ha. Only 12 % of the sand excavations are licensed. The major part is removed without permission. The extensive sand quarrying practises in the Gaza strip not only shorten the time period that this non-renewable resource will remain available, it also decreases the protection function of the crimping coastal sand dunes, the natural water purification capacity of the sub-soil and the habitat function for flora and fauna.

1.2.2 Erosion

New structures along the present coastline, like breakwaters, jetties, marinas and commercial ports, have blocked the along shore sand transport and have caused an erosive effect on the coast downstream. An example is the recently constructed fishing harbour, that has locally disturbed the coastal erosion and sedimentation pattern, resulting in local coastal sand erosion problems. The planned Gaza Sea Port will even more accelerate this problem. Building and roads that have constructed close to the waterline are faced already with stability problems and other related negative impacts.

1.2.3 Disturbance in Marine and Coastal Ecology

A recent biodiversity study in Gaza included a review of available information on coastal and marine ecology. Much attention is given to fish resources, as the fishery sector with some 800 fishing units, is very important economically. This sector is currently working under critical conditions, with an average area of fishing ground of about 0.5 square nautical

miles per unit. This is extremely low for international standards and there are strong indications that the coastal fish population diminishing due to overfishing, though exact data on the sustainable yield of the fisheries is not available. There is evidence that the fishing trawlers are damaging the seabed with their nets, affecting the ecological status of the marine areas and there are also indications that the quality of fish is affected by marine pollution.

Additionally, the endangered species of sea turtle is thought to exist in the coastal region of Gaza, and two turtle nesting beaches are known. In the past, these species and their eggs have been under extreme pressure from hunting and collecting, and there have been no reported sightings in the last two years, thus the existing status is uncertain. Only a very limited number of other marine reptiles have been reported. Little is documented on the status of marine mammals in the Gaza area, other than that the status of the Monk seals is unclear. Similarly, for marine flora, very little information is available. In any case, the marine ecological resources of Gaza are considered to be under great pressure from pollution inputs and the effects of the extensive fishery.

1.2.4 Pollution - Waste Water

The main source of pollution in the coastal zone of Gaza is the discharge of untreated waste water along the shoreline, both by the Palestinians as well as the Israeli settlements in the north, middle and south of Gaza. Especially the beaches in front of Gaza city, Beach Camp and Deir El-Balah are polluted by sewage discharges and individual sewage drains, ending either on the beach or a short distance away in the surf zone. About 80% of the waste water that is generated in Gaza is currently discharged without treatment into the sea (50,000 cubic meter per day). The pollution presents a major health risk for swimmers and marine life; there are also indications that the quality of fish is influenced by coastal pollution. Tourism development in the Gaza strip will largely depend on the extent to which the beaches and coastal cliffs will be cleared and stay clean from solid waste, and the extent to which the sewage effluent entering the surf zone of the coastal waters will be reduced.

1.2.5 Pollution - Solid Waste

Also dump sites for solid waste as well as littering contribute to the pollution of coast and seawater. Nevertheless, solid waste management has largely improved during the last years in Gaza. Also occasionally, shoreline cleaning actions take place on the initiative of MEnA , Ministry of Youth and municipalities. These measures contribute to mitigate the problems of open dump sites and waste littering along the shoreline.

1.2.6 Lack of Co-operation among the Concerned Parties

Currently, the awareness on environmental matters by the general public is not sufficient. This is partly caused by that fact that public information campaigns on environmental matters are only of very recent date, partly due to the fact that actual socio-economic problems tend to 'over rule' other issues, such as the environmental one, in the mind of the public. Target group information campaigns, for instance focused on the fishery sector, have not been organised yet.

Co-ordination between different parties involved does not take place sufficiently either. As a result, different authorities and stakeholders may have different agenda's on coastal and marine development issues.

1.2.7 Lack of Information

Currently, data and information on coastal and marine environmental matters are scattered throughout different authorities and project offices and donor organizations. An information system on the coastal and marine environment needed to support actions and co-ordination between the different agencies.

1.3 Need for a Coastal and Marine Environmental Action Programme

The Ministry of Environmental Affairs (MEnA) is responsible for promoting a sustainable environmental development of the Palestinian society. Its main task is the protection of the environment, including its water, soil, air, natural resources, nature and biodiversity, and in preventing public health risks related to environmental issues. In its current state of development, MEnA, as well as most of the Palestinian administrative bodies, depend largely on international financial resources to cover their budget needs.

MEnA, in co-operation with the Netherlands Development Agency (NEDA) has developed a Palestinian Environmental Strategy Plan for both the West Bank and Gaza. The objective of this Palestinian environmental strategy plan is to identify and analyse the main environmental problems and their causes in the West Bank and Gaza, to define environmental target and to present a series of prioritised measures that will lead to reaching these targets. This Palestinian Environmental Strategy Plan has a time span until the year 2010. The Environmental Strategy distinguishes next nine different environmental themes, that need to be addressed urgently in the coming ten years. These are: (1) Coastal and Marine Environmental Deterioration; (2) Depletion of Water Resources; (3) Deterioration of Water Quality; (4) Depletion of Natural Resources; (5) Land Degradation; (6) Air Pollution and Noise; (7) Deterioration of Nature and Biodiversity; (8) Landscape and Aesthetic distortion; (9) Threats to the Cultural Heritage. The current environmental status, as well as targets and indicators have been formulated for each of these themes.

With regard to the coastal and marine deterioration theme, a series of urgent actions have been identified in the field of : (1) waste water management; (2) solid waste management; (3) sand exploitation and erosion management; (4) marine ecological protection; (5) institutional strengthening. In addition, the need to organise and manage coastal and marine environment data and information has also been identified clearly.

The actions in the field of wastewater management and solid waste management are currently under preparation by the Ministry of Environmental Affairs and the Palestinian Water Authority in co-operation with international donor organisations. The urgent actions in the field of sand exploitation and erosion management, marine ecological management, institutional strengthening and information management are not yet initiated, nor are they

linked to international financial resources. This study focuses on these four fields of urgent actions. The results of this project are urgently needed to reverse the deterioration of the coastal zone environment.

The project takes furthermore into account the measures and actions that have already been initiated through other channels. Finally, this study is consistent with the EC Environmental Policies and European Agreements, such as the Mediterranean Action Plan and the Barcelona Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean. It also corresponds to the Agreement on the Conservation of the ACCOBAMS (including the Mediterranean) and the priorities agrees upon within the Short and Medium Term Environment Priority Action Programme (SMAP) under the Euro-Mediterranean Partnership.

1.4 Overall Objective

"The overall objective of this plan is to reverse and prevent further depletion and deterioration of the Gaza Coastal Zone and Marine Environment.". The plan itself will clearly contribute to reaching this overall objective, but also other conditions have to be met. First of all, the planned wastewater treatment projects that have been prepared by the Ministry of Environmental Affairs and the Palestinian Water Authority have to be implemented successfully. Secondly, solid waste management, that is currently implemented, has to be completed. Also the Gaza land use plans that have been prepared by the Ministry of Planning and International Co-operation (MOPIC) have to be implemented successfully, including establishment of ecological and natural resources protection zones. Finally, a more general condition is that the economic and political developments will be positive, in the sense that they will not hamper developments in the environmental sector.

1.5 Plan Purpose and Results

The direct purpose of this plan is formulated as follows: *to develop a coastal and marine action program.* This program will consist of two major parts. The first part is development of a coastal and marine protection committee that will include representatives of the key stakeholders in the coastal and marine zone. The stakeholders are not only the responsible municipalities, authorities and ministries, but also the non-governmental representatives of the various social and economic sectors that depend for various reasons on the coastal and marine zone. Examples are the fishery sector, the construction sector, nature protection organisations and the tourist industry. One of the success factors of such a committee is surely the willingness and preparedness of the various parties to participate in the committee. Provision of information on objectives and activities of the committee is therefor essential prior to establishment.

The second part of the programme consists of preparation of a balanced set of coastal and marine protection measures that are in line with the Palestinian Environmental Strategy Plan. These actions consist of: (1) preparation of a Sand Exploitation and Erosion Protection Plan; (2) preparation of a Marine Ecological Conservation Plan and (3) Development of a Coastal and Marine Information System.

The following scheme provides an overview of the logical framework.

Logical Framework

	Intervention Logic	Verifiable Indicators	Verification	Assumptions and Risks
Overall Objectives	To reverse and prevent further depletion and deterioration of the Gaza Coastal Zone and Marine Environment			
Project Purpose	Development of a Coastal and Marine Environmental Action Programme	Approval rate of the plan by MEnA and other involved authorities/stake holders	The Plan itself and opinion of representatives of MEnA and other involved authorities	Waste water and Solid waste management plans are implemented Socio-economic and political circumstances are reasonably favorable
Project Results	1. Establishment of Coastal and Marine Protection Committee 2. Coastal and Marine Management Plan	1. Environmental values and associated sand protection zones 2. verifiability of environmental indicators 3. composition of the committee, commitment of members, number of meetings so far	1. The plan and the protection zones themselves 2. options to monitor the coastal protection plan 3. Members of Committee	1. willingness by stakeholders to participate in committee 2. support from key stakeholders to the protection plan and willingness to share information 3. enforceability of the plan
Project Activities	1. identification of key stake holders 2. formulation of objectives and statutes 3. establishment of secretariat 4. meetings and evaluation of actions 5. preparation of a Sand Exploitation and Erosion Protection Plan 6. preparation of a Marine Ecological Conservation Plan 7. preparation of a Coastal and Marine Information System 8. Development of Coastal and Marine Information System			

1.6 Risk Analysis

The socio-economic and administrative environment in which this study has been executed implies that some risks are eminent. First of all, the regional political circumstances (sometimes resulting in complete closure of the borders of Gaza) have proved to have a great impact on social and administrative processes in Gaza.

Wastewater management and solid water management are essential steps to reach the overall objective that is to reverse and prevent further deterioration of the Gaza Coastal Zone and Marine Environment. This plan does cover these fields. On the other hand, co-operation with others in these fields will be accomplished whenever necessary.

The success factor for reaching a sustainable and effective Coastal and Marine Protection Committee depends on the willingness of the stakeholders to participate and to take corresponding responsibilities. The idea for such a committee is widely agreed upon already, and the various parties are indeed willing to share information and responsibilities.

The outputs of the committee will be approved actions in the fields of coastal and/or marine environmental protection. These actions have to be implemented by the various

implementing agencies, for instance MEnA. It is therefore, all potential implementing agencies are participating in the committee. For instance, the sand exploitation and erosion protection plan are effective based on reliable and sufficient information on current exploitation measures, ecological important sand areas, projected sand use figures, etc. This information were gathered from various sources.

The enforceability of the sand exploitation and erosion protection plan is an essential condition for its success. Related measures have therefore to fit to the local socio-ecomic conditions. Also here, the Committee has an important role to play.

Development of a Coastal and Marine Information system is considered an essential element of this plan. Information on various compartments of the coastal and marine environment has been gathered and updated during the plan preparation. The information management system for the coastal and marine was imbed in the existing information system of MEnA , so that required human resources, soft- and hardware fit in the already available structure at MEnA.

1.7 Potential for Reproduction

The set up of this plan gives good opportunities for reproduction in other areas of the Mediterranean or else where. Reasons are that, first of all, the coastal and marine problems that will be addressed in this plan are similar to many other coastal areas in the world. Secondly, the experience in establishing a Coastal and Marine Protection Committee will be very valuable for other countries with similar administrative structures and cultural values (such as other countries in the Middle East). Thirdly, the sand exploitation and erosions protection plan provides a methodological framework that might prove to be very valuable to areas with similar problems, not only around the Mediterranean. Establishment of a Coastal and Marine Information Management System has similar advantages.

1.8 Financial and Technical Sustainability

Financial sustainability in general in Gaza is an issue that differs from many other countries. Due to the recent political developments, the governmental sector in the West Bank and Gaza depends largely on international financiers. This will likely continue to some extend for the coming years. On the other hand, the plan focused on issues that have both an environmental protection component as well as a (sustainable) economic component. A clear example is the sand exploitation and erosion protection plan. This will contribute to planned and responsible exploitation and protection measures. For these reasons it is expected that local and long-term international support will not be difficult to find.

The plan components have been formulated so to fit in the existing structures of MEnA as good as possible. This relates to both the technical aspects as well as the required experience of the MEnA staff level. This will guarantee to a maximum extend the technical sustainability of the project.

1.9 Options for Follow-up

This project provides also a good basis for additional and broader project opportunities. The Sand Exploitation and Erosion Protection Plan will be followed by an implementation phase, in which the elements of the plan have to be implemented and enforced. The same counts for the Marine Ecological Protection Plan. Finally, there are options to enlarge the scope of this project (Coastal and Marine environment) to a wider perspective, both in terms if sectors (urban, agriculture, etc.) as in spatial terms (i.e. broader coastal zone, Gaza as a whole). The feasibility of these options will of course depend fully on the plan results themselves and the support that will be given to them.

1.10 Conceptual Framework

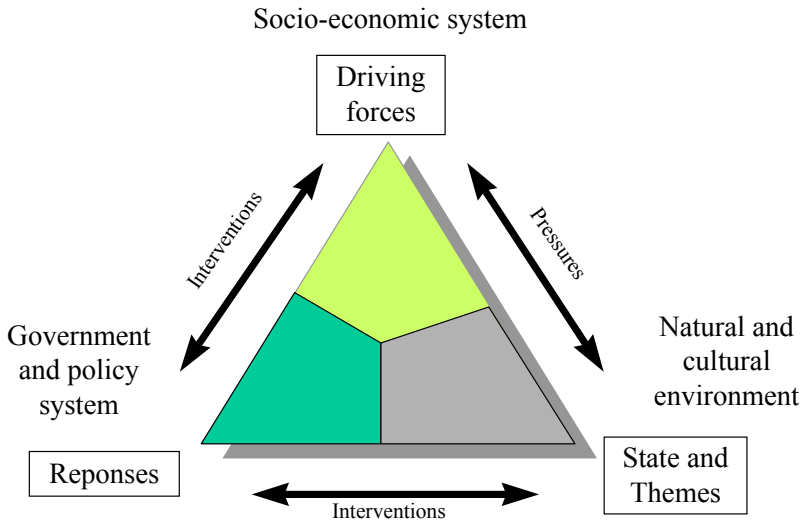
The second project result will be a balanced set of coastal and marine protection measures, which will together form the *Coastal and Marine Protection and Management Plan*.

This plan contained a sand exploitation and erosion protection plan and a marine and coastal ecology conservation and management plan.

Other issues of key concern in the marine area, such as actions in the field of wastewater treatment and solid waste management, are not included in the main focus of the plan. These plans have been developed and will be implemented independently from this project. Of course, co-ordination with wastewater and solid waste management activities will occur whenever necessary.

The coastal and marine environmental protection and management plan consists of a set of well described actions that directed at the main problems areas. The actions may relate to physical interventions in the coastal and marine environment as well as non-physical interventions, such as monitoring and enforcement, institutional interventions, public information, etc. The conceptual framework for reaching the actions is schematised in Figure 1.2.

Figure 1.2- Conceptual Framework



The following sequence of steps were undertaken to reach these project results.

1- ***current status:*** first, an identification of the current status of the environmental system was made in terms of spatial distribution, quality and quantities, etc. of the sand, coastal erosion and marine ecological circumstances. Also an inventory of the status of the government system was made in terms of authorities and ministries that have been involved in the coastal and marine environment, as well as the interventions (policies, actions and projects) that have been initiated already.

2- ***functions and driving forces:*** secondly, the socio-economic system were analysed in terms of the sectors involved as well as the related pressures on the environmental system. This step includes a description of the various sectors (construction sector, tourism sector, etc.), that are related to the coastal and marine environment. It also includes a description of the type and extent of the uses (for instance: which beach segments are used for tourism, which beaches are applied for urban development, where is discharge of urban/industrial waste water in the coastal area taking place, how much sand is used by the construction sector and from where, etc.). Again, the information was ***located and quantified*** as much as possible. For instance: provision on a map of the location and quantity of sand being annually excavated for construction purposes, locations on a map of tourist beaches in relation to locations of potential public health hazards, etc.

3- Formulation of ***coastal and marine themes***. These themes relate to specific problem areas that need to be addressed, due to a friction between the current status (and related carrying capacity) and the current uses and impacts on the coastal and marine environment. In addition to the themes, also the ***targets and indicators***, related to these themes have been identified. The targets represent the situation in which the problem related to the theme is solved (for instance: complete stop of coastal erosion process). The indicator represents the way the theme and target can be measured (for instance: actual erosion in m^2 per year) and monitored.

Steps 1 to 3 relate to the problem analysis, which has done separately for the marine ecological aspects on one hand and the sand and erosion problems on the other hand. Steps 4 to 7 relate to formulation of solutions and has been done for both sides in an integrated manner.

4- Collection and formulation of long list of ***intervention*** to address the coastal and marine themes. This based on an integrated analysis of: (1) the driving forces; (2) the environmental themes and (3) the impacts of the interventions on both 1 and 2. These interventions may relate to structural measures, such as construction of coastal protection works, but also to non-structural measures, like setting up a licensing/enforcement system for sand exploitation, or public information systems.

5- Next the interventions will be described in terms of ***criteria***, including impacts on the environmental themes, cost and finance, technical description, institutional set up and more. The actions are ***prioritised***, based on pre-set evaluation criteria

6- ***Elaboration*** of the high priority actions into detailed project proposals. These proposals will be elaborated in the level of pre-feasibility studies, based on standard formats.

7- Completion of the ***Coastal and Marine Protection and Management Plan***, including the list of prioritised actions and the related financial, organisational and institutional measures involved.

1.11 Historical Background

The coastline of the Gaza strip forms only a small section of a larger concave system (a "litoral cell") that extends from Alexandria at the west side of the Nile Delta, via Port Said, Bardawil Lagoon, El Arish, Gaza, Ashqelon, and Tel Aviv to the Bay of Haifa. This litoral cell forms the SE corner of the Levantine Basin (Figure 1.3). This entire coastline, including the coastline of the Gaza Strip, has been shaped over the last 15,000 years by the Nile river and especially its sediment yield originating from Africa's mountains. The Nile sand moves along the entire concave coastline in an anti-clockwise direction, generally in a NE direction. Within this concave SE corner of the Mediterranean, the relatively short 42 km Gaza coastline is almost straight.

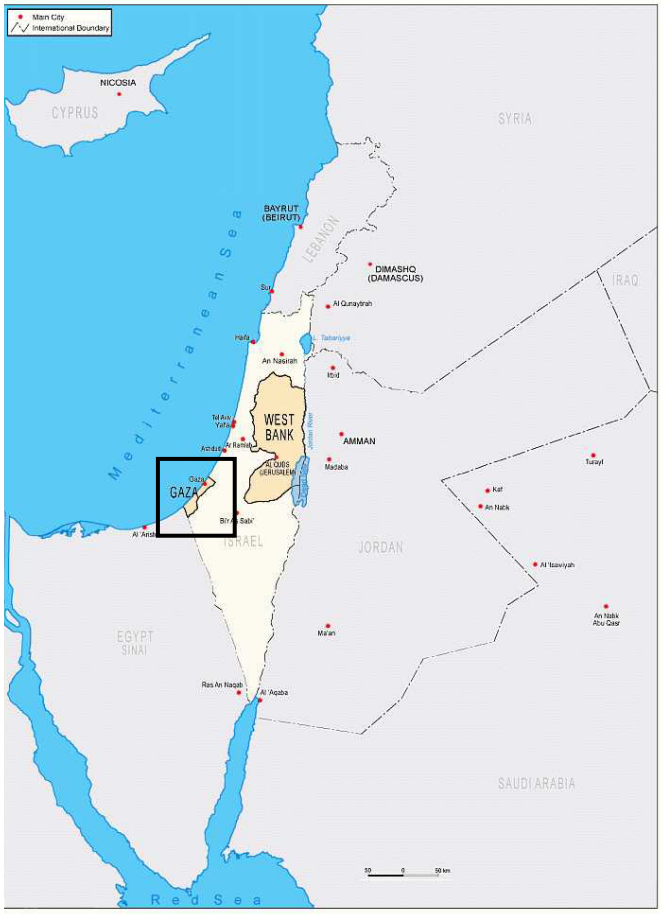
A coastline, by definition, is the - generally curved - line at the intersection of a body of land - a continent - and the horizontal plane of the adjacent sea surface. Obvious as this definition may seem, a sometimes overlooked implication is that the position of the coastline, both in horizontal and in vertical sense, is constantly subject to changes, because both the land and the sea level are subject to change.

Since the world-wide temperature started rising after the last glacial period some 15,000 ybp, the sea level has risen about 100 m. After a period of fast rise, since about 7,000 ybp the rate of sea level rise slowed down. Around that time, the rate of accumulation of Nile sediments at the shores of Egypt at last became stronger than the rate of sea level rise, and as a consequence the Nile Delta finally emerged, and grew into its form as we know it today.

Over the last century the average rate of sea level rise is 1.5 mm per year. This rate may again increase due to a climate change, and the Intergovernmental Panel on Climate Change (IPCC) conservatively expects that the sea level may rise another 0.4 to 0.6 m over the next

100 years. In addition, a possible rise or lowering of the land, due to either natural or man-made causes, must be added to find the total relative (effective) rate of sea level rise on any particular location on earth in the Mediterranean context.

Figure 1.3- Gaza Coastline in the Mediterranean Context



1.12 Main Concerns on the Coastal Protection

Massive sand mining from the dunes and beaches has occurred and is still going on largely without planning. This undermines the natural dune system as a defence against wave attack and flooding. In addition, many historic and archaeology remainders are known to be buried under the dunes or are partially exposed above the seabed. There is a risk that these be damaged during unauthorised sand mining or marine dredging. This coast-related cultural heritage should be protected.

Roads, restaurants, hotels, and other buildings have been and still are being constructed very close to and even right on the active part of the shore, in some cases too close to the sea, thereby constraining the range of free space needed for the natural Mediterranean coastline dynamics. Piers, breakwaters, harbours, revetments and waste dumps have been placed in the sea and on the beach in a haphazard and unplanned way, without regard to their negative effects on wave action, seawater circulation, sediment transport patterns, or landscape amenity.

Locally the beach rock and kurkar ridges, protruding above the seabed, have been levelled to ease fishing practices, disregarding their natural breakwater function for beach protection. The recently constructed Fishing Port, just upstream (southward) of the already heavily attacked coastline of Beach Camp, has further increased the need to protect this coastal section. A protection plan is ready , but implementation has not yet started.

The planned Gaza Sea Port will further greatly affect the Gaza coastal and beach dynamics; the envisaged mitigating measures which are planned to be implemented, should be in place before the Port's main breakwaters construction starts. A good co-ordination and well-balanced plan with respect to coastal erosion and protection in the whole Gaza Strip area N of the Wadi Gaza mouth is lacking. This may be a threat to the integrity of the coastline, to an economically effective operation of both new Ports, and to the effective use of the scarce financial resources invested in the Gaza socio-economic system.

Between Rafah in the south and the mouth of Wadi Gaza, no major coastal structures are planned as far as we know. Nevertheless there is a great pressure on the sandy coastline, dune face and kurkar cliffs because many small-scale tourism facilities appear, without much control - if any - to respect the vulnerable and ecologically precious character of this narrow shoreline.

The knowledge about the Gaza Strip's coastal sea and beach dynamics, especially focused on the processes of wave action, longshore currents, sediment motion, and the resulting rate of beach accretion and erosion, is extremely limited. No systematic observations, let alone measurements, are available to support sound planning and erosion protection policies. Therefore, a systematic coastal monitoring programme is one of the most urgent needs that must be addressed.

2 Current status of the Coastal Zone

The Gaza coastal line is 42 km long, between 6 and 12 km wide and covers an area of 365 km^2. It is situated in the south part of Palestine and south-east of the Mediterranean. An estimated 1.3 million people live in Gaza. Within the Gaza area, a number of Israeli settlements are located that cover a total area of 80 km^2 and have a population of 3000-5000 inhabitants (Hassanen & Abu Daya, 2000). (Figure 2.1)

The coastal zone of Gaza is defined as the band of water and land along the marine shoreline where 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, the Wadis and part of Gaza City. The land side of the coastal zone covers an area of about 74 km^2, of which 2.7 km^2 are beaches. About 48 km^2 of the coastal zone is occupied by Israel (MOPIC, 1996).

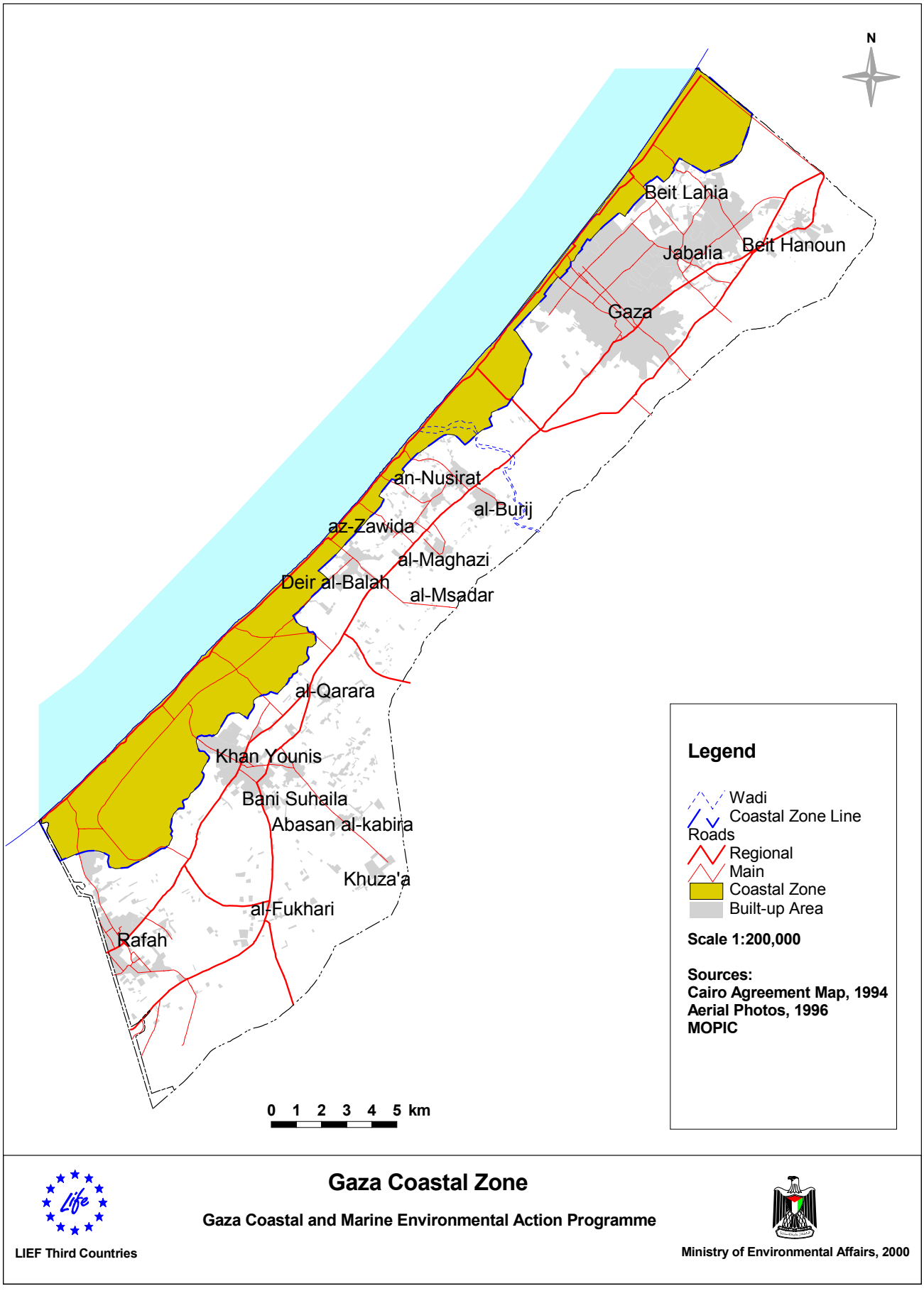
The coastline is dissected by three valleys, Wadi Gaza in the center, Wadi Beit-Hanoun in the north and Wadi El-Saiqa in the south. The Wadi Beit-Hanoun and Wadi al-Salqa valleys are dry throughout the summer and wet in the rainy, winter season. Wadi Gaza has surface water year-round, but this is due to the discharge of untreated waste water. Unfortunately, the wadis in Gaza do not function as natural wadis anymore. Their natural supply of water is limited or has stopped (Goodson, 1999).

The coastal shelf of Gaza is part of the Nile littoral cell, that extends from Alexandria, Egypt to the Bay of Haifa, north of Palestine. The south-eastern Mediterranean coast has been shaped by the sediment transport from the Nile river, upwards via the north coast of Sinai to Gaza.

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 (fill).

In the following sections the current status of the coastal and marine environment is described, based on available and newly collected information. It includes an overview of the authorities and ministries that share responsibility for the coastal and marine environment as well as the actions and projects that have already been planned for, or have already been imposed on the coast

Figure 2.1: The Coastal Zone of Gaza



2.1 Coastal Erosion

Coastal erosion is a serious problem since many years. Many archaeological sites were disappeared. In this vision, different characteristics of the coastal area will be focused in details, as bathymetry, Sea level fluctuations, etc. This would enable us to find the themes of the system, problems and interventions.

2.1.1 Bathymetry

The bathymetry (geometry of the seabed) off Gaza is given in Figure 2.2. 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).

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 20 m depth contour is found some 1600 m seaward of the shoreline, so the average sea bed slope is 1 in 80. (See also Delft Hydraulics, 1994). For easy reference, the following table represents the coastal profile of Gaza.

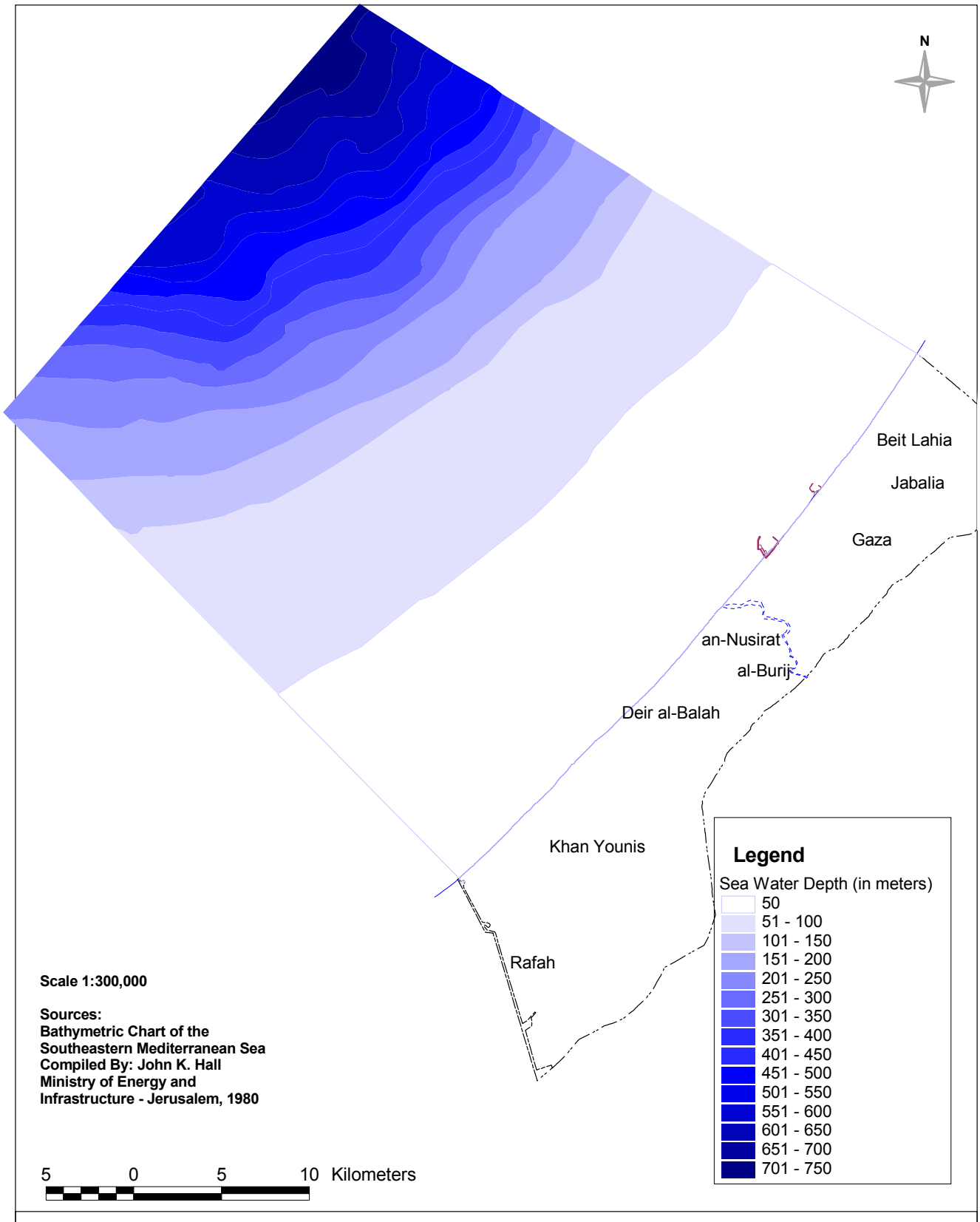
Depth (m) below MSL	***Distance from shore (m)***
0	0
2	100
4	200
6	350
8	500
10	670
12	870
14	1070
16	1260
18	1460
20	1660

Note. This depth profile should not be taken as representative for the entire Gaza coast.

A more complicated coastal profile form, with one or two offshore submerged sand bars, has been described for an area somewhat more northward by Striem (1974) and also by Goldsmith et al (1982). 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. They play an important role in the sediment transport, both alongshore and perpendicular to the shore.

For the Gaza Sea Port, a detailed bathymetric survey has been carried out in an area of 2 by 4 km. A detailed bathymetric survey along the entire Gaza coast is expected soon to be made under a Danish Project by the Fisheries Directorate of the Ministry of Agriculture.

Figure 2.2: Overall Bathymetric Map



2.1.2 Sea Level Fluctuations

For a detailed description of the wind and wave climate, the currents and the water levels, reference is made to Part 5 of the Final Report, Port of Gaza, Basic Engineering Study. Sea level fluctuations occur 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 of sea levels however, At Ashdod, (Latitude N 31 50 and Longitude E 34 38), some 40 km North of Gaza City, the following tidal levels are known:

MHWS 0.6 m
MHWN 0.4 m
MLWN 0.1 m
MLWS 0.0 m
all levels referred to local Datum of soundings.

In Rosen (1998a) it is reported that the Israel Land Survey Datum (ILSD), which is the land survey datum level used to define topographical zero level, lies 8.1 cm below MSL (mean sea level), with MLLW (mean low low water) at 13.6 cm below MSL and MHHW (mean high high water) at 15.1 cm above MSL.

Seasonal variations in mean sea level are probably restricted to 0.2 m. Sea level exceedance levels (mainly due to storm surge events which may have a duration of say one day) on the coasts of Israel are reported by Rosen (1998a) to be, on the average, MSL +0.64 m once per year, and MSL +1.10 m once per 100 years.

2.1.3 Currents, winds, and waves

For a detailed description of the wind and wave climate, the currents and the water levels, reference is made again to the Final Report, Port of Gaza, Basic Engineering Study, Part 5.

Flow velocities due to the tide and the large-scale anti-clockwise gyre in the SE corner of the Levantine Basin are small in the nearshore zone. In the deeper regions their maximum magnitude is about 0.2 m/s. Wave-induced currents in the breaker zone, under extremely severe wave conditions, might reach maximum velocities of 1.0 m/s according to numerical model results (Delft Hydraulics, 1994). In winter the prevailing wind direction is SW with an average speed of 4.2 m/s. During summer the prevailing winds are from NW directions.

Waves at the Gaza coastline have never been recorded in a systematic way. Based on wind statistics and fetch considerations, wave statistics have been computed for Gaza, Ashquelon and Ashdod. On a location of Ashdod, actual wave height and wave direction measurements have recently been carried out, but their results are not available at this moment. Earlier, Rosen (1998a) presented the following *significant* wave height exceedance values:

Hs : 1 in 2 yrs 5.2 m
Hs : 1 in 10 yrs 6.8 m
Hs : 1 in 50 yrs 8.2 m,

These extreme wave height statistics might, for the time being, also be regarded as indicative for the situation off Gaza. Local wave characteristics, particularly direction and height, play a crucially important role in the understanding and quantification of the longshore sediment transport characteristics, which on their turn determine the coastal erosion effects of man-made coastal structures. Without reliable local wave data no reliable forecasts can be made of the coastal behaviour. In addition, and at least as important, reliable wave measurement results are necessary for the design of ports, breakwaters, and other coastal protection works.

2.1.4 Coastal Geology

The text of this section is largely based on Grabowski & Poort, 1994. The Holocene and Pleistocene deposits in the Gaza terrestrial area are approximately 160 m thick and cover the underlying Pliocene sediments. These deposits consist of marine kurkar formation, shell fragments and quartz sands cemented together, and sometimes calcareous sandstone. Due to its high porosity and permeability the marine kurkar forms a good ground water aquifer. Most of the groundwater in the Gaza Strip is extracted from this layer. The thickness of the marine kurkar varies between 10 m and 100 m showing a tendency to be thicker near the coast.

The continental kurkar formation varies 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 and can locally reach a thickness of 25 m. Four types of alluvial deposits can be distinguished:

- Sand dunes especially in the south near Rafah, oriented mainly ENE to WSW. More to the north dunes become sporadic and the sand accumulations are scattered in a zone of 2 to 3 km from the coast;
- Wadi fillings consisting of sandy loess and gravel beds, which can reach a thickness of 10 to 20 m;
- 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 brown clay;
- Beach formation consisting of a fairly thin layer of sand and shell fragments.

2.1.5 Coast and Seabed Characteristics

Going from sea to land, the coastal profile can be divided into the seabed, the beach, the dune face or kurkar cliffs, and the adjacent body of the dune or cliff plateau.

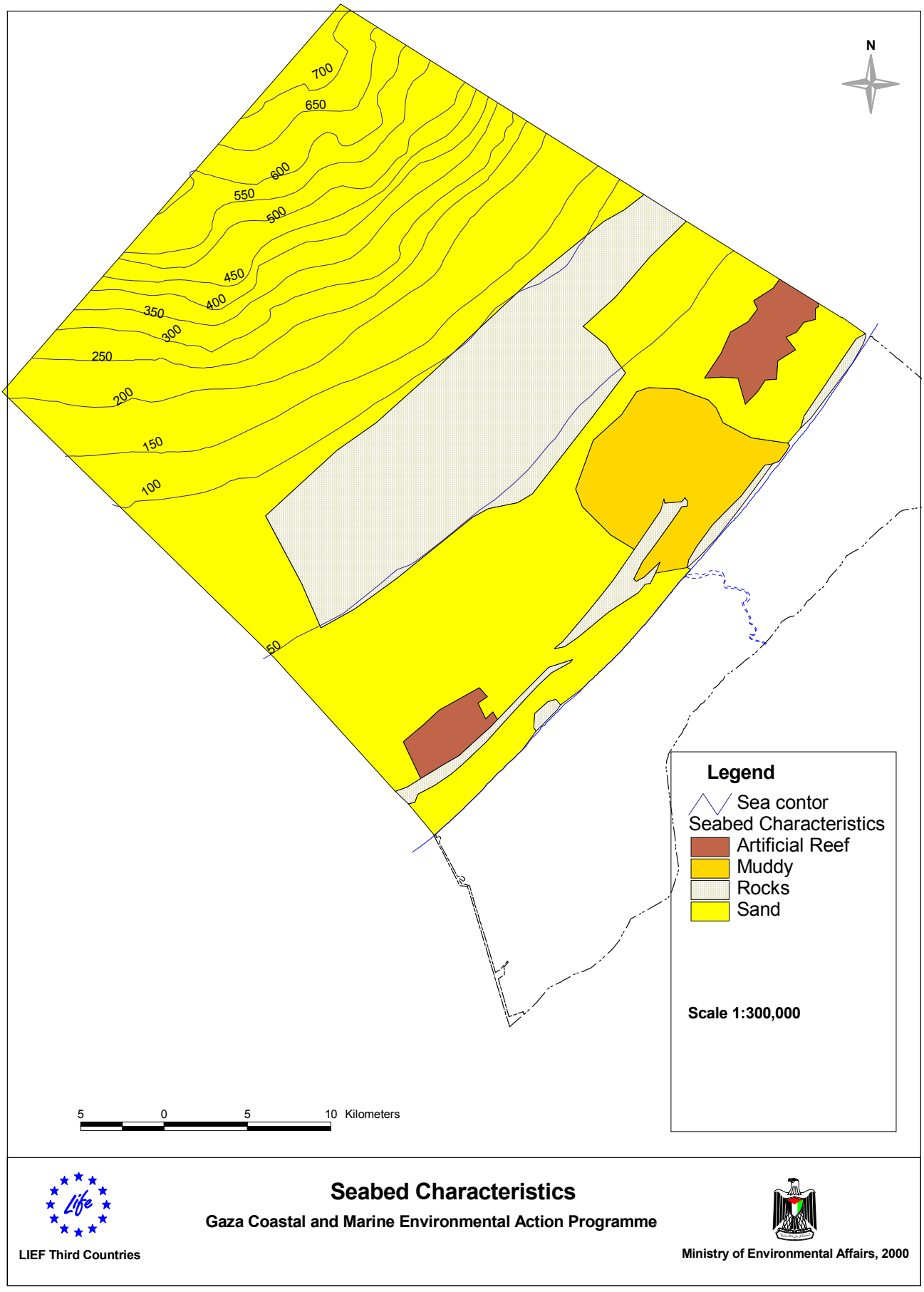
The coastal profile does not only consist of sand, but locally also erosion-resistant formations of rock and kurkar protrude, on the seabed, on the beach, and in the cliffs. The geophysical survey for the Port of Gaza demonstrated the presence of non-erodible layers at a mean distance of about 3m below the alluvial seabed. Further, 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 characterised by areas of rock outcrops and linear features of

sand bars (Sogreah, 1996). On the beach and near the waterline of the Gaza shoreline on many places kurkar outcrops and rocky ridges can be seen.

These hard ridges are important coastal features in that they form natural breakwaters which tend to mitigate an eroding trend. Where these hard layers are covered only by a relatively thin layer of sand, a retreating coastal profile will gradually consist of an increasing amount of erosion-resistant surface (Figure 2.3).

Defining the erodibility and composition of the steep kurkar cliffs along the Gaza coastline is another important challenge, which will hopefully be undertaken soon. These cliffs themselves are to an (un-)certain extent able to retard an erosional tendency. If they are attacked by waves and locally collapse, the eroded kurkar material will feed the beach with a mixture of very fine to very coarse sediment. The fines will soon be transported to deep water, whereas the coarse particles will act as an armour layer, protecting the freshly exposed kurkar cliff face during some time.

Figure 2.3- Seabed Characteristics



2.1.6 Sediment Transport: processes and quantities

It is important to first assess the natural behaviour of the *undisturbed* Gaza coastline, because this will give us a basis for comparison and a more clear insight into possible causes and remedies when we subsequently turn to the situation after human interventions in the next Chapter.

Until around 1950, few human interventions were imposed on the natural coastal system of Gaza, so it may be assumed that before that time the coast of Gaza largely behaved in an undisturbed, natural way. Unfortunately, regarding that period no structured information is readily available on whether the coastline of Gaza was changing, either landward or seaward. There must be a possibility to retrieve information from various sources, but that will take much time.

However we can relate to the somewhat similar coastline of eastern Mediterranean sea. According to Nir (1985) the kurkar cliffs ('carbonate-cemented quartz sandstone, red loams, and sands at different stages of cementation, all of Pleistocene age') are slowly but continuously retreating: "Because of the action of marine and atmospheric agents, the coastal kurkar cliffs are very steep and unstable, retreating landward at a rate of at least 3 to 4 cm/yr for the last 6,000 years".

If this also holds for Gaza, the landward (horizontal) retreat of the kurkar cliffs between 1950 and 2000 would be 1.5 to 2 m, only due to natural causes, probably mainly due to the ongoing rate of sea level rise which is 1.5 mm/yr.

A factor of overwhelming importance in shaping the coastline of Gaza has been the semi-continuous supply of Nile sediment, which is being transported by NE directed wave-driven longshore currents along the entire coastline of the Nile litoral cell since thousands of years. This sand forms the bulk of the Gaza coastal sediments together with additional calcareous, aeolian and alluvial silty and clayey material. The sand is composed of well sorted quartz sands.

The sediments from the Nile are easily picked up by the near-bed orbital velocities of the Mediterranean wave motion, and are then transported according to the prevailing currents. These currents on their turn are mainly induced by the near-coast breaking process of the waves, i.e. in the surf zone. Depending on the direction of the waves and especially on the angle between the breaking wave crest and the shoreline, these so-called longshore currents transport the suspended sediments either to NE or to SW. This direction can vary from day to day depending on the incident waves of that day. The waves, generated by the wind, either by local winds or by storms hundreds of kilometres away, may approach the shoreline from any direction. Due to this wave-associated variability, sometimes the sand goes SW, but mostly NE, which is defined by the wind climate over the Mediterranean, and the geometry of the Mediterranean basin. On the average the resulting sand transport direction is from the Nile delta along the coast, anti-clockwise, say NE.

Apart from being transported parallel to the shoreline, there is also a sediment transport component perpendicular to the coastline. Due to the complex pattern of wave-induced secondary currents both inside and offshore of the surf zone, in combination with the particular differential settling velocity of finer and coarser sediment particles, in general the finer sediments (silt and clay) are washed to deeper water offshore. In contrast, the coarser

material (such as sand, shells and gravel) is transported towards the shore, and finally onto the beach by the wave uprush. If there are strong enough landward winds the sand is even blown further ashore where it may form accumulations in the form of sometimes very high and extensive coastal dune complexes, well-known in Egypt, Gaza and Israel (Figure 1).

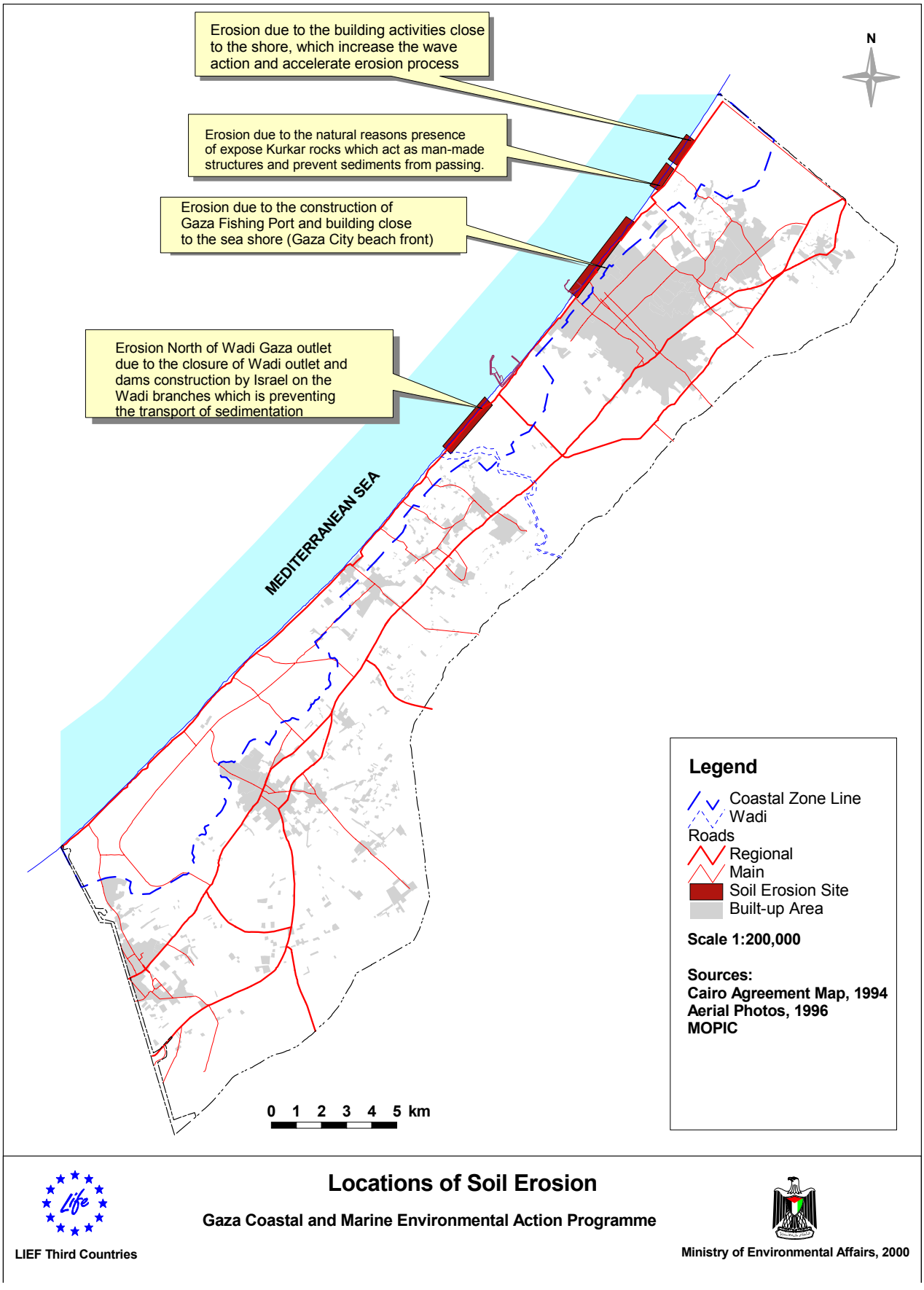
In addition to the fact that sand can be transported from the seabed onto the land, also a sediment transport in the seaward direction may take place. This was briefly described above in the case of coastal kurkar cliffs being attacked by waves, which then especially carry the finer particles to the deep sea (whereas the coarser parts remain moving alongshore).

Altogether, a most complicated and time-varying movement of various kinds of sediment occurs in the coastal area. In many cases, different sorts of sediment move, simultaneously, in different directions, at different elevations in the water column, subject to the primary and secondary (residual) water motions associated with irregular waves, which generally incide from different directions at the same moment. Nowadays the resulting sediment motions, both in direction and quantity, are subject to calculation according to physically justified numerical models. The accuracy of the computed results however is heavily leaning on the quality of the input, thus on measured and verified local data: mainly bathymetry, seabed erodibility characteristics, and waves.

The need for a detailed understanding and quantification of the longshore and perpendicular sediment transportation rates at Gaza was particularly created by the Gaza Sea Port plans. In the extensive series of study reports devoted to the planning and design of the Gaza Port, an extensive background is presented on the data and assumptions which have been applied in the various assessments of the coastal changes to be expected. Considerations by Delft Hydraulics (1994), taking into account the available data from the literature result in a net northward directed sand transport along the Gaza coast of 350,000 m^3/yr., with a rather wide uncertainty range. This rate is composed of a N component of 510,000 m^3/yr and a S component of 160,000 m^3/yr. (Recent, yet unpublished information on wave characteristics in southern Israel however points towards a somewhat smaller net NE directed sand transport. A closer study based on local measurements and data analysis in the Gaza Strip coastal area itself is necessary to shed more light on this major uncertainty.). Due to various circumstances, the net NE-ward rate of sand transport decreases going north, whereas it is supposed to be larger at El-Arish, Egypt.

In contrast to the longshore sand transport, the rate of sustained perpendicular (or 'cross-shore') sand transport is not yet susceptible to a realistic model computation, even if all relevant wave data were known. Rather, the resulting long-term average cross-shore sand transport must be inferred from an overall, long-term sand balance consideration, in which the actually observed rate of coastal recession must be known.

Figure 2.4- Locations of Soil Erosion along Gaza Coastal Line.



2.2 Sand Exploitation

The following description of the current status of the sand availability and sand exploitation practises is based on available information and includes an inventory of ongoing and previous projects that have been involved in the sand exploitation and management. It also includes a description of the authorities and ministries that share responsibility for the sand exploitation as well as the policies, actions that have already been imposed with regard to sand exploitation.

Figure 2.5- Sand Querying Site in Gaza

Sands Origins

There are different opinions regarding the origin of these sands. Most regard the Nile River as their principal source, during the pluvial periods of the subtropical areas, the Nile brought down to the sea not only fine alluvium as in our days, but also coarse sand from the Abyssinian highlands, the hardest components, quartz sands, were transported through the sea and cast up on the Palestinian shore. Others hold that the sand was carried by Wadi El-Arish from the lofty mountains in the south of the Sinai Peninsula. At all events, the quantity of the sand on the coast decreases, proceeding from south to north up to Haifa. In fact, the siliceous sands are clearly derived from external sources which can be described as non-renewable resources. Figure 2.4 present the location of sand dues a long the coastal area and the different soil types exists in Gaza Governorates.

Exploitation

Sand quarrying has become a big business in Gaza Governorates, since the start of the construction boom in the Mid 1994 the demand for sand " the most important building material that is locally available " has soared. The sand is also transported to Israel by the settlements. Yet, in the manner in which this business is being conducted at present, only

few profit. And it is certain that many will loose in the future. The losers will not be those who profit now, but it will be the community at large who will pay for the mistakes made in the past. Figure 2.6 shows the existing soil types in Gaza while, Figure 2.7 present a map for old and current sand querying sites.

While the built up areas expand under the construction boom, the natural areas from which the sand is excavated diminish and deteriorate. The dunes that are so characteristic for the Gaza strip disappear rapidly. Once excavations has started in a particular dune area, it takes just a few days to transfer it to low land area, mostly used for dumping of solid waste and construction waste. With this transfer a number of functions of sand dunes are lost. Protection against the sea reduces, a habitat for all sorts of wild life is lost, infiltration of rainfall (replenishment of the ground water) reduces and as a result the quality of the ground water deteriorates. And there are many hazards associated with sand quarrying most of them lead not to immediate damage but to damage in the medium and long term.

Different ministries realized the need for sand alternatives and have started counter actions. The Ministry of Housing has undertaken a comprehensive survey of existing sand quarries, and the Ministry of Planning and International co-operation has developed the Emergency Resources Protection Plan that restricts sand quarrying in certain areas and bans it in others, However, a lot of joint work and efforts has yet to be done, and should ultimately result in tow outputs.

First there should be a clear sand quarrying policy. This includes a projection of demand, an estimate of sand availability, a clear delineation of potential sand quarries. It also includes a realistic pricing system, clear regulations and an effective system of enforcement.

Second, the remaining sand resources that serve critical functions like protection against the sea, replenishment of ground water resources, bio diversity habitat and natural areas should be protected.

Figure 2.6- Map for Soil Types of Gaza.

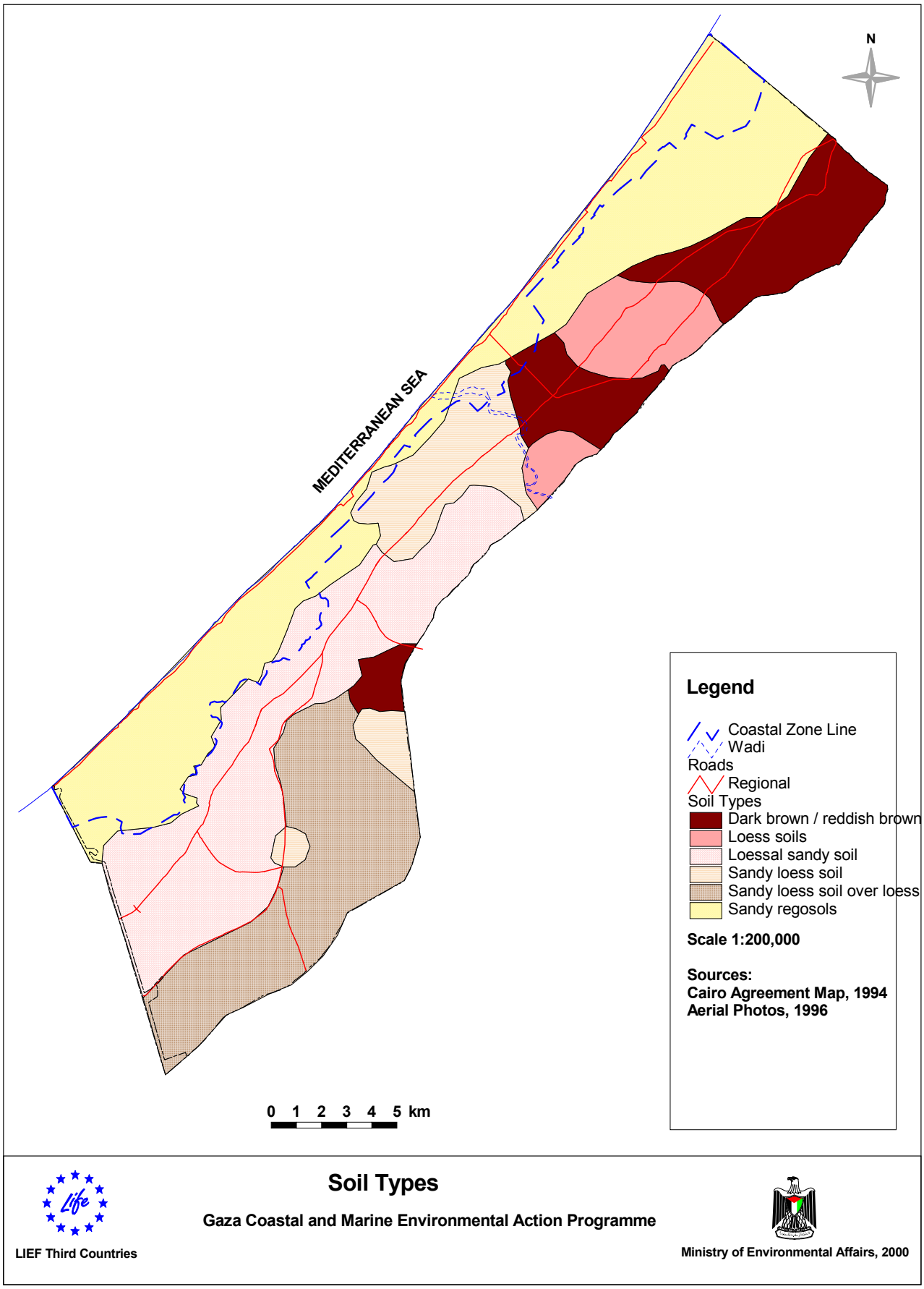
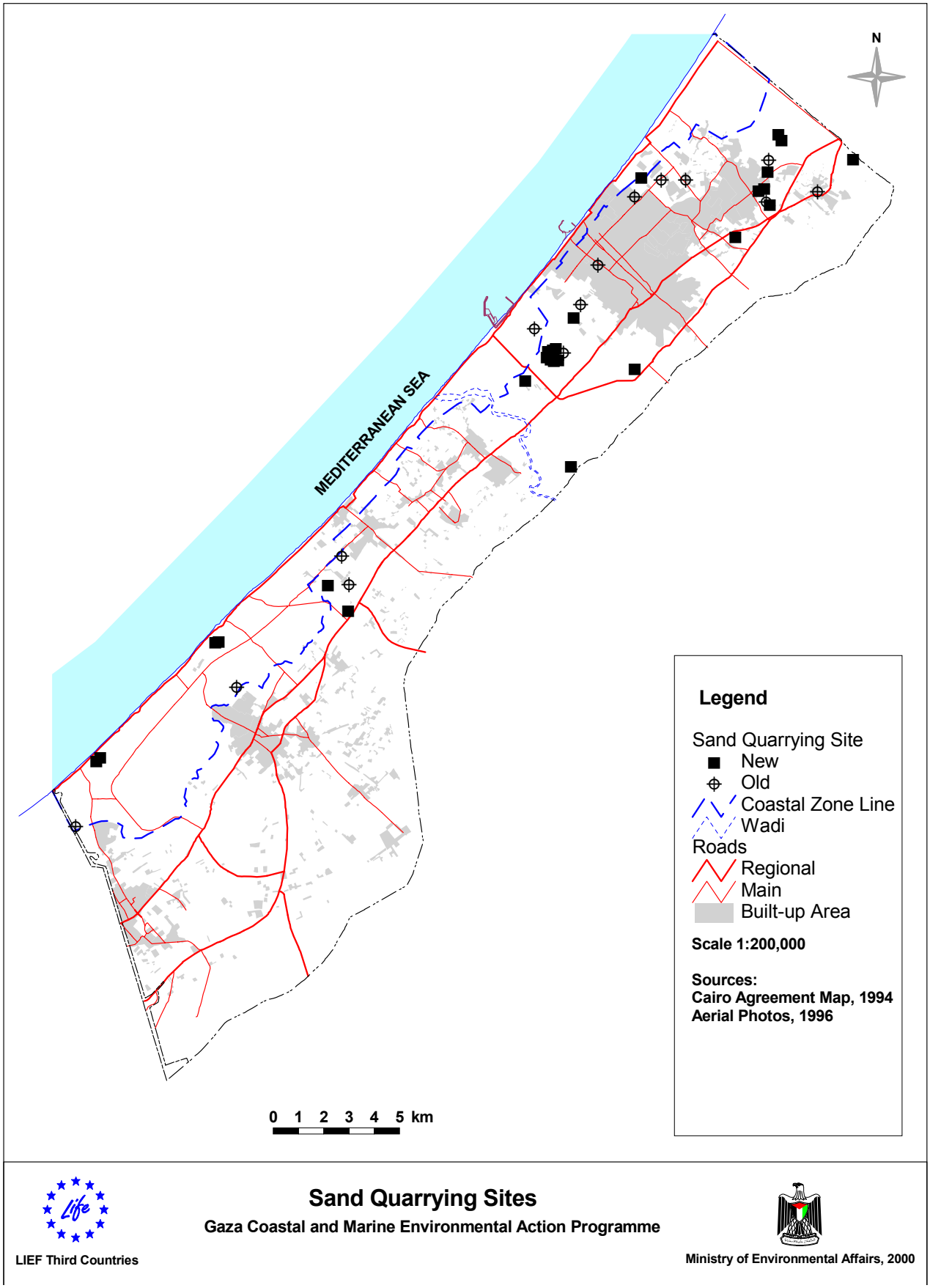


Figure 2.7- Map for the Current and Old sand Querying Sites.



2.2.1 Sand Quarrying Practices Until 1994

Sand quarrying was controlled by Israeli authorities during the occupation time, great amounts of sand was transported to Israel, Dahlan and Shami studied the records of sand quarrying department in the ministry of housing from 1972 to 1994 and came up with the following results:

The sand volumes that have been excavated for commercial reasons, and that have been registered by the Gaza Property Department during the period from 1972 until 1994 are presented in the following Table:

Table 2.1- Registered Volume of Sand Commercially Excavated, 1972 - March 1994

Period	Sand Volume (m3)
1972-1975	152,569
1976-1979	147,803
1982-1985	63,321
1986-1990	951,891
1991-March 1994	621,032
Total	1,936,616 (with a total area of 164 dunum)

Source : Calculated from : Gaza Property Department, Personal communication

These amounts have been registered. It was believed by Dahlan and Shami, that this does not cover the total amounts of sand being excavated. Especially, large amounts of sand have been excavated for reasons of levelling agricultural fields, throughout Gaza, were left out o the 'official figures'. Based on field surveys during 1994 and interviews with persons involved at various sites, an estimation has been made for the total amount of sand that has been excavated during the period from 1972 - 1994. In this regard, there are three main fields where sand exploration happened.

- sand excavation directly linked to levelling agricultural fields
- sand excavated legally from designated excavation sites
- sand excavated illegally from other spots

With regard to the final destination of the excavated sand, it was noticed that there are three main destinations had been recorded

- local use in Gaza
- export to the West Bank
- export to Israel.

The total amounts, as assessed by Dahlan and Shami for the period from 1972 - 1994 are the following table. It is believed that these figures, as well as those presented in the next tables, represent the lower boundary of the range of possible figures (least estimate)

Table 2.2- Total Volumes of Sand Quarrying per Type of Excavation (1972 - 1994)

Type of Excavation	Volume (m^3X1000)			
	Locally Used	Exported to West Bank	Exported to Israel	Total
Licenced	1,332	1,324	386	3,042
Non-Licenced	1,379	-	-	1,379
Agricultural	13,022	5,888	3,204	22,114
Grand Total	15,733	7,212	3,590	26,535
% of Total	**59.3**	**27.2**	**13.5**	**100**

Source : Dahlan & Shami - Field Survey, December 1994

Totally, an amount of 3,042,000 m^3 is believed to be excavated during this period from licensed sites. The licensed excavation sites were distributed among nine different locations in Gaza. An overview of these locations, as well as the surface area of the excavation sites and the destination of the excavated sand is given in the following table.

Table 2.3- Total Volume of Sand Excavated from Licensed Quarries (1972 - 1994)

Location	Surface Area In Dunum	Volume (m^3 x 1000)			
		Total Volume	Locally Used	Exported to West Bank	Exported to Israel
Erez	70	102	-	71.4	30.6
Eli Sinai	5	10	-	7.0	3.0
Beit Lahiya	32	116	94.5	21.5	-
El Zitoun	75	515	355.8	136.5	22.7
Netzarim	50	300	15.0	270.0	15.0
Al-Sumiri (Qatif)	128	644	164.0	240.0	240.0
Al Satr	25	250	112.5	112.5	25.0
Al Amal	48	480	265.0	195.0	20.0
Tal El Sultan	45	625	325.0	270.0	30.0
Total	**478**	**3,042**	**1,331.8**	**1,323.9**	**386.3**
% Total			**43.8**	**43.5**	**12.7**

Source : Dahlan & Shami - Field Survey, December, 1994

Totally, an amount an area of 4,760 dunum, or 22,11,000 m3 is believed to be excavated during this period for reasons of levelling agricultural fields. These fields cover Palestinian fields, but also many agricultural fields controlled the Israeli settlements. These agricultural fields were distributed among ten different locations in Gaza. An overview of these locations, the surface area of the excavation sites and the destination of the excavated sand is given in the following table.

Table 2.4- Total Volume of Sands Excavated from Agricultural Lands (1972 - 1994)

No.	Location	Surface Area in Dunum	Total Volume (m^3 x 1000)	Volume in m^3 x 1000		
				Locally Used	Exported to West Bank	Exported to Israel
1.	**Beit Lahiya**	1,290	11,194	4,510	3,725	2,959
2.	**Jabalya**	300	900	750	150	-
3.	**Gaza**	1,010	3,335	2,400	780	155
4.	**Gaza Valley**	150	300	270	30	-
5.	**Nusireat**	490	1,715	1,458	257	-
6.	**Zawaida**	400	1,000	750	250	-
7.	**Deir el Balah**	150	450	450	-	-
8.	**Khan Yunis**	450	1,220	751	469	-
9.	**Rafah**	350	700	595	70	35
10.	**Mawasi (Several areas)**	200	1,300	1,088	157	55
Total		**4,790**	**22,114**	**13,022**	**5,888**	**3,204**
% Total				**58.9**	**26.6**	**14.5**

Source : Dahlan & Shami- Field Survey, December 1994

Totally, an amount of 1,379,000 m3 is believed to be excavated illegally during this period from non-licensed, non-agricultural sites. The non-licensed excavation sites were believed to be distributed among five different locations in Gaza. An overview of these locations, as well as the surface area of the excavation sites are given in the following table.

Table 2.5- Total Volume of Sand Excavated from Non-Licensed Sand Quarries (1972 - 1994)

Location	Surface Area in Dunum	Volume in m^3 x 1000
Beit Lahiya	80	232
Jabalia-Nazla	84	420
Gaza	405	517
Khan Yunis	30	180
Rafah	5	30
Total	604	1,379

Source : Dahlan & Shami- Field Survey, December 1994

provides an overview of the total amounts of sand that has been excavated during the period from 1972 - 1994 (for agricultural reasons as well as from licensed and non-licensed sites), and their distribution among five different locations in Gaza.

Table 2.6- Total Sand Quarrying by Surface Area and Volume Excavated (1972 - 1994)

Location	Surface Area in Dunum	% Surface Area	Volume In m^3 x 1000	% Volume
Beit Lahiya & Jabalya	1,861	31.7	12,974	48.9
Gaza	1,490	25.4	4,367	16.5
Middle Zone	1,368	23.3	4,409	16.6
Khan Yunis	553	9.4	2,130	8.0
Rafah	400	6.8	1,355	5.1
Mawasi	200	3.4	1,300	4.9
Total	5,870	100	26,535	100.0

Source : Dahlan & Shami- Field Survey, December 1994

2.2.2 Clay Quarrying Practices Until 1994

The sand dunes are underlain by a layer of clay and locally limestone (kurkar). This impermeable layer acts as protection of the deeper groundwater aquifer against surface pollution sources, such as pesticides and wastewater effluents.

In some sand excavation sites, the deeper clay and limestone layers have partly been excavated as well. Clay has been generally used to improve to top layers on agricultural fields, while the limestone has been mainly used for pavements of agricultural access roads.

This practise has been undertaken largely uncontrolled. It has consequently caused potential risks for pollution of the deeper aquifer system. An overview of the totally excavated amounts of clay and kurkar during the period from 1972 - 1994, distributed over four different areas, is given in Table 2.7.

Table 2.7- Volume of Excavated Limestone and Clay (1972 - 1994)

Area	Surface Area in Dunum	Volume (m^3 x 1000)
Beit Lahiya & Jabalya	73	14
Gaza	9	25
Khan Yunis	6	18
Rafah	8	16
Total	94	132

Source : Dahlan & Shami- Field Survey, December 1994

2.2.3 Approximate Reserve of Sand Available in Gaza Governorates

A field survey was carried out by the Ministry of Industry, Natural Resources Directorate December 1995, this study was based on visual and personal inspection of the director general of natural resources in the Ministry of Industry, the results of the study are shown below,

Table 2.8- Approximate Reserve of Sand Available in Gaza and Exploitation amount

Area	Approximate Amount (m^3)	Exploitable Amount (m^3)
Khanyunis – Rafah Settlements Area	450,000,000	100,000,000
Beitlahia Area	50,000,000	5,000,000
Shikh Ejleen Area	5,000,000	500,000
Middle Area	10,000,000	1,000,000
Khanyunis-Rafah Outside Settlement Area	10,000,000	1,000,000
Total	**525,000,000**	**107,500,000**

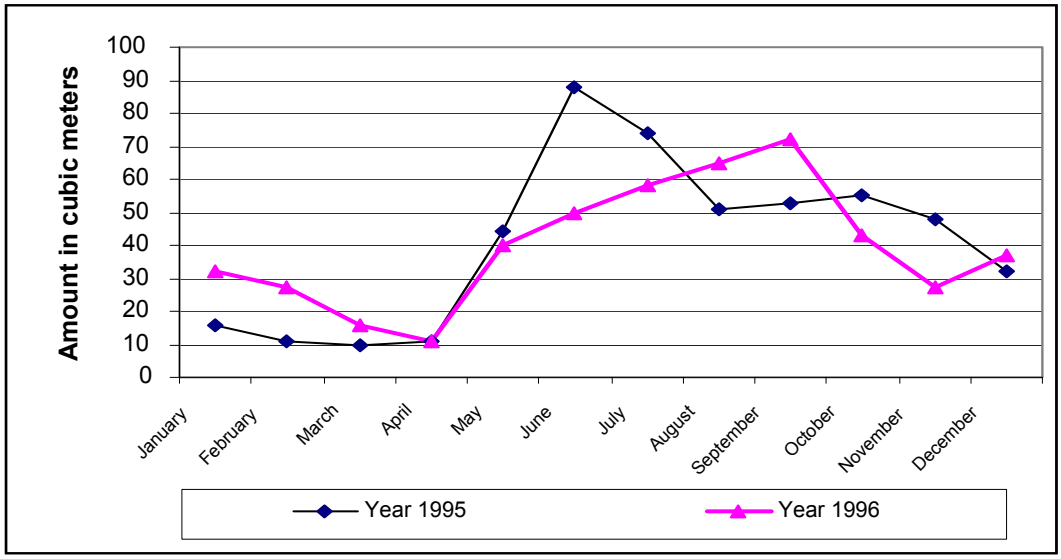
Source: Ministry of Industry, Almishal, Natural Resources Directorate, December 1995

Due to the political situation and Israeli constraints, the Palestinian Authorities Has access to Only 8 Million CM of the sand available in Gaza.

2.2.4 Sand Quarrying Practices Since 1994

By the year 1995 and directly after the Palestinian authority return to Gaza the responsibility over sand mining was put in the hands of government property department within the ministry of housing, who issued the licences for opening the new quarries. The implementation and monitoring for sand quarries was carried out by old war veteran Association. The total amount of excavated sand in the year 1995 reach to 493,000 cubic metres, while, in the year 1996 this amount decrease to reach 478,000 cubic metres. The figures below shoes the amounts of sand excavated over a year time.

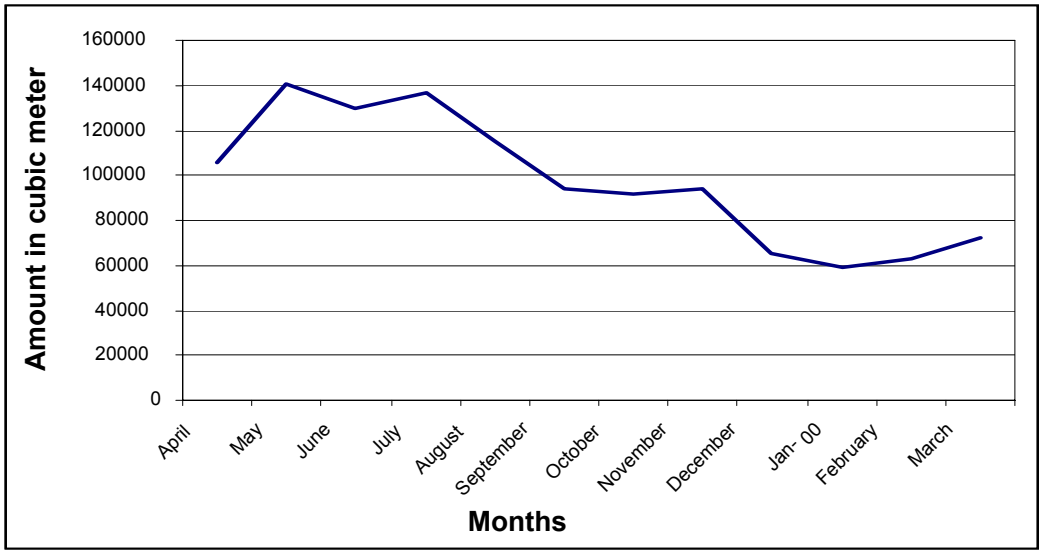
Figure 2.8- Amount of Sand Excavated in the Period from 1995 to 1996



Source: Personal calculations & Ministry of Housing

According to the presidential decree 1998 the responsibility for sand quarries transferred to the sand directorate under security forces umbrella. Sand directorate has a full control over the sand issues, however, the licensing was not given according to specific criteria. Figure 2.9 shows the amount of sand excavated in the period from April1999 to March 2000 wit a total amount of 1,165,875 cubic meters.

Figure 2.9 - Amount of Sand Excavated in the Period from April1999 to March 2000



Source: *Sand Directorate- General security*

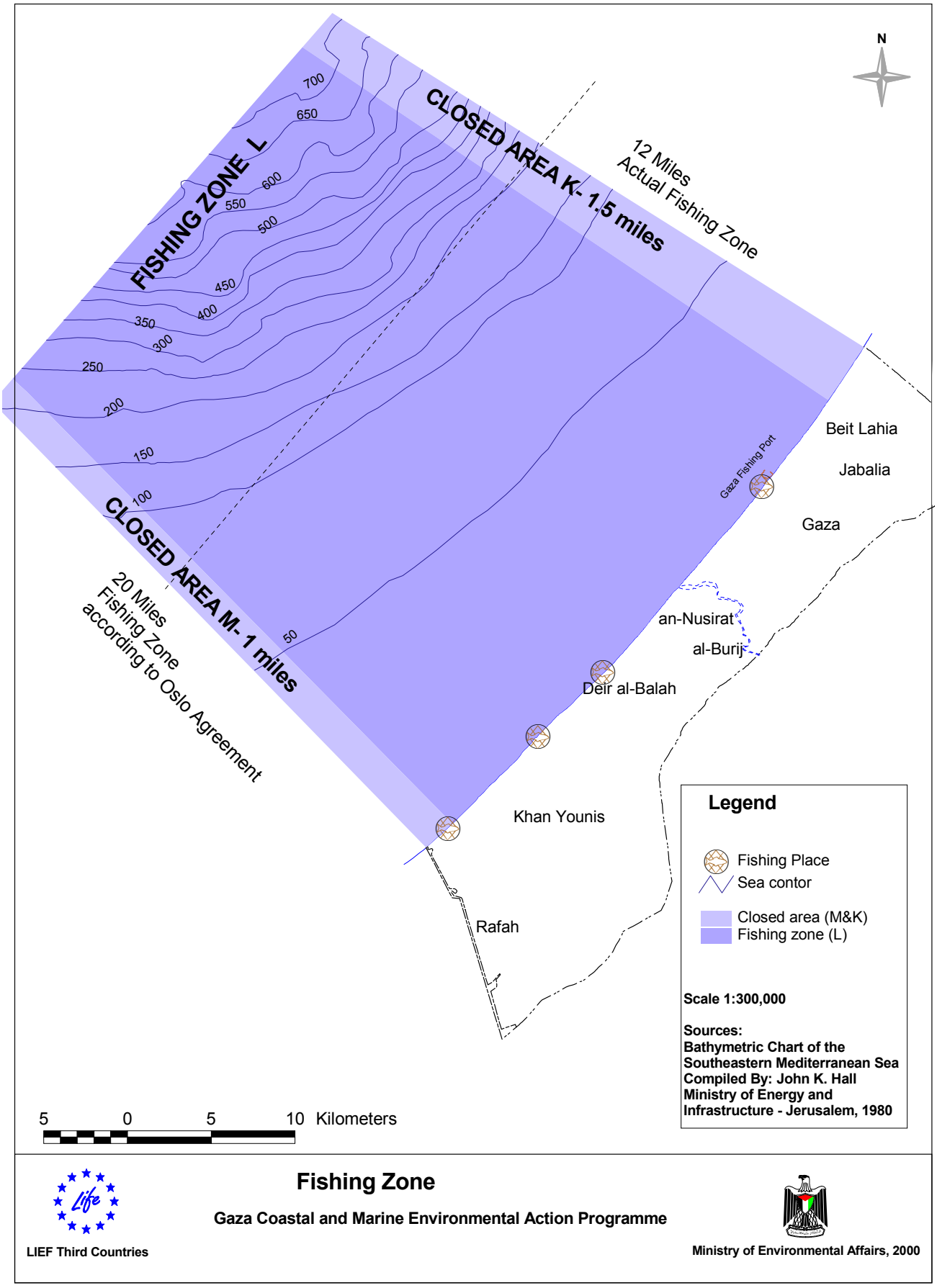
2.3 Marine and Coastal Ecosystem

2.3.1 Fish and Fisheries

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 2.2. 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 (Madi, 2000). This makes the total area where fishing is allowed about 660 km^2.

Figure 2.10: Fishing Zones of Gaza strip



Fishing Fleet

The latest survey of the fishing fleet (25 March 2000) showed that there are 723 vessels involved for a total of 2305 fishermen. The number of fishing vessels in Gaza strip is shown in Figure 2.11 for the period between 1968 to 2000. The number of fishermen and the number and types of vessels and their landing sites are presented in Table 2.9, the cost of each vessel from different types and the total value of the fishing fleet are also presented in

Figure 2.11- Number of Fishing Vessels and Fishermen from 1968-2000.

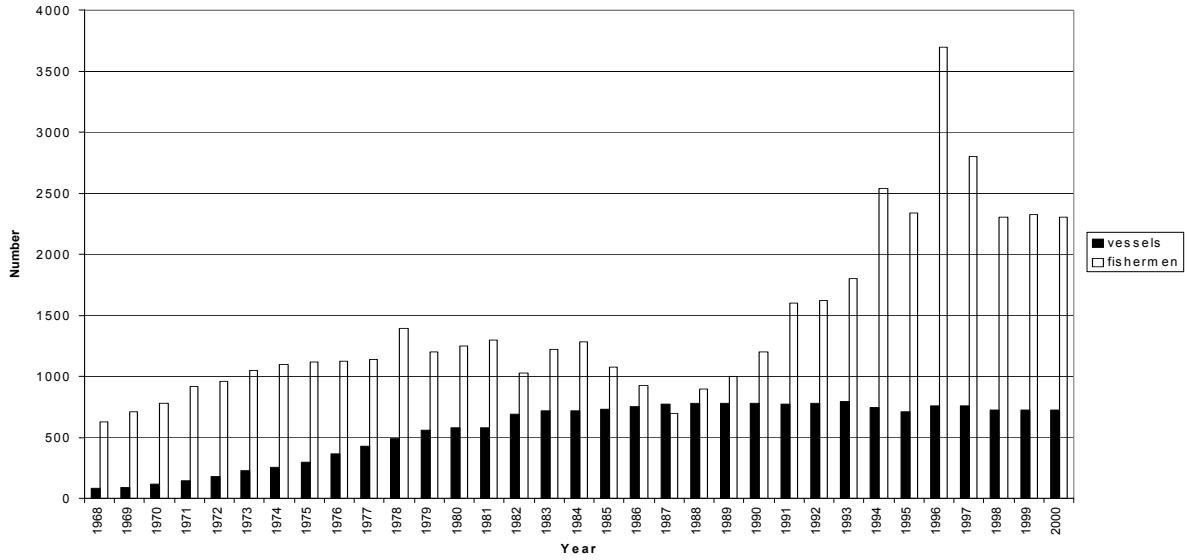


Table 2.9- Number of Fishermen and Fishing Vessels of Different Types

Type of Vessel	Gaza	Deir el-Balah	Khan Younis	Rafah	Total no.	Value of one vessel (US $)	Total value (US $)
Flouka	92	3	37	26	158	2,000	316,000
Oars hasaka	86	8	3	-	97	1,000	97,000
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 boat	4	-	-	-	4	40,000	160,000
Shanshula boat	36	-	11	8	55	40,000	2,200,000
Trawler	15	-	-	-	15	100,000	1,500,000
TOTAL	470	76	99	78	723		6,637,000
Number of fishermen	1170	327	532	276	2305	_____	_____

An unmotorised hasaka is a small vessel with a closed deck that is handled with oars by fishermen standing on the deck, the length is about 3 m. The motorised hasaka is a relatively small vessel, with a length of 5.5 to 8 m. A flouka is also a small vessel with out 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.

Fishing Methods and Fishing Gears

The fishing methods and the fishing gears of Gaza strip had been used traditionally by the fishermen of Palestine. In recent years, since 1984 and 1960, many changes have been carried out on the fishing gears and consequently on the fishing methods and technique including the type of vessels in order to meet those changes. The banned gears which had been used traditionally, are shown in Table 2.0. However, the fishing gears used by the fishermen of Gaza strip are presented in Table 2.71. The specifications and the costs are also provided.

Table 2.70- Banned Traditional Fishing gears of Palestine.

Fishing gear		Type of catch	Banned (year)
English name	**Local name**		
1- Floating trammel net.	Edit Al Bosse	Mullets	1948
2- Large hooks	El Helb	Large Sharks	1948
3- Surrounding net or Lampara	Edit Al Lux	Pelagic	1965
4- Shark gillnet.	El Mada	Sharks	1967
5- Gillnet.	El Boshlalah	Drums, Meagres	1967
6- Shallow water gillnet.	El Qata	Drums, Meagres	1967
7- Scoop baskets.	Salit El Sonnar	Help catch fish by lines	1967
8- Beach seine net	Garafah	Coastal fishes	2000

The following three main methods can be distinguished to be used for the fishing in Gaza strip:

1. Nets
2. Hooks and lines
3. Other devices

A description of these methods is provided as the following:

1. Nets

1. Bottom trawlers. Two types of bottom trawlers are used. A) Fish trawler which is used to catch demersal and benthic fish. B) Shrimp trawler which is used, mainly during the night, to catch shrimps. Semi-pelagic and midwater trawlers are not used by fishermen in the Gaza strip. Trawlers fish continuously and return once in the morning, to land the catch, get supplies and change crews.

2. Surrounding nets. Two main types of surrounding nets are used by the fishermen of Gaza these are: A) Beach purse seine, which is known as *Jarafah*, pulled by fishermen on the beach. B) Off-shore 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 epi-pelagic fish, such as flying fish and sardines. In this fishing method lights are used to attract fishes.

3. Drift net*s*. 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 fish 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 end, 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.

13 Represents different types of the fishing gears of Palestine used by the fishermen of Gaza strip, the estimated costs of the gears are included on the bases of the current prices. Local names are in parentheses.

Table 2.11- Types of the Fishing Gears of Palestine Used by the Fishermen of Gaza

Fishing gear English Name (Local Name)	History of use	Type of fish catch	Total No.	Total length (1000m)	Cost one USA$ (1000)	Total costs (1000USA$)
1-Fish Trawler (Gar)	After 1971	Benthic & epibenthic	15	Standered	1,5	22,5
2-Shrimp (Trawler)	After 1971	Shrimps	15	Standered	1,5	22,5
3-Purse seine nets (Shanshola) a-Short seine b-Long seine c-Devil seine	After 1964 = = =	Pelagic & Epipelagic = = =	238 56 120 62	56-67,8 14-19,8 42-48 27,9-42	4,5-6, 4,5-5, 5,-6, 5,-6,	852,-1,000 252,-280, 600,-720, 310,-372,
4-Beach seine net (Garafah)	Before 1948	Benthic & Pelagic	7	0.84-1.4	0.25-0.35	1,75-2,45
5-Fixed drift net (Zeda, Boshlalah)	Before 1948	Benthic, Pelagic& Epipelagic	75	45-63	1,5-1,8	157,5-189,
6- Drift net (Maltash)	Before 1948	Sardines & Flying fish	200	70-80	2,	400,
7-ShrimpTrammel net (entangling net (Monofil)	After 1967	Shrimp	40-50	9-15	0.15	6,-7,5
8-FishTrammel net (Monofil)	Before 1948	Benthic &Epibenthic	600-1000	27-45	0.15	90,-150,
9- Hand cast net (Shabaka)	Before 1948	Mullet	200-250	Standerd 2-3 radius	0.03	6,-7,5
10- Lines and Hooks (Sharak)	Before 1948	Benthic &Epibenthic	138-172 hooks	690-860	1.2dollar per a hook	165,-207,36
Total Cost						1,723.85-2,008.81

2. 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 not used by the fishermen of Gaza strip.

3. Other devices: In this report other devices are mentioned to show that certain methods are used not only by 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. This method is used by many swimmers to catch fish as a hobby. This method does not affect the fish population very much.

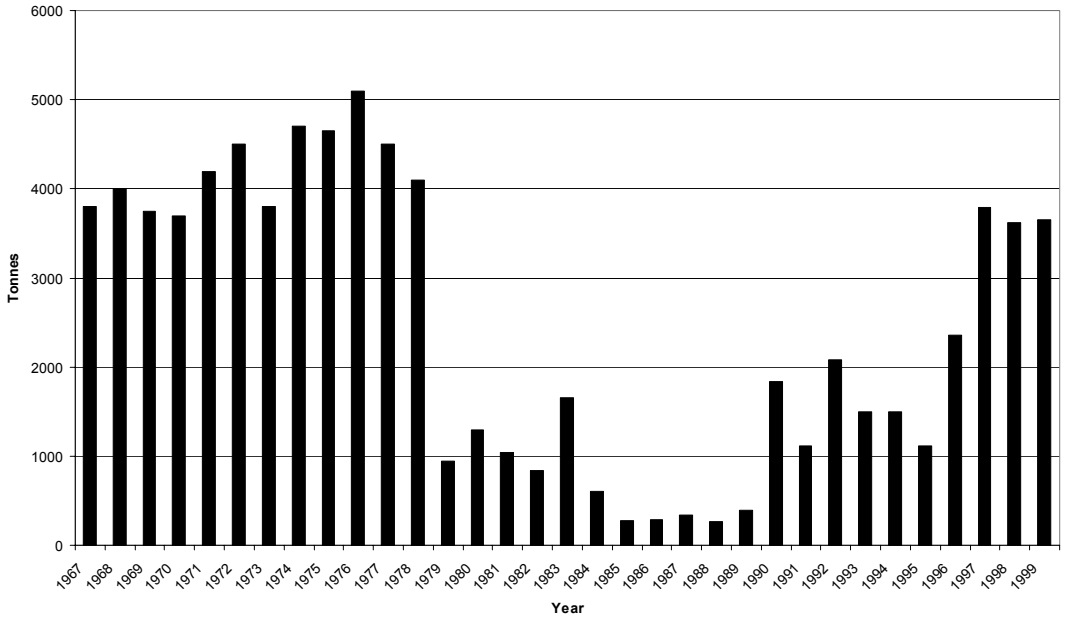
4. Rods. Rod-fishing is used on the beach as a hobby by many people.

Fish Landing Statistics

Traditionally, fisheries in the Gaza strip is a major activity of Palestinian economy. Most of the high value demersal species are exported to Israel. All pelagic landings are consumed locally, they provide an important source of protein in the diet of the Gaza strip inhabitants.

In 1996, the CARE and MA'AN projects worked to standardise fish names and train data collectors, in order to quantify correctly the fish landings of the Gaza strip. Also a database of landings by species, boat type and location was established. Since 1997, measurements of fish production have been monitored by the Department of Fisheries of the Ministry of Agriculture. Figure 2.12 shows the quantity in tons of fish landings since 1967.

Figure 2.12- Reported Fish Landings During the Period 1967-1999



Source: Madi, 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 2.12 shows that six stages can be distinguished and interpreted as following:

1) The first stage was before 1978 (Camp David Treaty), the average production was estimated 4,000 ton/year. In that period the fishing area involved both the Gaza strip and Sinai coasts (total fishing area 75.000 km^2).

2) The second stage was after 1978 when the catch dropped to approximately 1,200 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) The third stage was between (1985-1989), the total production declined severely to reach the lowest ever catch recorded of only 400 ton/year, this may be due to many factors including: the establishment of settlements across Gaza strip, the uprising situation (*intifada*), the military restrictions and by the limited fishing zone.

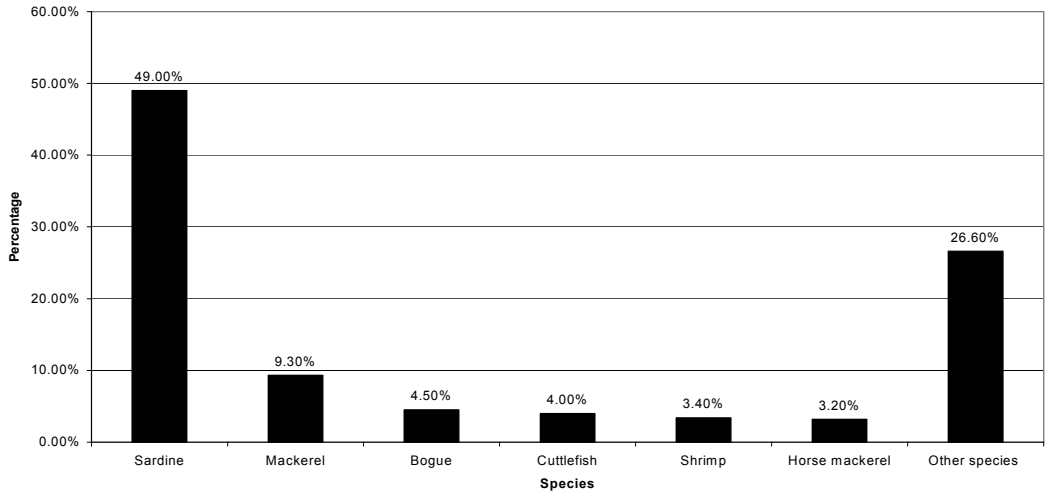
4) The fourth stage was between (1990-1992), the total production started to rise reaching 2000 ton/year. This may be due to the growing of the fish population during the previous period and also may to the settlement of the uprising during this period.

5) The fifth period was in 1994, after the Oslo agreement, the total production declined again reaching the fourth stage. This declining however may be due to the limitation of the fishing area from 20 nautical miles to 12 nautical miles (fishing area 660 km^2) and also maybe to the Israeli military restrictions.

6) The sixth stage is the most recent stage was between (1996-1999), this stage has been marked by rising production which may be due to the following factors: 1) better reporting since the Fisheries Department is responsible, 2) the use of new methods, as the hasaka shanshula fishing gear, 3) the use of new equipment the 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 shows that Sardines constitute half of the commercial catch. The most important commercial species and the percentage of the landings of 1998 are shown in Figure 2.13, cuttlefish and shrimps are also shown..

Figure 2.13- Species Composition of Commercial Fish Catches in 1998



Source: Saqr, 1999

Fish species of Gaza strip

A database of Gaza strip ichtyofauna is compiled for this study by Dr. Mahmoud Ali on the bases of different references (Whitehead, et al 1986; Campbell, 1982; Khalaf and Disi, 1997; Golani, 1996; Jennings, 1979; Wheeler, 1978). Each fish species that occurs in the waters of Gaza strip is listed with its scientific name, common English name and Arabic names. Arabic names were drawn from local names in use by the fishermen or from the translation of the English common names, when Arabic names are not available. The database includes the classes of both the Bony fishes and the Cartilaginous fishes. Each fish species is categorised according to the following measures:

- size in cm (minimum to maximum size)
- depth range in m (minimum to maximum depth)
- the status of abundance in categories 'common', 'rare' or 'very rare'
- habitat in classes 'epipelagic' (near the surface), 'pelagic' and demersal or benthic. The benthic and demersal habitats are subdivided in classes 'muddy', 'sandy', 'rocky' and 'vegetation'. Occurrence in more than one class is possible.
- additional data in classes 'migratory', 'Red Sea immigrant', 'threatened' and 'commercial' are provided in Appendix I.

A summary of the checklist of the ichthyo fauna of Gaza strip is presented in Table 2.82.

Table 2.82- Numbers of Fish Species Recorded and Presented for Different Categories.

Abundance & Status	**Categories**	**Bony fishes 163 spp.(81%)**	**Cartilaginous fishes 38 spp. (19%)**	**Total fishes 201 spp.**
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	54	2	**56**
	New observation	3	0	**3**
	New record	1	0	**1**

Abundance and Status

In Gaza strip waters 201 fish species have been recorded so far. The majority of the species are bony fishes 163 species consisting (81%) of the fish population. 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

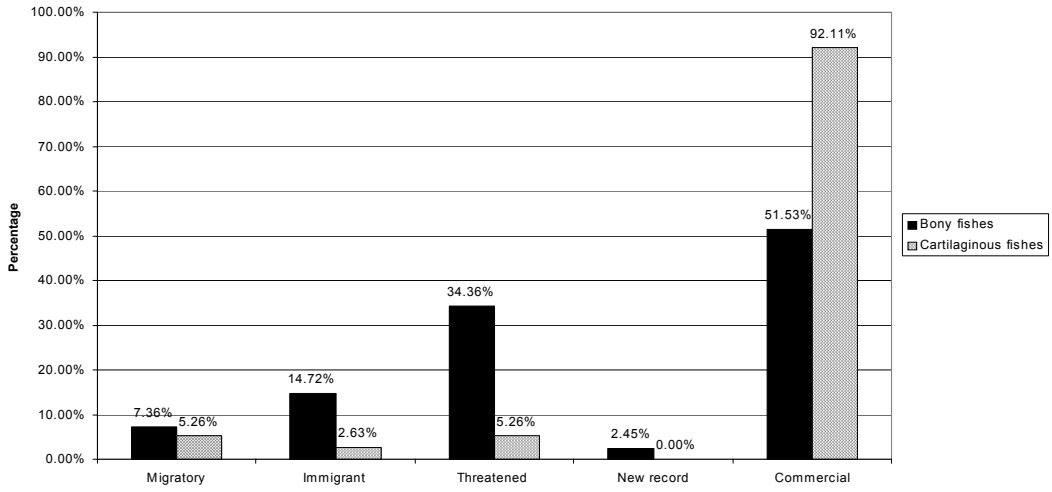
Bony fishes are immigrants from the Red Sea, Figure 2.6, among them four new species have been recorded in Gaza strip waters. The new record of one specimen, the Painted sweetlip (*Diagramma pictum*), may be the evidence of a continuous newly immigrant for the Mediterranean Sea. The increasing number of reported species from different areas in the eastern Levant of the Mediterranean sea (Golani, 1996) is an evidence of this immigration. In Gaza strip, after the removal of the sea shore rocks, the most important fish habitat, and the sea pollution it was found that about a third of the bony fishes are considered under serious environmental threats, this also may be due to that of various environmental problems of the Mediterranean sea. The over fishing, by using small mesh size and increasing efforts in addition to illegal fishing, as the use of poisons, may be anther factor of the threats.

The presence of cartilaginous fishes as sharks, rays and other forms is 19% of the observed fish fauna. Of these fishes 66% is common, 24% is rare and 10% is very rare. Of the cartilaginous fishes it is found that 5.3% are migratory and 2.6% are immigrants (Figure 2.14). It is found that 5.3% of the cartilaginous fishes are threatened which may be due to that of the previous factors.

Of the total ichtyofauna (bony and cartilaginous) of Gaza, 58% is common, 34% is rare and 8.5% is very rare. About 7% is 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 2.14: The Present Status of the Bony and Cartilaginous Fishes of Gaza Strip.

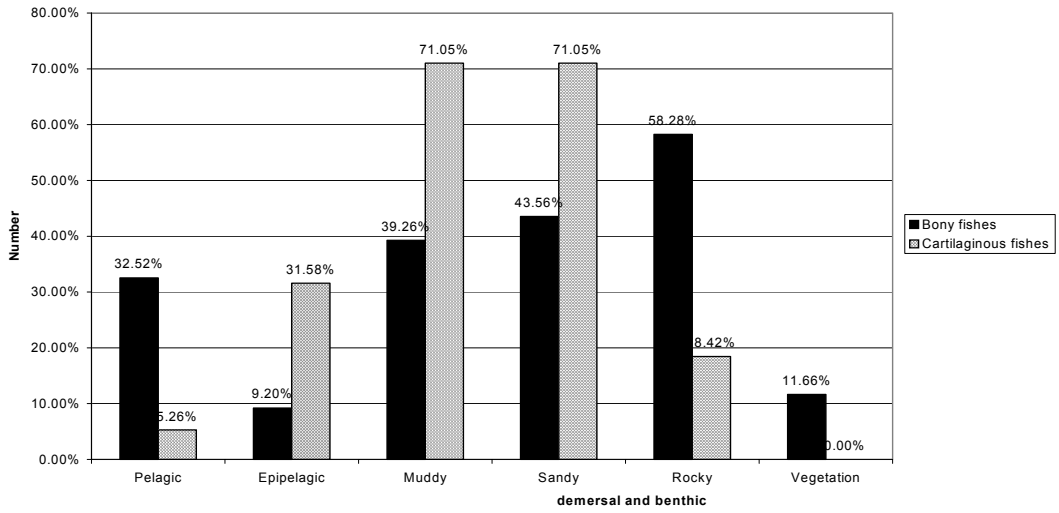


Habitats

The fish of Gaza strip distribute in different types of habitats. 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 of different habitats.

Figure 2.15 shows that the most important habitat for the Bony fishes of Gaza strip is the rocky substrate, while the majority of the cartilaginous fishes use the soft bottoms, muddy and sandy substrates. It is obvious from that the sea bed of Gaza strip is dominant by the sand and mud. 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, different species of fishes become under severe marine environmental pressure.

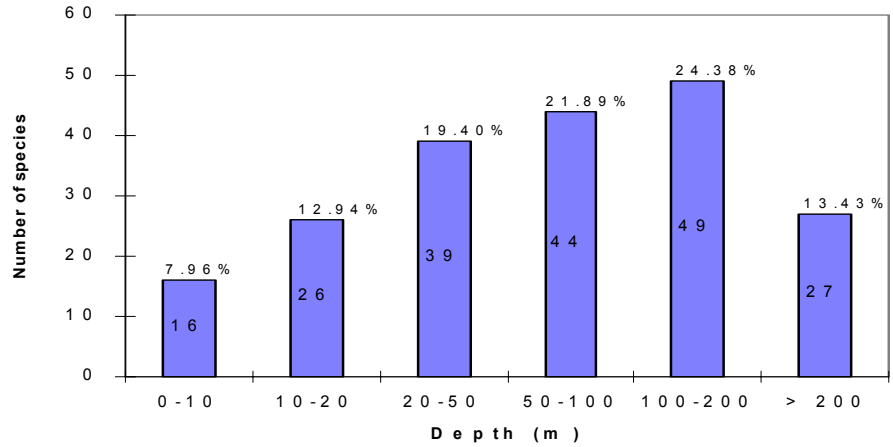
Figure 2.15- The Distribution of the Fishes of Gaza strip at Different Habitats.



Depth Distribution

The fishes of Gaza strip are distributed according the depth of habitats as shown in Figure 2.16. The figure shows that between 20 and 200 metres most of the fish are found, in particular the highest rate of abundance is between 100 and 200 metres, where the abundance of fish in deep waters (>200 metres) becomes declining. The marine area of Gaza strip between 20 and 200 metres is the zone of most of the fishing activities, where the fish become under severe pressure particularly the small and fry fish.

Figure 2.16: Distribution Over Depth of the Fish of Gaza strip.



2.3.2 Marine Flora and Fauna

Specific information or literature on marine flora and fauna of Gaza strip of Palestine, except of fishes, appears to be very scarce. In this study the available species of the flora and fauna were identified on the bases of the previous work of many workers (Ben-Eliahu & Por, 1994; Barrett and Yonge, 1980; Campbell, 1982; Golani, 1996 and the publication of Hebrew University, 1971).

Marine and Coastal Flora

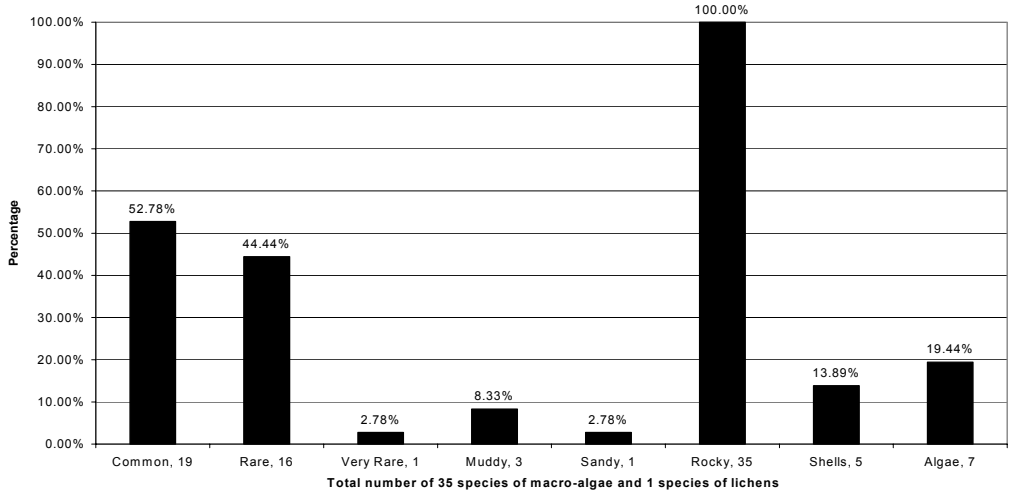
Gaza Environmental Profile (1994) gave an overview of the vegetation types of the coastal zone of Gaza strip, although data base is not provided. In the present study a flora database of marine macro-algae has been compiled by Dr. Mahmoud Ali on the bases of the data which was presented by many workers (Barrett and Yonge, 1980 and Campbell, 1982).

Each 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. Moreover each species is categorised according to the following categories:

- size in cm (minimum to maximum size).
- depth range in m (minimum to maximum depth).
- the status of abundance in categories 'common', 'rare' or 'very rare'.
- habitat in classes 'muddy bottom', 'sandy bottom', 'rocky bottom', 'on shells' and 'on other algae'. Occurrence in more than one class is possible.
- additional data include the status for 'threatened'.

Sea grass species are not present in the sea of Gaza strip, because the sea bed of this area is not sheltered and the rocks of the sea bed are covered by the sand at least during Winter where the water current appears to be strong enough to prevent the weed's growth, despite the nature of the sea bed is suitable for their growth. Figure 2.17 shows an overview of the data for marine macro-algae and lichens.

Figure 2.17. The Status of Marine Algae and Lichens of Gaza Strip, Palestine, 2000.



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

The tropical, toxic, green macro-algae the *Caulerpa taxifolia* from the Caribbean has not been recorded among the algae of Gaza strip. Some researchers believe that the coastal habitats of the eastern Mediterranean are less vulnerable than to the northern and western parts, despite the thermal conditions in the eastern part is favourable to accelerate its spreading (Medwaves, 1997). This algae demonstrates dominance, toxicity, occupation of all sublittoral biotopes, absence or scarcity of predators and longevity are also observed.

Macrobenthos

Many species of macrobenthos have been identified in the coastal zone of Gaza strip up to a depth of 80 metres. 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.*
- *Patella coerulea*

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. monocerus* and the swimming crab *Charybdis longicollis* (Gaza Environmental Profile, 1994). Numerous fish species of the Eastern Mediterranean, including Gaza strip, are immigrants (Golani, 1996).

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, but regular sightings at sea are reported by fishermen (Department of Fisheries, pers. comm. 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 stop-over on the flyway of many birds. Gaza Environmental Profile (1994) provides an overview of the birds of Gaza strip.

The conclusion from the above results would suggest that each subject of the flora and of the fauna of Gaza strip needs further research and detailed study.

Sea Water Quality

Afifi (1999) describes the results of a nine month monitoring campaign of 17 sampling sites along the Gaza coast. Samples were evaluated chemically for biological oxygen demand, dissolved oxygen, total nitrogen and total inorganic phosphorus and microbiologically for faecal coliforms, streptococci and salmonella. Results showed large numbers of microorganisms in the sea water, dependent on the distance to the outfall and seasonal variations (highest numbers in January and February). A peak counting of faecal streptococcus was measured on 23 February 1999 of 233000 per 100 ml for a discharge location north of Gaza City. The bathing water quality prescribes a counting of less than 2000 per 100 ml. The measured biological oxygen demand is high, up to 22 mg/l, and the dissolved oxygen content is therefore likely to be low, indeed as low as 4.1 mg/l, at a water temperature of around 30 degrees Celsius. Dissolved oxygen did not reach concentrations above 9 mg/l for all measuring locations and is usually around 5 mg/l. A dissolved oxygen concentration of less than 5 mg/l is not healthy for most marine fauna. Orthophosphorus concentrations showed a maximum of 0.436 mg/l, so a lot of nutrients enter the sea.

The Gaza Municipality currently monitors the sea water quality on a monthly basis. The locations of the wastewater outfalls along the coastline of Gaza strip are shown in Figure 2.20.

2.3.3 Current Projects and Activities

The activities and the projects that are currently undertaken in the fields of marine and coastal environmental protection are listed below:

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

- Wadi Gaza protection project, GEF

3 Pressures and impacts on the Coastal and Marine Environment

This Chapter provides a description of the 'driving forces' which are in general events and actions that cause negative impacts ('pressures') on the 'undisturbed status' of the beach and the coastline. Before discussing the various 'pressures' for the particular case of the Gaza coastline, the following remarks were made.

- When we discuss the 'undisturbed status' we refer to the situation of the Gaza coastline before 1950.

- From the description in Chapter 2 it may have become clear that the coastline is considered to be 'a living process', and not an entity with stability status. A basic characteristic of the coastline is precisely the fact that it is the delicate and ever changing result of a more or less balanced set of dynamic processes involving water and sediment motion. These processes may have their origin hundreds of kilometres away. If 'something man-made' interferes somewhere in between the source and the area of interest, then it is sometimes very difficult to pinpoint the exact cause.

- As a consequence it is sometimes useful but not always possible to make a distinction between natural and man-made driving forces. In addition a distinction may be used between 'local' and 'distant' driving forces, or 'direct' and 'indirect' driving forces. To a certain extent these distinctions are sometimes arbitrary, but this is not really a problem. The most important thing to keep in mind is that we work in a very dynamic environment, in which every human interference will kick back.

3.1 Coastal Erosion

There are two main pressures on the beach coastline, Interruption of the longshore sediment transport and Near-coast and cliff-top land use. These two pressures are described below:

3.1.1 Interruption of the Longshore Sediment Transport

Aswan Dam, Egypt

Construction of the Low Aswan Dam (1902) and High Aswan Dam (1964) has almost completely interrupted the Nile River sediment discharge to the sea. Fortunately for Gaza, the Bardawil Lagoon sandbar (halfway between Port Said and Gaza) continues to act as a significant source and supplier of sand to the Gaza coast. As a consequence, any measures to prevent the current erosion at Bardawil could seriously affect the sand supply to the Gaza coast.

El Arish, Egypt

A particular kind of sediment transport interruption can occur due to purely natural conditions, as the next example shows. Between Bardawil Lagoon and Gaza, the Wadi El Arish debouches in the sea near El Arish. After one of the rare floods a small delta can be

produced by this wadi. Usually this delta disappears during the subsequent dry winters. According to Nir, 1982:"This region (east of Wadi El Arish) was severely eroded subsequent of the large river flood of 1975. The 'over-night' deposition of a huge delta that protruded about 500 m into the water, interrupted the regular West to East longshore sediment transport, causing a severe coastal erosion on the East Side".

Along the coast of El Arish a series of groins have been built to mitigate local shoreline erosion. These groins themselves form an obstruction to the overall West-East sediment transport. As these groins are not very long, they will enable a part of the sand to pass. Only a very long extending breakwater might, on the long run, jeopardise the ongoing sand transport from El Arish to Gaza. In this respect it is strongly advised to keep in close contact with Egypt (Coastal Research Institute in Alexandria) concerning possible coastline related developments at El Arish.

Fishing Wharves (1968)

On the sea front of Gaza City particularly at the Beach Camp there are two low concrete groins (or fishing wharves) which had been built in 1968. The objectives of their built was to serve fishing vessels. These structures have a total length of 120 m (measured from the toe of the cliff), and protruded some 40 m into the sea (Witteveen + Bos, 1998; Italconsult, 1994). They are 500 m apart. These coastal structures act as barriers to the longshore sediment transport. In the early 70's it was necessary to defend the coast north of these two wharves (or groins) in order to control the erosion of the shoreline, and to protect hotels located on the cliff. This coastal defence consisted of a linear row of rock armour present on the beach around MSL over a length of approximately 800 m. An aerial photography was conducted in 1976 and 1984, and it was evident that the shore to the southern side of the two groins was widened by 16 m, and the northern shore (north of the protective row of rock armour) was eroded by 35 m for an additional length of 750 m.

At present, this rock armour does not form a continuous defence structure anymore. At irregular intervals it contains sometimes wide gaps, with pools formed behind the smaller gaps. At other locations the only remainders are flattened, submerged patches of rubble, which nevertheless still provide some protection. At about 700 m to the north of the old northern groin, just three separate pieces of breakwater, each some 100 m long, remain, with deeply indented semi-circular beaches at the landward side. These may look like a deliberately designed system of detached parallel breakwaters, connected with tombolos to the land. However this is not the case. The 'tombolos' are all that is left of the original beach, which apparently was some 45 m wide at the moment it was protected by an ongoing rock revetment which was later gradually disrupted.

Based on the long term negative experience with the erosion of the coastline along Beach Camp, and in addition since it was (rightly) expected that the Fishing Port (see below) would unfavourably affect the shore in front of Beach Camp, in 1998 a detailed design was made to protect the shoreline of Beach Camp. This design could build on an earlier protection study (Italconsult, 1994). The updated coastal protection plan consists of a system of a row of groins combined with local cliff protection along a stretch of about 1.6 km N of the Fishing Port, including an archaeologically interesting site with an old harbour at the north corner of the Beach Camp (Haskoning and Team Palestine, 1998).

Gaza shoreline erosion just North of the fishing wharves, along the entire sea front of Beach Camp, has strongly increased between October 1995 and October 1996 as aerial photographs show. Coastal erosion was further increased after natural beach rock, originally present in ridges under and above the water near the shoreline, was removed to be used for building the Fishing Port. This practice was terminated on behalf of the Steering Group to the Beach Camp Shore Protection Plan, consisting of the Mayor of Gaza Municipality, a representative of MOPIC, and representative of UNRWA.

From personal observations the strong impression is that not only the beach has eroded, but also the foreshore is deepening along the shoreline over the first km N of the fishing port. Large breaking waves, up to 1.5 m high at plunge point, break sometimes very close to the shore, at perhaps 50 m distance. This occurs especially in front of the remaining three pieces of parallel breakwater, but not only there. This would mean that the local depth is some 3 m at that location. Both the unbalance of sand supply, and the strong wave reflection against the breakwaters and other revetments are the cause of this deepening effect. This might lead to severe damage during the next winter season if implementation of the protective work is further delayed.

Fishing Port (1998)

In 1997 the construction of a Fishing Port was started, and in 1998 its main (S) breakwater was constructed into the sea. This breakwater starts on a location right in between the two old fishing wharves, and after a 90 degree bend its seaward limit reaches to about 450 m seaward of the tip of the old groin, which is 500 m from the old shoreline, where the original water depth was some 8 m. The Fishing Port's shorter north groin is situated 240 m N of the old northern fishing wharf. The old northern groin now sits within the Fishing Port area, next to a sewage outfall draining black effluent in the stagnant port basin.

At the southern side of the Fishing Port there are clear signs of strong sand accumulation (as is expected, due to the South to North longshore sand transport). However it is difficult to assess the rate of accumulation now, because in the meantime much construction work has been carried out in that corner. This is quite unfortunate, since this would have been a rare opportunity to determine rather exactly the actual rate of longshore sand transport along the coastline of Gaza. It is nevertheless strongly recommended to assess the local rate of sand accumulation as good as possible. Also there are signs that the accumulated sand is partly removed from the coastal system, which should be stopped immediately.

Gaza Sea Port

Plans for the Gaza Sea Port (GSP) have been developed by the Palestine National Authority (PNA) a long time ago. The selection of its best location, the functional and structural design, and its Environmental Impacts have been laid down in a number of reports since 1994, e.g. Delft Hydraulics, 1994; Witteveen + Bos and Team Palestine, 1996; Witteveen + Bos, 1998.

According to the Basic Engineering Study (BES), the GSP will be located on the coastal section between Wadi Gaza and Gaza City, on location IVA. This coastal section with relatively wide beaches fronting sand and kurkar cliffs has a total length of 5.25 kms. The GSP itself will occupy a coast length of some 2.5 kms.

The GSP's outer breakwater, which will be constructed in phases, will have an alignment similar to that of the Fishing Port. It will extend more seaward however, and its seaward tip will have a distance of between 1100 and 1200 m from the shore, where the water depth at present is 12 m, which is 1.5 times as deep as the breakwater of the Fishing Port. Thus, the GSP breakwater will virtually completely interrupt the existing S to N longshore sediment transport, which mainly takes place in a zone between the shoreline and a depth of 10 m.

The effects of this interruption on shoreline dynamics will be significant. S of the GSP the beach will accrete, whereas to the N erosion will take place. Both effects have adverse impacts, if nothing is done to mitigate this. Accretion in the south will probably over time adversely interfere with the outflow mode of Wadi Gaza. Erosion will intensify the already existing severe coastal erosion N of the Fishing Port, and the present eroding area will expand to the north. Therefore, plans have been proposed by the GSP design team to 'by-pass' the blocked sand around the GSP, which in principle is a good intervention to address these problems. However, in view of the local history there is no guarantee that the badly needed mitigating measures are well in place before the construction of the breakwater starts. Moreover, since the sand by-pass concepts were already designed before the Fishing Port was constructed, it is strongly recommended to critically review and update the by-pass design. Also, it seems necessary to critically reviewing the UNRWA protection plans as mentioned above, since the part of the coastline to be protected by the UNRWA plan will be directly affected by the by-pass plan.

Scattered Groins and Other Structures on and Near the Beach

A large number of small-scale structures, scattered along the entire coastline of the Gaza Strip, have been constructed, some of them very recently. These include groins, fences, concrete and wooden beach cabins, concrete stairs on cliff slopes, beach watch towers, sea walls, etc.

Restaurants, hotels, and other users, both private and public, have built for example small fences and groins, either to fence off their 'claimed' sector of beach against unwanted visitors, or to protect their property against erosion. An example of this last category can be found at Al Waha hotel near the N border. They have built, endorsed by high-level authorities, a 100 m long array of beach bungalows right on the active shoreline. Around November 1999 these were attacked by waves. Then a concrete sea wall was built, which actually acerbates the situation because waves reflect against this vertical wall and start deepening the adjacent seabed, etc. Also, a 40m long groin was placed, made of construction rubble. Not only is this very bad from a landscaping point of view, but it will aggravate the situation during northerly waves as well. In addition, it will cause erosion to the adjacent beach to the north of the hotel. Altogether this near-coast development is a very bad example to the public of Gaza of how to manage the coastline with respect to the environment.

Since no complete list of these small-scale structures was yet available, the team members conducted a first inventory, which .is presented below.

Preliminary inventory of scattered beach structures violating the 100 m set-back line (going from N to S)

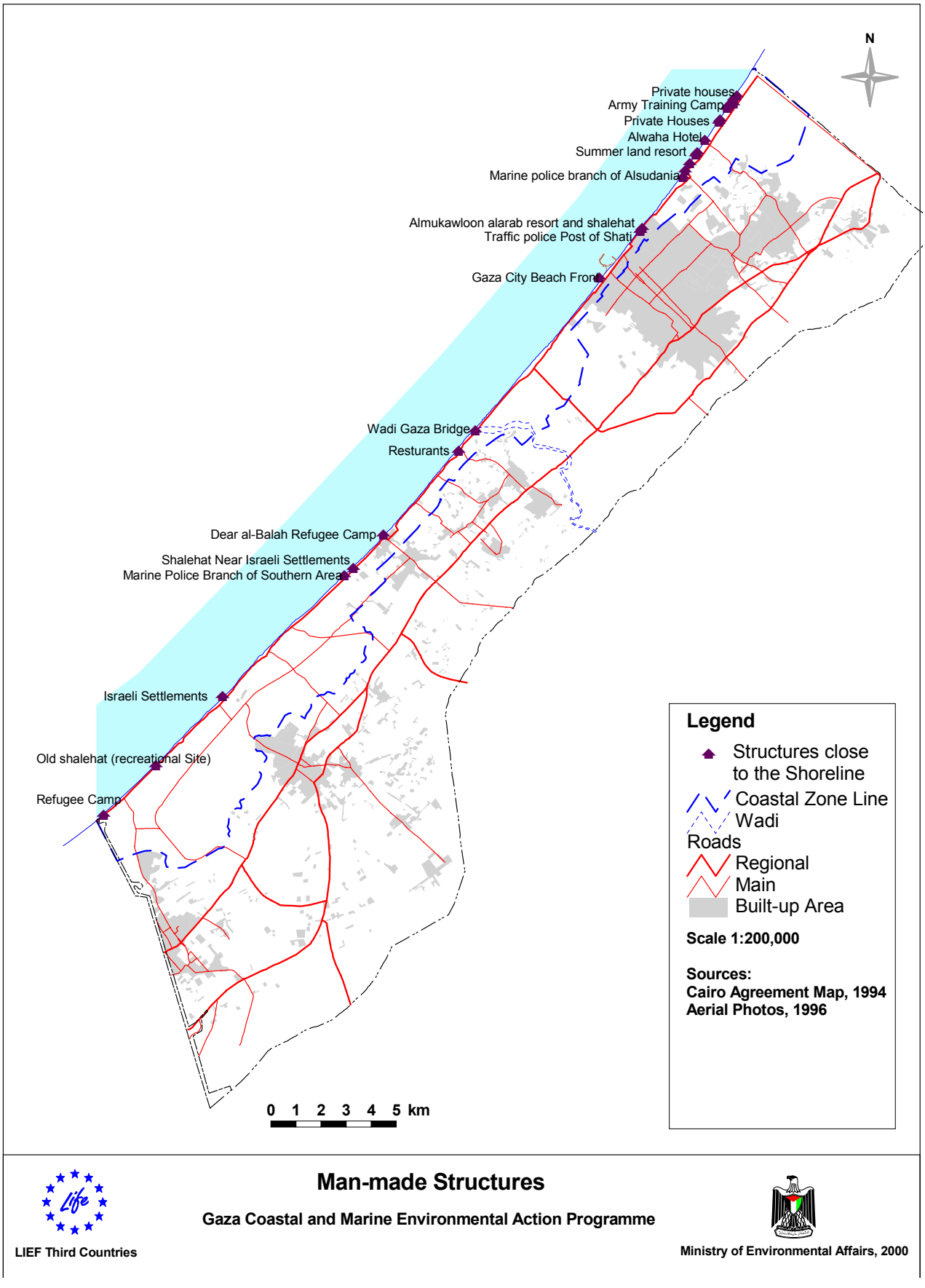
No.	Item	Government/Private

1	Youth permanent camping centre	G
2	Army training camps (3)	G
3	Private summer houses (3)	P
4	Alwaha hotels	P
5	Summer land resort	P
6	Marine headquarters	G
7	Marine police branch of Alsudania	G
8	Traffic police post of Jabalia beach	G
9	Almukawloon Alarab resort ans Shalehat	P
10	Houses of refugees living in Shati camp	P
11	Traffic police post of Shati beach	G
12	Gaza city beach front, west of the road (buildings and hotels)	P
13	Wadi Gaza bridge	G
14	Restaurants south of Wadi Gaza (3)	P
15	Marine police branch of Southern area	G
16	Houses of refugees living in Derelballah camp	P
17	Shalehat near the Israeli settlements	G
18	Israeli settlements on the Khanyounis beaches	P
19	Old Shalehat between Khanyounis and Raffah	G
20	Houses of refugees living in Raffah beach camp	P

G- Governmental

P- Private

Figure 3.1: Man-Made Structures Close to the Seashore



Near-Coast and Cliff-top Land Use

As shown in the previous Sections, the shoreline is a dynamic environment. This comprises a sandy belt which includes the following units, going from sea to the land:

1. the deep water range, until say MSL - 15 m
2. the surf zone and the associated seabed, sometimes featuring sand bars
3. the intertidal zone (the 'wet beach'), between low and high water level
4. the higher beach (the 'dry beach')
5. the dune face or cliff slope, depending on the location
6. the near-coast dune body or cliff platform
7. the inland part of the dunes and kurkar formations.

Of these, units 2) through 6) form the most mobile part of the coast. This mobility stems in the first place from purely natural mechanisms and processes as described before. Secondly, this is the zone where any human interference, especially the 'upstream' interruption of the longshore sediment transport, is working out as erosion of the beach and consequently as recession of the entire coastline.

Building amidst this dynamic area is asking for problems. Not only will the sea gradually and sometimes suddenly erode the beach away, causing big trouble for everything standing in its way, but the very construction activities and excavations for all kinds of structures near and on the cliff tops will dramatically weaken the natural defence line of this coast. In addition, archaeologically interesting sites might be damaged or even demolished due to haphazard construction work in the beach and cliff area. Also, these many scattered structures in general negatively affect the landscape amenity.

3.1.2 Summary of Pressures and Impacts

Based on the previous analysis, pressures and impacts on the coastline may be grouped in three major categories, as follows.

Sea Level Rise Causes Increasing Coastal Erosion

At present the atonomous rate of sea level rise is 1.5 mm/yr. This causes a very gradual retreat of the coastlines world-wide. It is assumed that in Gaza the natural rate of horizontal retreat of the coast where it is dominated by kurkar cliffs is similar as in Israel, at some 3 tot 4 cm/yr, or 3 to 4 m per century.

According to the expectations of the IPPC, an acceleration must be expected to about 7 mm/yr in the course of the next 100 years, i.e.5 times as much as at present. The resulting sea level will be about 0.50 m higher after 100 yrs. It is difficult to estimate the resulting increase in horizontal retreat of the coastline. This will much depend on the erodibility, so on the particular characteristics of the eroding cliff face, on which hardly any research has been done in Gaza. If the rate of horizontal retreat will also be 5 times as fast, it will be 15 to 20 cm per year, or 15 to 20 m per century.

Ports and groins interrupt longshore sand transport and cause downdrift erosion

Apart from the desastrous practice of beach mining (which is assumed to be completely stopped by now), by far the greatest pressure on the coastline comes from the man-made interruption of the longshore sediment transport, mainly caused by groins, ports and breakwaters. The effect is seen as beach accumulation on the updrift (south) side of the particular structure, and beach/cliff erosion on the downdrift (north) side.

Downdrift erosion is felt as a problem. because the eroded coast is in many instances intensively used by man, certainly in one of the most densely populated areas of the world, the Gaza Strip. Land loss because of downdrift erosion is an ongoing process and may be quite substantial in the long run as has been shown by model computations for the Gaza Sea Port. Although downdrift erosion may be effectively combatted using different techniques, this costs money on an ever ongoing yearly basis, and thus goes at the expense of alternative investment opportunities. Also, coastal erosion mitigation measures have adverse environmental effects.

Building Close to the Shore Causes Problems

No matter which is the cause of coastal erosion, world-wide experience has shown that it is wise to stay well clear of the coastline wherever there is an option to do so. Governmental and privately owned establishments close to the shoreline run the risk of being jeopardised by the sea. This risk could at first sight be regarded as being of their particular (private) concern only. However, building close to the shoreline has a number of disadvantages:

- Structures built in the dynamic zone of the shoreline cause weakening of the natural line of defence against the sea, consisting of the beach, the dune face, and the cliff slope. These are damaged or even completely demolished in the building process;
- Structures built at and near the coastline may negatively affect the natural landscape amenity;
- Likewise, such structures may cause damage sites of archaeological interest;
- When attacked by the sea, either during a single storm or during a long-term process of ongoing downdrift erosion, protective measures (groins, breakwaters, revetments) tend to be taken, which generally cause a lot of additional damage to a greater coastline area due to the associated and almost unavoidable process of downdrift erosion.

3.2 Sand Exploitation

This Section provides a description of the driving forces that cause negative impacts (pressures) on the sand resources and related environmental values. The following table summarises the driving forces, pressures and associated impacts on the environment.

Driving Forces	Pressures	Impacts
construction of buildings and roads in Gaza, the West Bank, settlements and Israel	excavation of the top sand layers, largely illegal and unlicensed.	Flora (Acacia) has been removed from most of the sand dunes.
need for agricultural fields, also at the settlements	excavation and leveling of agricultural fields	Large area of these dunes has been levelled out and used for Israeli Settlements.
need to improve quality of agricultural top-layers, need to construct agricultural access roads	excavation of deeper layers of clay and Kurkar	Temporary nomadic settlements could be collapsed as a result of unlicensed removal of sands north of Gaza beach camp and close to Jabalya.
industrial sector Israeli (hazardous) waste producers	dumping of solid, industrial and hazardous waste in sand quarries	Severe pollution may occur to the underground water as a result of uncontrolled quarrying of Kurkar and clay especially in area such as Beit Lahia, Gaza and Khan Younis.
domestic sector	discharge of waste water in open sand quarries	pollution of the aquifer system, migration of pollutants into the environment, exposure to dangerous substances by local people..
Need of sand for construction and acquiring land for housing projects	Excavation of sand dunes for sand mining and migration of nomadic settlements	Temporary nomadic settlements could be collapsed as a result of unlicensed removal of sands north of Gaza beach camp and close to Jabalya.
Need of sand for construction and acquiring land for housing projects	Excavation of sand dunes for sand mining	Possible destruction of archeological and historic monuments might occur.
domestic sector	discharge of waste water in open sand quarries	Public health hazard may happen due to pumping sewage in the allocated sites for sand quarrying as in north of Al-Amal quarter in Khan Younis and in Jabalya-Nazlah.
Need of sand for construction and acquiring land for housing projects	Excavation of sand from beaches and cliffs	Coastal roads may be destroyed as a result of unlicensed quarrying of sand and erosion.
Need of sand for construction and clay sub layers for land reclamation	Leveling of dune landscape and lowering its surface	Sea water intrusion could happen as a consequence of changing the topography of the Gaza Strip and lowering its surface.

The major environmental problems related to sand quarrying could be summarised into the following points:

- Sand quarrying in ecologically sensitive areas lead to the destruction of coastal habitat (dunes flora and fauna).

The Sand excavation in areas with rich ecological and biological diversity distracts the habitat of dune plans and reptiles and mammals and also destroys the dunes as a representative ecological system and as a cultural character of the Gaza region.

- Levelling of dunes and removal of sand layers causes runoff to the rainwater, increase soil erosion and lower filtration rates of soil.

The dune face compose a rolling landscape forms which act as temporary water catchment area and reservoirs for rainwater witch later infiltrate to the ground water of the area and replenish the ground water reservoirs, due to the levelling of the dunes after excavations the rainwater runs of and causes a soil erosion problem and lost of big amounts of rainwater due to evaporation and run of into the sea and sewerage systems .

As the excavations go deeper it exposes the sub layers of clay and thus reduces the infiltration rates of soil to the ground water.

- Deep digging of sand and clay layers damages the protection of ground water against pollution from different sources.

As the excavations go deeper it exposes the sub layers of clay it not only reduces the infiltration rates of soil to the ground water but also impose a pollution risk for the ground water from different pollution sources.

- Over exploitation of sand as natural non renewable resource.

The vast amount of sand excavated is no longer a sustainable use of this non renewable natural resource, it is estimated that after some 50 years in the current levels of excavation no sand will remain in Gaza for the generations to come.

- Limit and jeopardy future use of sand quarrying areas.

After the excavations finished the quarry is normally lifted without closing it in a sustainable manner and some times filled by rubble and construction and demolition waste or even soiled waste, which restrict the future use of the land.

3.3 Marine and Coastal Ecosystem

Different types of the pressures on the marine ecosystem of Gaza strip are identified and the impacts are also described and presented in Table 3.1.

Table 3.1. Summarises the Pressures and the Associated Impacts of the Marine Ecosystem

Pressure	Impact
Increasing fishing efforts	Deterioration of fish population Non-sustainable fish population growth Destruction of fish habitats, i.e. habitats for spawning, nursery, feeding.
Waste water discharge	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: Algal 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.
Removal of rocks for construction	Destruction of fish habitat, shelter, and marine flora Increases erosion rate
Solid waste dumping	Affects respiration of fish Many solid wastes are toxic Decrease of habitat availability and quality Obstruction of fishing activities
Unlicensed fishing	Catch of fish including small fish, without control (in spawning season).
Agriculture (run-off and discharge of pesticides and fertilisers)	Toxic effects of pesticides and eutrophication by fertilisers
Pesticide fishing	Affects fish population, affects food chain, may cause serious diseases to humans.
Oil spills	Toxic
Coastal structures	Habitat destruction Changed sedimentation or erosion rates
Wadi Gaza flooding	Pollution of marine water and destruction of marine habitat
Sand mining	Habitat destruction

3.3.1 Increasing Fishing Efforts

In the current status of the marine fisheries, several environmental threats and impacts are identified. The most important impacts are listed below.

- Deterioration of fish population
- Non-sustainable fish population growth
- Destruction of fish habitats, i.e. habitats for spawning, nursery, feeding.

Overfishing

There are concerns about overfishing of pelagic, but especially of demersal fish. In the Gaza marine zone there is a high density of fishermen (723 boats on 660 km^2) 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. Here fishermen use beach shanshula (purse seine fishing) to catch small, juvenile fish. In this way, juvenile fish cannot grow to adult size and the population cannot be replenished. 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.

Based on the complexity of the situation and the available data for fish catches it is not possible to state with certainty that there is overfishing . In order to assess this problem, the fishing populations and fishing efforts in the greater surroundings of the Gaza coastal zone have to be analysed. At this moment there is no detailed data or accurate estimates available of the sustainable yield of the fisheries. There is also no data on the fish reproduction within the Gaza marine zone. In 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

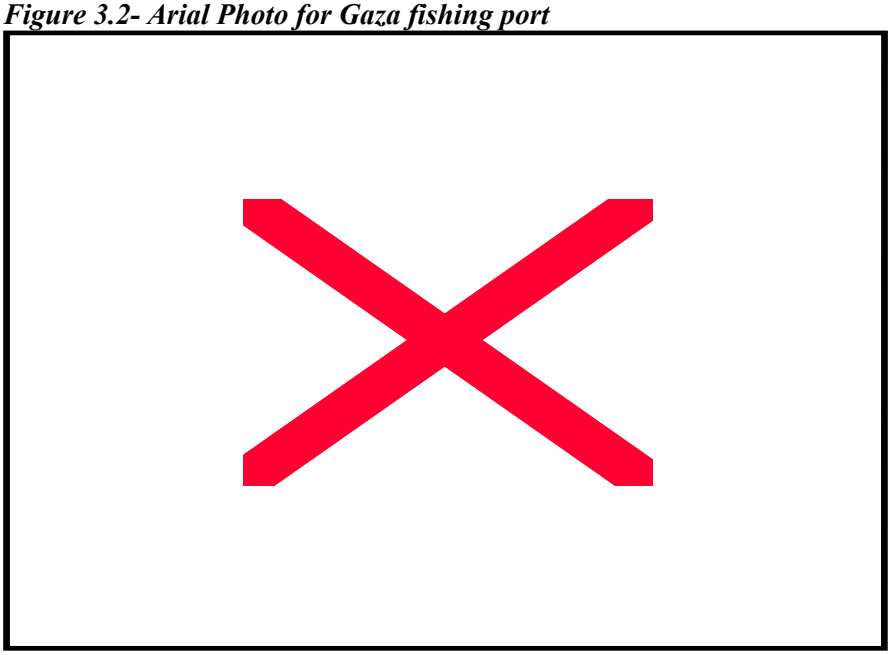
Habitat Destruction

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.

Figure 3.2- Arial Photo for Gaza fishing port



Artificial Reefs

Attempts to build artificial reefs have been carried out by fishermen by dumping old cars and old tyres in the sea near Rafah and Gaza city. Other attempts were carried out by the Palestinian marine ecologist Dr. Mahmoud Ali who used the wastes of domestic potteries as artificial reefs, that it is apparently to help to increase the fish population size and to protected and allows other biodiversity as benthic fauna to grow.

3.3.2 Wastewater Discharge

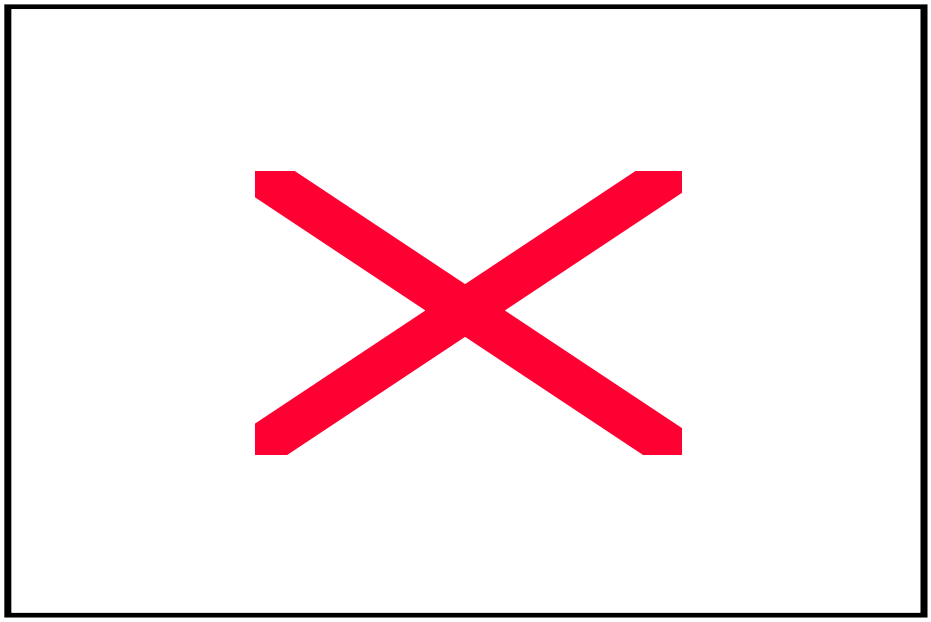
The discharge of untreated waste water into the shallow waters of Gaza strip is a serious problem for the status of the marine ecological system. The input of raw sewage water into the sea can cause a number of detrimental effects, that are listed below. About 80% of the waste water that is generated in Gaza strip is currently discharged without treatment into the sea (50,000 m^3 per day).

- 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:
- Algal 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.

Untreated sewage discharge affects the complete marine foodchain ranging from phytoplankton, via zooplankton, crustaceans, macrobenthos, 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). The ecosystem is fitted to these conditions. An increase in nutrient concentrations can therefore change the ecosystem. High nutrient levels, high temperatures and sunlight enhances the growth of phytoplankton species and may result in algal blooms that even may be toxic. Excessive bacterial growth may also occur. The increased nutrient and organic matter concentrations may favour certain species at the expense of others. Macrobenthic species for example that feed on dead organic material, will have more food and their growth may be promoted. As a result the species composition may shift from a pelagically dominated system to a benthically 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.

Figure 3.3- Wastewater Outlet South Gaza City



Untreated sewage outfalls contain organic and inorganic toxic substances, such as nitrates and chlorine. 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, Figure 3.4.

Figure 3.4- Locations of the Wastewater Outfalls of Gaza strip

3.3.3 Removal of Rocks for Construction

- *Destruction of fish habitat, shelter, and marine flora*
- *Increases erosion rate*

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.

3.3.4 Solid Waste Dumping

- *Affects respiration of fish*
- *Many solid wastes are toxic*
- *Decrease of habitat availability and quality*
- *Obstruction of fishing activities*

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.

Figure 3.5- Dumping of Solid Wastes Along the Coast of Gaza Strip

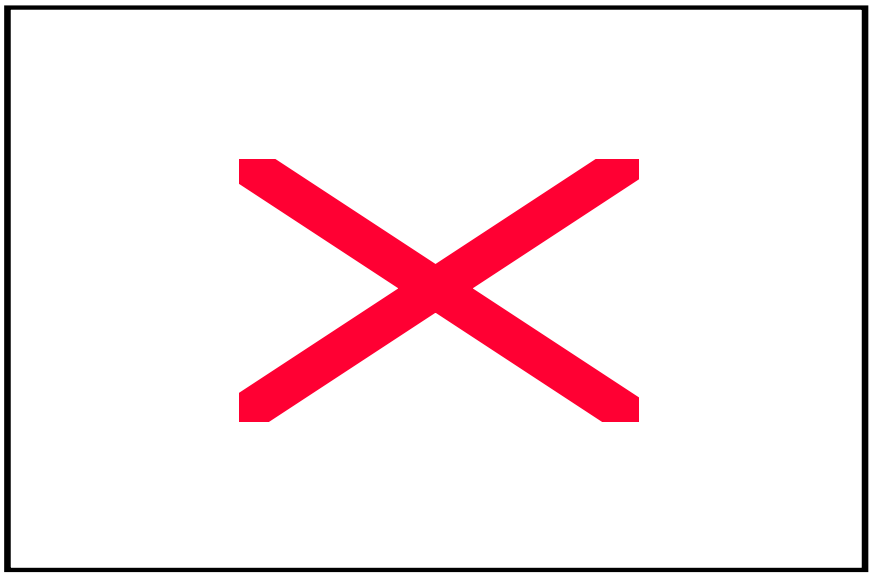
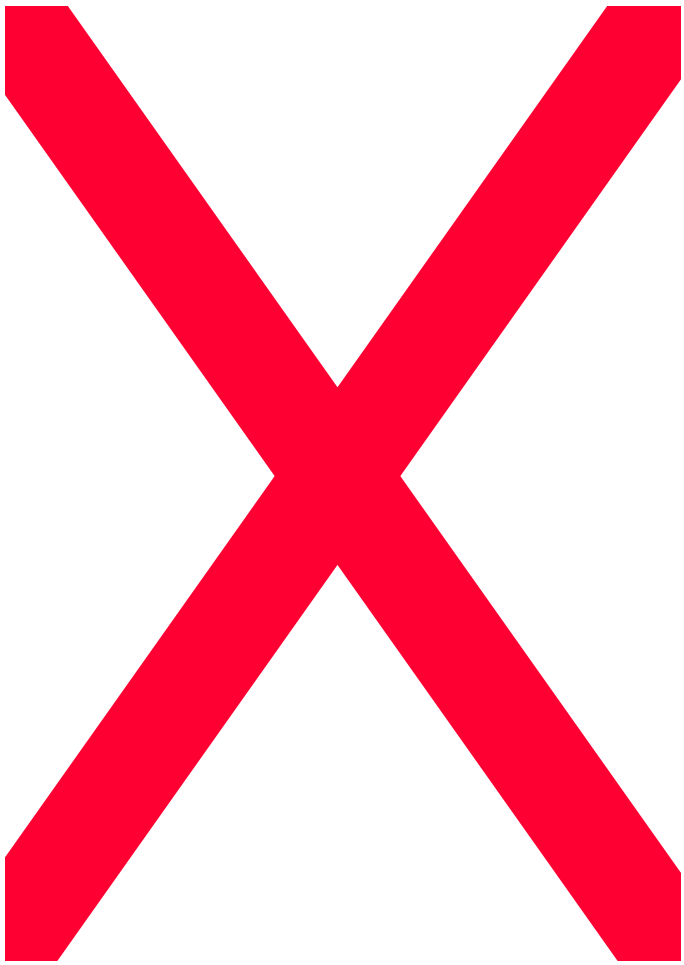


Figure 3.6- Map for Solid Wastes Sites within Gaza Strip



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.

3.3.5 Unlicensed Fishing

❖ *Catch of fish including small fish, without control (in spawning season).*

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.

3.3.6 Agriculture

❖ Toxic effects of pesticides and eutrophication by fertilisers

The coastal zone of Gaza has a surface 74 km^2 (see paragraph 1.1). Agricultural land amounts to 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 dune area has good water resources, it is therefore expected that the unused sand dunes and open land in the coastal zone (32%) will be used in the future to expand the agricultural area. From an environmental point of view it is important to preserve the coastal dunes as a natural habitat and for coastal protection. Figure 3.7 presents the different agricultural land use of Gaza.

The use of fertilisers 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 fertilisers 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; several of these have been banned by WHO, including DDT, lindane and parathion. The density of active ingredients that are locally used is exceptionally high compared with figures from other countries (MEnA, 1999).

Figure 3.7- Map for Gaza Agricultural land use

3.3.7 Fishing Using Poisons

❖ *Affects fish population, affects food chain, may cause serious diseases to humans.*

In the past the use of pesticide to catch fish was more common than it is today. However, it must be made clear to the fishermen that this method is absolutely not sustainable, it affects the entire foodchain and it may be very dangerous to humans.

3.9. Oil Spills

❖ *Toxic*

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:

1. chronic oil spillage
2. 'one-time exposure' to an oil spill
3. chemically dispersed oil

1). The majority of oil pollution in Gaza waters does not come from major accidents, but from sewer outfalls, ships 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.

2.) 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, dispersion of small droplets in the water column, sedimentation, biodegradation and oxidation. Emulsification (formation of soared '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 extend 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.

3) Spilt oil will quickly cover the sea surface. This surface slick will gradually breakup, caused by breaking waves, and form a plume of dispersed oil droplets. A non-natural cause of dispersed oil is the widely used method to combat oil spills with the use of chemical dispersants on the polluted area. In earlier days these dispersants were sometimes more toxic than the oil and from an ecological point of view not preferred. New less toxic dispersants have been developed (e.g. Cold Clean-500, Finasol-OSR7, and Corexit 9550). However, a recently chemically dispersed slick can have more serious effects on the ecosystem than a drifting slick can have, as high concentrations of dissolved and dispersed oil particularly affect species. NOAA (1999) presents Environmental Sensitivity Index (ESI) maps on oil pollution for the coastal zone of Gaza strip.

Figure 3.8- Map for Seashore Environmental sensitivity

3.3.8 Coastal Structures

- *Habitat destruction*
- *Changed sedimentation or erosion rates*

The construction of ports, breakwater 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, that also affect habitats. Furthermore, the structures are used for many purposes, that may impact the environment, by for example pollution with oil.

On the other hand, coastal structures do not necessarily have to be a threat to the environment, they can also be an opportunity. A port or breakwater introduces new habitats in the form of hard substrate, that may be advantageous to certain species. They also provide shelter for wind, currents and waves and may therefore serve as an important area to marine life.

3.3.9 Wadi Gaza flooding

- *Pollution of marine water and destruction of marine habitat*

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 km^2 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 flooded 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.

3.3.10 Sand Mining

- *Habitat destruction*

In the past three decades large quantities of the beach sand, but no sand has been mined in the sea so far. Sand mining leads to habitat destruction of the benthic and demersal species that live in, on the top or just above the sandy sediments.

4 Identification of Protection Themes, Targets and Indicators

This Chapter identifies the most relevant protection themes that relate to coastal and marine ecology. These protection themes are described in terms of:

1. the type of the problem that is encountered
2. the extent and location of the problem
3. the gravity and urgency of the problem
4. the direct causes of the problem

Theme-related targets and indicators are also formulated. The target is a (qualitative or if possible quantitative) description of the future situation in which the problem is considered to be solved. The indicators describe how the current situation, as well as the process towards the 'target' situation, can be measured and monitored.

4.1 Coastal Erosion

4.1.1 Themes

Four different themes can be distinguished, which differ in space, in urgency, and in nature.

1) an apparent lack of co-ordination of coastal development and protection N of Wadi Gaza (between the Gaza Sea Port and the North border of the Gaza Strip)
2) the mouth of Wadi Gaza is normally closed, which is a serious set-back for wetland dynamics and biodiversity in the Wadi
3) many scattered small-to-medium scale near-coast developments threaten the naturalness of the coastline mainly S of Wadi Gaza, and may cause erosion problems over time
4) there are hardly any actual data on the coastal behaviour (beach profiles) and coastal processes (waves, tides), which is a very bad starting situation for coastal erosion and protection management.

Lack of Co-ordination in North Sector

The first theme concerns the urgent need for coordination in the northern sector, including the Gaza Sea Port, the Fishery Port, the Beach Camp shoreline protection, and the adjacent coastline up to the north border. This sector comprises about 12 kms of coastline, ranging from Wadi Gaza to the N border. Since a detailed coastal protection plan for Beach Camp has already been designed and is at the verge of being implemented, and because the design and the EIA of the GSP specifically includes the mitigation of envisaged coastal erosion problems, it seems not necessary to define ‘coastal erosion protection’ as a ‘theme’ of concern. However, the greatest concern, as we see it, is ***the urgent need for high-level and***

technical co-ordination of the various plans in the entire northern sector concerning coastal development and coastal erosion mitigation. If the existing coastal protection and by-pass studies are not effectively evaluated in their mutual context and not thoroughly coordinated, a lot of time, money, and public goodwill may be lost. In addition, effective coastal erosion protection may be too late in place. A special item is the possible relocation of the Fisheries Port. This issue has a direct relation with the sand bypass plan around the GSP. The bypassed sand must be transported all the way around the Fishing Port to be effective for the northern beaches. This will appreciably increases the maintenance costs, not only during the first 5 years which are paid by the Netherlands, but forever, to be paid by the Palestinian Government. By the same token, also the earlier protection plans (applying groins etc.) along the coastline of Beach Camp should not be implemented without being critically reviewed in the framework of the coming large scale by-pass operations associated with the Gaza Sea Port.

This is a very urgent and important, far-reaching theme indeed. The direct cause of the problem is partly due to a lack of co-ordination between various parties. The main cause however lies in the difficulty to plan the actual implementation of large infrastructure works, which stems from funding problems but also from political problems (importing protective rocks from Israel). Up to a certain extent the delay of both the Beach Camp coastline protection and the Gaza Sea Port is a favourable circumstance, as it provides additional time for the necessary studies and decision making.

Stagnant Ecosystem (mouth almost permanently closed) in Wadi Gaza

The second theme addresses a technical option for the permanent opening of the mouth of Wadi Gaza, in order to increase the tidal wetland dynamics and biodiversity. The urgency and importance of this theme may be small compared to the others, when looked at from an economic perspective. However, improvement plans for the biodiversity of the Wadi Gaza ecosystem are important, and should be prepared in a coordinated way with the ongoing plans to improve the wastewater situation in the Wadi Gaza area.

Encroaching Developments on Natural Shoreline in South Sector

The third theme concerns the problem of encroaching small- and medium-scale tourism developments towards the beloved shoreline, thus demolishing the dune face, the cliff slopes, and the landscape at large. In addition, these developments heavily damage the natural defence line of the dune face and kurkar cliffs, thus weakening the natural resilience of this 30 kilo meters long coastal stretch.

Lack of Coastal Data and Regular Monitoring

The lack of data and regular monitoring makes it impossible to see any trends in erosion, accretion, steepening of the foreshore, dune face deterioration, etc. Given the major problems at hand, and with the Gaza Sea Port at the verge of being constructed, it is an urgent and basic matter of coastal management to start regular monitoring. This must be done on the basis of a complete monitoring plan, which plan should be implemented in the right institutional context. Necessary budget, tools, equipment and staffing must be in place very soon.

4.1.2 Targets

North of Wadi Gaza

This coastal section is, or will soon be, completely dominated by the Gaza Sea Port, the Fisheries Port, the Gaza City sea front, and the continuous shoreline developments towards the N border. Soon there will not be a single piece of natural coastline left. This entire section of 12 km will be completely an 'engineered' coastline. The coastline, which will be partly sandy and partly rocky/concrete, will be entirely under control. This sketch is not so much a 'target', but rather a reality.

Under the given circumstances, the target may be described as consisting of the following elements:

- a safe coastline without the threat of erosion
- clearly marked and maintained beach sectors for industrial, fisheries, and recreational use
- the recreational beach length should be as long as possible to accommodate the growing population of Gaza city and tourism.
- the Fishery Port to be removed and combined with the GSP, in view of:

⇒ maximum length of recreational beach in front of existing hotels

⇒ minimum 'industrial' coast length

⇒ optimised port & harbour management

⇒ improvement of badly constructed Fishery Port

⇒ reuse of rock and concrete of Fishery Port in GSP

⇒ optimum energy and cost effectiveness of sand bypass operation (shorter bypass route)

Although it is difficult to expect anything like a 'natural' shoreline in this northern beach compartment, yet everything should be done to improve the present dramatic beach landscape.

As far as the recreational sections of beach are concerned, the following targets might be set:

- a nice and broad beach, easily accessible for recreation and tourism use
- a clean coastline, free of seaborne and landborne waste (solid nor liquid)
- a beach with a pleasant 'soft' sandy waterline, without rocky revetments
- a beach with safe swimming conditions (no sudden steep underwater slopes in the wading area, no dangerous currents)

- a beach bordering a nice public beach park, instead of a noisy motorway running along it

Wadi Gaza

The Wadi Gaza is one of the very few land areas of the Gaza Strip which used to have an important role in biodiversity. Its original function of a natural 'Wadi' has been compromised by an Israeli built dam just outside the border, and the continuous barbed wire fence around the Gaza Strip has effectively stopped the options for fauna migration into and through the Wadi.

It might therefore be interesting to investigate the possibility to permanently open up the Wadi on the sea side, in an attempt to re-vitalise it.

The target here would thus be:

⇒ to create a dynamic, micro-tidal open estuary with a special saltwater habitat, neighbouring a stagnant and rather dry freshwater habitat.

Of course the tidal range is very small (maximum about 0.6 m at spring tide). This limits the possibility to keep the mouth permanently open in a natural way, in view of the local net rate of longshore sand transport, about 300,000 m3 per year, which is rather large.

The construction of the Gaza Sea port (GSP) at just a few kilometres to the north will probably affect the morphologic dynamics of the mouth on the long term, but this also depends on the final decisions of the location, size, phasing, and bypass system of the GSP.

South of Wadi Gaza

The target for the 30 km of coast south of Wadi Gaza is: *an essentially natural beach backed up by the natural sea defence line consisting of dune faces and kurkar cliffs*.

To put it in other words: *'hands off'*. Do not 'develop' this last natural resort of the entire Gaza Strip. Keep the 'developers', both small and big, at bay, safely behind a 100m set-back-line (SBL). A well designed, effectuated and strictly enforced SBL is the best (in fact: the only) guarantee that this beautiful coastline will be preserved for future generations, who will be happy that this decision was taken, maybe against the wish of some of the short-sighted developers.

Figure 4.1- Map for Beach Sectors (North, Middle and South)

Coastal Monitoring

The target for coastal monitoring is to have available, very soon, an ongoing system of permanent coastal monitoring. The resulting data, information, and analysis results form an important basis for preparing interventions and other decisions for coastal erosion protection and natural coastal development. The results of the monitoring activities will be introduced into the coastal information system GAMIS.

4.1.3 Indicators

North of Wadi Gaza

Indicators are, in the preparation stage:

- ❖ a strong Co-ordinating Committee put into place
- ❖ co-ordination and integration of the detailed designs for:

⇒ the Beach Camp shore protection,

⇒ the Gaza Sea Port construction,

⇒ the Fisheries Port relocation, and

⇒ the overall beach development and protection plan over 12 km

In the implementation stage:

- ❖ funding
- ❖ execution
- ❖ control

In the operational stage:

- ❖ maintenance
- ❖ monitoring of beach profiles and foreshore seabed shows no signs of ongoing deepening
- ❖ social and technical beach monitoring
- ❖ high appreciation scores of the interviewed public using the beach
- ❖ no complaints from Israelis about deficit of incoming longshore sand transport.

Wadi Gaza

Indicators for an improved and dynamic Wadi Gaza mouth are, in the initial stage:

- ❖ a strong Open Wadi Gaza Committee in place
- ❖ a preliminary feasibility study carried out. If this results in a positive recommandation:
- ❖ find funding

In the final stage, after implementation of the open mouth and associated works:

- ❖ increased dynamic environmental components (water flow, tidal range, salinity gradients)
- ❖ increased wetland area

- ❖ improved biodiversity

South of Wadi Gaza

Indicators for the targeted beach condition are, in the beginning:

- ❖ strong and high-level Committee in place
- ❖ preparation of law and by-laws on Set Back Line
- ❖ initiate measures to be taken when law is effective
- ❖ coordinate and plan Corniche to support SBL effectiveness

In the implementation stage:

- ❖ alignment of Cornich e according to SBL
- ❖ removal of structures violating the SBL
- ❖ public awareness campaign
- ❖ return of flora and fauna on beach and dune face
- ❖ satisfaction of nature auditors and public

Coastal Monitoring

Indicators for a successful start-up of coastal monitoring are:

- availability of an overall Coastal Monitoring Plan.
- establishment of the proper institutional setting for coastal monitoring
- availability of a **long-term budget**, equipment, staff, and training.

In the operational stage, important indicators are:

- general annual reports with activities, main results, and next-year plans
- specific reports on monitoring campaigns, including interpretation and evaluation of the results, and scientific publications.
- satisfied the users of the monitoring reports.

4.2 Sand Exploitation

4.2.1 Themes

Long Term Demand (including local use and export of sand):

The future sand and clay demand need to be quantified in terms of amounts needed as will as in terms of the quality of sand for deferent uses and purposes, and weather or not to allow sand to be exported beyond Gaza to the West Bank and Israel.

The non-optimised use of designated quarries increases the demand for new quarries and the pricing of sand is currently being charged on arbitrary bases and due to the relatively low price, users are misusing the sand

Long Term Availability:

The designated areas for sand/clay exploitation, based on environmental concerns and based on availability of sufficient quality (land use plans) should be identified soon, and the sand/clay that is totally available in these areas, should be quantified based on the environmental and quality concerns

Importing of sand (from West Bank, Egypt), to increase sand availability in Gaza should be investigated and the reuse of demolition waste (from buildings, roads, etc.) could reduce demands for raw sand and clay, but till now no serious effort done on this regard.

Obtaining sand from the sea has not been investigated yet and the need to carry out detailed studies is very important in this regard

The combination of sand excavation with other projects (i.e. Wadi Gaza redevelopment, levelling for road construction, building construction, development of agricultural fields is currently not will co-ordinated and the possibilities of using the sand in these project areas must be addressed

Operation and Aftercare Regulations:

The question of who is allowed to operate a quarry, how and by who should sand quarrying should be licensed, how and by whom should the licenses be enforced and the destination of the excavated sand of that quarry, all that has no clear cut distributed responsibilities.

The measures needed to avoid spill, and to maximise the use of quarry, avoid misuse of quarry (solid waste dumping, wastewater discharge, and other operational/environmental measures should be taken during operation (access roads, fencing, etc).

The aftercare measures to be taken after exhaustion of the quarry (landscaping, planting trees or plants, other measures) and the environmental concerns to be incorporated in the licenses and the price (EIAs) should be drafted.

Co-operation and Co-ordination:

The authorities to be involved in sand quarrying needs to be identified according to mandate and existing laws and regulations and issues have to be co-ordinate between these authorities and the main responsible authority for licensing and enforcement must be determined with clear roles and the role of MEnA must be set in this regard.

4.2.2 Targets

The nature of sand as being a non renewable resource implicates that a careful exploitation should be implemented, due to the shortage of other resources and the huge demand over the sand as building material and the limited access to dune areas and as for the proposed regional plans with respect to the proposed future function of the sand dunes, under the given circumstances, the target may be described as consisting of the following elements:

- A Clear policy of determining and projecting the future sand and clay demand
- A scientific study of the sand quality needed for deferent uses
- A sound and rational pricing policy which helps in reducing the misuse of sand
- A detailed survey of sand availability by type, amount and location
- Introduction of alternative building material to reduce the use of sand
- Consumption of rubble and construction and demolition waste
- Study the economic viability of importing sand from outside Gaza
- Implementation of land use plans with regard to allocation of areas foe sand mining
- A plan for operational and environmental measures for sand excavations practices
- Stakeholders analysis and recommendations for institutional and legal reforms for sand quarrying licensing and monitoring

4.2.3 Indicators

Indicators for sand quarrying include the following:

- Amount of reduction of the sand excavated by type and use
- Area of protected sand dunes
- Amount of construction and demolition waste reused
- The number of opened and functioning quarries
- Availability of deferent information and statistics about types, amounts and locations of sand in a will organised manner

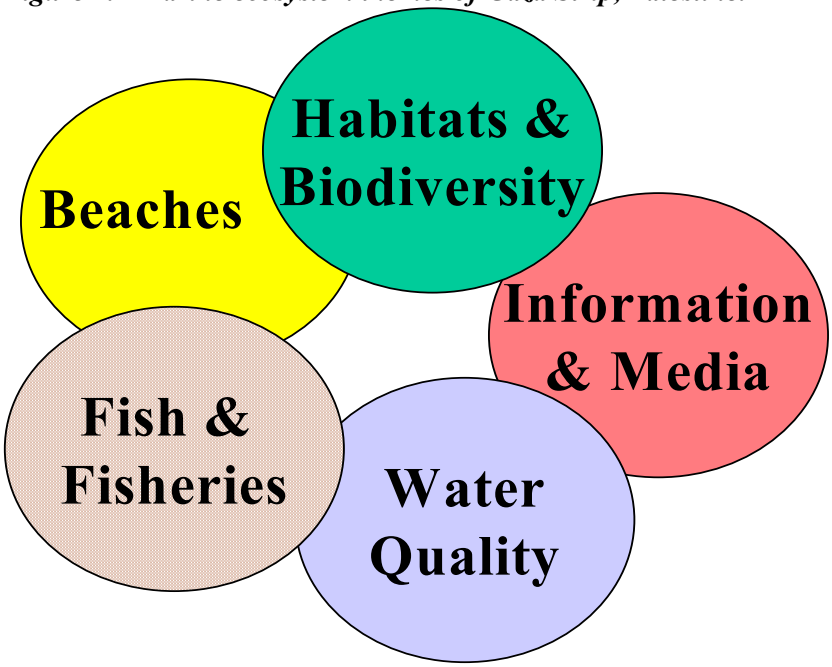
- Availability of sand and other soils for building purposes

4.3 Marine and Coastal Ecosystem

4.3.1 Identified Themes

On the bases of the results of chapter three the marine ecosystem of Gaza strip has been identified into five major themes to enable us to study the threats on the marine environment in some details. In this chapter these themes are presented below and illustrated in Figure 4.1.

Figure 4.2 Marine ecosystem themes of Gaza Strip, Palestine.



Fish and 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 are the untreated waste water outfalls on the beaches. Already, working programs and groups are into action to solve this urgent problem. Waste water treatment plants are under construction and within a few years, 60% of the waste water 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 by either 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.

4.3.2 Targets and Indicators

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

Fish and 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 sea water quality, international guidelines on water quality objectives and indicators exist. Water quality monitoring is necessary to check whether the Gaza waters comply to these standards. Studies may be carried out to establish the maximum allowable discharge quantities that can be allowed without exceedance 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.

Indicators for habitats are habitat area (m^2) for different types of habitats and habitat quality, for example in terms of habitat density, distance between habitats, size of habitat units or habitat patchiness.

For biodiversity, indicators may be the species and community diversity, species and community rarity, naturalness of biotopes and biodiversity indices (for example Shannon-Wiener).

Beaches

With regard to beaches the targets are clean beaches (no litter), with a diverse flora and fauna, where Palestinians and tourists can swim safely, have picnics and enjoy the natural beauty. Indicators are the absence of solid waste, the presence of vegetation on the beach and dunes, wide beaches and safe swimming water.

Information and Media

With regard to information and media the target is a general awareness of the importance of the coastal and marine system, a general knowledge on the species that live in the Gaza strip and a general impression of what are good and bad practices.

5 Interventions for Coastal Protection and Prioritization

The interventions that can be made to address the protection themes is based on an integrated analysis of the pressures on the physical coastal environment and their impacts and related targets and indicators, as discussed in the previous Chapters of this study.

Interventions may be cross-sectoral and may relate to structural measures as well as non-structural measures. The long-list may also contain actions that have already been identified previously by MEnA or others.

After the long-list of interventions has been defined, a prioritisation of interventions has been made in order to select those actions that have to be implemented most urgently during the next years. The ranking is to be based on evaluation criteria and their validation. The priority ranking process has to be performed in consultation with the stakeholders (Task Groups, or co-ordinating Committees).

Each intervention is prioritised according to five general evaluation criteria. These criteria are:

- Environmental aspects:

  ++ If the environmental benefits of the intervention are very large

  + If the environmental benefits of the intervention are large

  0 If the environmental benefits of the intervention are small

- Technical aspects:

  ++ If the intervention is technically very easy to implement and operate

  + If the intervention is technically less easy to implement

  0 If the intervention is technically difficult to implement

- Cost / Financial aspects:

  ++ If the costs of the intervention are low ($0 - $100,00)

  + If the costs of the intervention are medium ($100,000-$500,000)

  0 If the costs of the intervention are high ($500,000 and higher)

- Socio-economic aspects:

  ++ If the socio-economic impacts of the intervention are positive

  + If the socio-economic impacts of the intervention are neutral

0 If the socio-economic impacts of the intervention are negative

- Legal / Institutional aspects:

  ++ If there are no legal or institutional bottlenecks related to the intervention

  + If there are limited legal or institutional bottlenecks related to the intervention

  0 If there are large legal or institutional bottlenecks related to the intervention

5.1 Coastal Erosion

Interventions

Approach

In order to finally reach the targets, it is necessary to come up with some ideas, even in a form which may be just a preliminary concept, and not yet fully detailed, or not yet fully presenting a complete solution. To stimulate the generation of ideas which might bring us closer to the final target, all ideas are welcome and should be assembled on paper.

- So, first, a 'long list' of interventions must be made.
- Second, these interventions must be described in some detail, for which 'intervention sheets' have been used, with room to describe important aspects such as the effect of the intervention on the environment, in the technical domain, cost/financial consequences, socio/economic implications, and legal/institutional requirements.
- Third, this description must be used and further evaluated to screen and rank the 'long list' according to evaluation criteria.
- In the final stage (in the current Project), the best selected, top-ranking interventions must be prepared for actual implementation, either by accommodating them within current Palestine Ministries etc, or by calling for outside donors to adopt these projects.

'Long list' of interventions

The following 'long list of possible interventions' has been drawn up and discussed during the Coastal Erosion Protection Committee meetings.

1. Beach nourishment along Gaza beaches in hot spots (hotels on Gaza beach front)
2. Beach revetment in selected areas (Shammalakh and Sudania areas)
3. Construction of groins in selected areas (Jabalia Beach till Sudania)
4. Construction of detached breakwaters in selected areas (Alwaha area)
5. Allow interaction between dunes and beaches in selected areas (Rafah and Khanyounis)
6. Prohibit all non sea related business from the beach area (all beaches)
7. Prohibit all offshore structures except ports
8. Remove all Set-Back-Line violating buildings from the beaches (all beaches)
9. Enforce the existing land use planning schemes
10. Enforce the 100 m Set-Back-Line (500 m in some places)
11. Keep the mouth of Wadi Gaza open
12. Design and implement a coastal monitoring system
13. Establish a well functioning Coastal Information System
14. Move the Fishing Port to the Gaza Sea Port
15. Conduct public awareness campaigns
16. Let flora and fauna return on beaches and dune face

17. Establish powerful Coastal and Marine Protection and Development Committee
18. Find (offshore) sand resources for artificial beach nourishment and protection
19. Make coordinated shore protection plan for North sector.

Within this 'long list', mainly 3 types of interventions/solutions may be distinguished:
E **engineering** interventions, i.e. physical actions such as placing sand nourishment, revetments, groins and jetties
L **legal** and administrative/regulatory interventions
I **information**, including *finding* information (such as beach monitoring and sand inventory), *combining* information (coordinated plan), and *disseminating* information (such as public information campaigns).

Although in general each intervention may show some aspects of each type, the dominant picture is:
E-type interventions are 1, 2, 3, 4, 5, 11, 14, 16;
L-type interventions are 6, 7, 8, 9, 10, 17;
I-type interventions are 12, 13, 15, 18 and 19.

The three types of interventions **E/L/I** may again be roughly grouped in terms of the coastal area where they are most dominant, yielding the following schematic picture:

- The Northern and Middle sectors are dominated by E-type interventions (physical beach protection and improvement measures)
- The Southern sector is dominated by L-type interventions (legal action: install Set-Back-Line)

Not every single intervention has yet been described in detail. Instead, five 'grouped' intervention packages have been defined: three in the North, one in the Middle, and also one in the South

North sector

In the North sector new, and especially coordinated, coastal protection plans must be made. To support this, a good data and knowledge basis is essential:

- an ongoing beach monitoring action is needed (on permanent basis)

- an offshore sand inventory is absolutely essential (a once through activity).

These are two very important issues indeed, which must be converted into detailed Action Plans in the coming months.

Meanwhile, at this moment we do not yet know if, where, how much, and what quality of sea sand is available to be dredged for artifical nourishment. Because of this lack of information at this moment, we will make a preliminary consideration of two more or less extreme alternative interventions, labeled North 1 and North 2. In addition, we have a look at the pros and cons of moving the Fishing port, labeled North 3.

North 1: 'abundant sand'. We assume that abundant sea sand will be available to be used for the coastal protection, so that we can make and maintain broad sandy beaches. Main characteristics of this intervention are described in the 'intervention sheet' at the end of this paper.

A more thorough evaluation of this intervention has to wait until more information has become available from the study of the large scale sand by-pass plan. A final decision of

how to plan the large-scale beach improvement for Gaza would typically be a task for the advocated Coastal Coordination Committee.

North 2: 'no sand'. In contrast to North 1, it is now assumed that hardly any nourishment sand will be available. This means that for the protection of eroding beaches we have to revert to 'hard' engineering measures such as:

- rock revetment along the threatened coastline
- row of groins perpendicular to the coastline
- detached breakwaters, parallel to the coastline

This type of interventions will not create or habilitate nice beaches, but the erosion will stop. Unfortunately, to the North of the protected coast, erosion will go on.

Also in this case an evaluation of this intervention has to wait until more information has become available from the study of the large scale sand by-pass plan. The advocated Coastal Coordination Committee should be closely involved in the final decision on how to find the best balance among the several aspects involved.

North 3: 'move Fishing Port to Gaza Sea Port' As a possibly interesting alternative in the integrated beach protection and development plan, we regard the relocation of the Fishing Port (FP): move it about 4 km to the South, and combine it with the Gaza Sea Port (GSP).

Arguments in favour of moving the FP towards the GSP include:

1) At its present location the FP occupies 500 m of shore length, in an area that has a big potential (and thus economic value) to be developed for recreation and tourism.
2) The FP is under security control, and therefore access to its beach is restricted for recreation and tourism
3) In the original plans for the GSP, the FP was indeed combined with the GSP on a location some 4 km to the South.
4) The FP was built on its present location with the idea in mind that it could serve as a temporary commercial harbour in case of further postponement of the agreement on the proper GSP; this reason has now vanished.
5) Combined ports may be better and more effectively managed: logistics, maintenance of the breakwaters and the access channel (periodic maintenance), pollution control.
6) Upon removal of the present FP and its breakwaters, the obstructed Northward coastal sand transport will be restored, so that the badly eroded beaches to the North of it will immediately start receiving sand from the wide beaches in the South.
7) The FP on its present location increases the length of the intended sand by-pass operation by about 4 kms: sand from South of GSP must be transported all the way to the North of the FP in order to feed the eroding beaches North of it .

8) The present FP design is not optimal, in terms of lay-out, structural design, and fish-management aspects (it was built before the Danish fisheries improvement project was started); in the new location these aspects may be much improved, in favour of the fisheries' effectivity.

Arguments against moving the FP include:

1) Costs of the moving operation

2) If the construction material of the present FP is used for the FP on its new location, there will be a temporary problem to accommodate fisheries

3) Existing fisheries-related activities and its buildings must also be moved, such as Fisheries Directorate office, ice plant, auction/market, training center, workshops

4) Travel distance between fishermen's houses and FP may increase

5) Combined FP and GSP may have adverse effects on nautic safety because of mixing different types of ships, small and large.

6) The FP on a new location near the GSP, for example combined with the small NE groin of the GSP, might form an obstruction for future expansion plans of the GSP and its related industrial activities

7) Risk of pollution and health effects from GSP/industry on fish

8) Difficult to coordinate these matters with the fisheries sector

9) At its present location, sand is accumulating on the South side of the FP, forming a nice and wide beach; this beach will become narrower after removal of the FP.

Both lists may be further completed. The arguments, which are of various types and weights, must be screened for consistency, relevance, and should where possible be put in a more quantitative form, especially when it comes to their financial implications. It is expected that the arguments related to coastal erosion and improvement will be looked at in more detail in the framework of the soon expected study sponsored by the Dutch Govt. A final decision on moving the FP to the site of the GSP would typically be a task for the advocated Coastal Coordination Committee.

Middle sector: Wadi Gaza mouth

Intervention M 1: 'open Wadi Gaza mouth.' The mouth can be opened in an artificial way using four techniques or a combination of them:

- build seaward jetties on both sides of the Wadi mouth to stop the longshore sand transport and fix the open mouth
- deepen the seabed in front of the mouth by dredging large quantities of sand,
- deepen the Wadi mouth on the inland side.
- the coastal road bridge piers are said to have exerted a distinct negative effect on the dynamics of the Wadi mouth immediately after their construction; an alternative alignment or construction of the bridge might be combined with the other options.

The aspect of deepening the bed may be very interesting in the framework of the task to find good quality dredging sand for the sand by-pass plan. Also here, it is advised to study this in more detail in the framework of the soon expected study sponsored by the Dutch Govt.

South sector

Intervention S 1: 'SBL'. Implement, monitor and enforce the 100 m/ 500 m Set-Back-Line.

This intervention (or rather: target) is easy to put on paper, but very difficult to implement. In any case, there is an important task for public information. This could be supported and mobilized by setting a clear example: demolishing a violating building. This must be the major subject of a number of subsequent Coastal Protection Committee meetings.

Intervention sheets

An example of a typical 'intervention sheet' is shown here. It describes the intervention It is emphasized that some of the quantities entered in the sheet below are first estimates only, to be checked and improved in the subsequent evaluation process.

INTERVENTION SHEET	**Subject: Coastal Erosion Protection** **Item: North 1 'Protection with abundant sand'**
Intervention name	**Coastal Protection in entire North Sector, (between Wadi Gaza mouth and North border with Israel) supposing that sufficient sand is available**
Responsible authorities	Municipality of Gaza will be the main 'user' of the improved shoreline, and should therefore play a major role in terms of responsibilities for planning.
Status of intervention	Dutch Government will be donor to implement massive by-pass of sand, sufficient for first 5 years (2001 - 2005).
Objective of the intervention	To improve poor beach quality (combat ongoing beach erosion since 1970), and to mitigate future erosion effects caused by Gaza Sea Port in entire North section, by applying artificial sand nourishment.
Description of the intervention	Through this intervention, the North sector will be artificially nourished with large quantities of good quality beach sand. The nourishment operation consists of two parts: Initial nourishment, and maintenance nourishment. Initial nourishment is needed for rehabilitation of beaches which have suffered ongoing erosion over the past 30 years. This will take some 3.5 million m3 of sand, for a 100 m wide beach over a length of 6 km, i.e. from the Fishing Port up to and including the Alwaha hotel. After the initial nourishment, semi-permanent maintenance nourishment will require some 350,000 m3 per year.
Environmental aspects	Major positive aspect is: present narrow, polluted, and health-hazardous beaches will be rehabilitated Some negative effects are: benthos will be disturbed where the sand is dredged effects of sand transport operation by truck: noise, pollution, traffic risk effects on water quality (turbidity) at location of nourishment
Technical aspects	No particular problems; artificial nourishment is a 'well proven technique' on many locations in the Mediterranean, but not yet in Gaza
Cost/Financial aspects	Dutch Government is donor for a single, large-scale nourishment operation which will be sufficient for the first 5 years only. Various alternatives will be assessed, depending on actual sand source location, distance between borrow area and delivery area, sand operation techniques (trucking or hydraulic transport), each alternative with its particular cost.

	After 5 years however, teh PA itself has to fund the required ongoing nourishment maintenance. So it is important that the Dutch donor money should be invested in such a technical sand nourishment scheme that it requires only limited funding on the long run.
Social-economic aspects	protection of the threatened Beach Camp area improvement of the entire Gaza city beach front for recreation and tourism Much value will be added to coastal land strip because of of beach improvement. Good basis for new tourism developments with their associated benefits.
Legal/Institutional aspects	Strict enforcement of Set Back Line is needed after beaches have been widened. Law enforcing measures must be in place before beach widening has been implemented. New detailed Gaza City beach front plan must be made to form a planning framework in which the large-scale beach improvement may be incorporated.
Cost estimation	Initial sand nourishment of 3,5 million m3, @ $2/m3, will cost about $ 7 million, donated by Dutch Govt. Cost of maintenance nourishment in the long term will be some $ 0.7 million per year, on average; funding to be guaranteed by the Palestinian Authority.

Not only Roads, houses, hotels, restaurants, but also agriculture and horticulture infrastructure, should simply stay away from the dune face and cliff edge, behind a safe limiting line. This is called the 'set-back-line'. The principle to stay behind such 'Set-Back-Line' or SBL with all future coast-related developments, small and large, public and private, is nowadays widely accepted and welcomed as a major Coastal Zone Management principle.

The sooner such SBL is implemented the better. Any delay will cause extra trouble, because people simply tend to stake their (private or commercial) claims very close to the shoreline as soon as they feel it is profitable to do so.

In principle, all existing structures seaward of the SBL should be removed as well. There may be exeptions to this principle, but in exceptional circumstances only , e.g. if high public interests demand so. The more exceptions are tolerated, the weaker the SBL is as an instrument of coastal zone policy, and the faster public support for this principle will erode.

A number of important questions are to be addressed before a SBL is defined and made effective:

- how far should this SBL be from the cliff edge? (This could be in the order of 100 m.)
- how can this distance be determined in a scientific and socially acceptable way?
- should the SBL be everywhere the same, in built-up areas and in rural areas?
- how must the SBL be established legally
- should the SBL be visible on the ground?
- can nothing be built seaward of the SBL?
- can the SBL be used as a major public leverage to help establish and strengthen CZM?
- may the 'Corniche' play a role in establishing the SBL?
- can the SBL be implemented very soon, maybe in a preliminary form to start with?

When looking to the entire shoreline of the Gaza Strip, it is clear that there are great differences between the situations in the north and in the south (where we assume the boundary just north of the Wadi Gaza).

North of Wadi Gaza the situation (including the Gaza Sea Port) is very complicated. The Beach Camp, and the fast near-coastal developments in Gaza City itself and between Gaza City and the N-border, show many examples where developments have already taken place right on the beach. In the entire area North of Wadi Gaza the coastline will in the near future completely be 'engineered' in the sense that the entire coastline will be artificially protected against erosion which is a direct consequence of the construction of the Fishing Port and the Gaza Sea Port.

In the southern part of the Gaza Strip in contrast, the coast is still relatively free of major sand-interrupting structures. The near-coast built-up areas are confined to the Deir El Balah camp (which is a difficult point anyway). Although numerous scattered small-scale tourism facilities etc. are found along the dune ridge and on the beach, these are mainly temporary, restricted to the summer season.

Establishment and enforcement of a SBL is a major intervention and should be carefully planned. A broadly composed Committee, representing all stakeholders, should be called for advice in order to secure a qualitatively sound, widely acceptable, and effective result.

We recommend that something like establishing a SBL should happen fast to prevent the **further creation of enormous erosion-related problems**, where there would only be a minor problem (i.e. the generally slow natural coastal retreat), if one had enforced a 'no-build zone' parallel to the beach.

A set of two specially designed jetties might keep the mouth open. That must first be checked in a preliminary feasibility phase. If that is possible, the tidal in- and outflow but especially the tidal range in the mouth and the lower stretch of the Wadi will certainly add to the dynamics of the habitat. The alternating flow might be increased through the excavation of some land at MSL, which measure would simultaneously increase the physical area where new micro-tidal colonisation of flora and fauna could occur. The excavated sand might be sold to support the cost of constructing the jetties.

5.2 Sand Exploitation

5.2.1 Summary of Analysis of Present Situation.

Projected sand volume needed for housing/construction is 1 million m^3/yr up to 2010.

Much additional sand is needed for coastal protection (Gaza Sea Port etc.)

At present, allowable sand volume to be exploited on land in the Gaza Strip is less than 8 million m3 in total. This available volume will further decrease due to natural resources protection policies.

More work is needed in making detailed analysis of present and future Demand and Supply of sand, rock, clay and kurkar.

Conclusion 1: Serious sand shortage (deficit) will appear within 5 years from now.

Conclusion 2: Interventions are needed to guarantee sufficient supply for the construction of houses and the improvement of beaches, while at the same time protecting the environment and safeguarding the natural sand resources in a sustainable way.

5.2.2 Long List of Interventions, Regrouped

A first 'long list of interventions' showing 17 items has been proposed during the previous months by the Task Force for the sand exploitation problem. These (and possibly additional) items may be reshuffled into two groups with a different character:

Group 1 Interventions, which are in the first place aiming to relieve the future sand deficit: increase the Supply, and decrease the Demand

Group 2 Interventions, which primarily aim at protection of the environment, and therefore are likely tending to increase the future sand deficit.

Both groups are needed, and much creativity will be asked to define a balanced set of interventions.

Group 3 is defined as an additional group containing actions to generate the needed additional quantitative information regarding future Demand and Supply

Group 1

Open new quarries (but in an environmentally acceptable setting)
Use existing quarries more effectively
Reduce sand Demand (in various ways: pricing policy; new techniques; public information)
Reuse construction waste
Use crushed rock (kurkar) instead of sand
Introduce clay bricks for construction
Use offshore sand
Import sand (from West Bank/Egypt/Israel)
Reclaim sand stolen by Israel

Group 2

Define good engineering practices for sand exploitation
Define terms and conditions for sand exploitation, focused on environmental protection
Define rules and regulations for sand exploitation, focused on environmental protection
Define institutional reforms for sand exploitation
Implement land use plans
Enforce regulations
Define professional monitoring and inspection plan for sand exploitation
Establish 'sand fund' to finance quarry site rehabilitation

Group 3

Additional information and analysis related to Supply and Demand
Supply: Full inventory to assess the present stock of sand (clay; kurkar) available, both on land and in the sea
Supply: Assess the environmentally allowable exploitation of sand (clay; kurkar)

Supply: Assess potential supply from alternative sources (construction waste)
Supply: Assess potential supply from abroad
Demand: Full assessment of sand (clay; kurkar) demand for individual classes of users
Demand: Assessment of potential demand for alternative materials (construction waste)
Demand: Assess potential reduction of demand due to pricing regulation

Next actions:

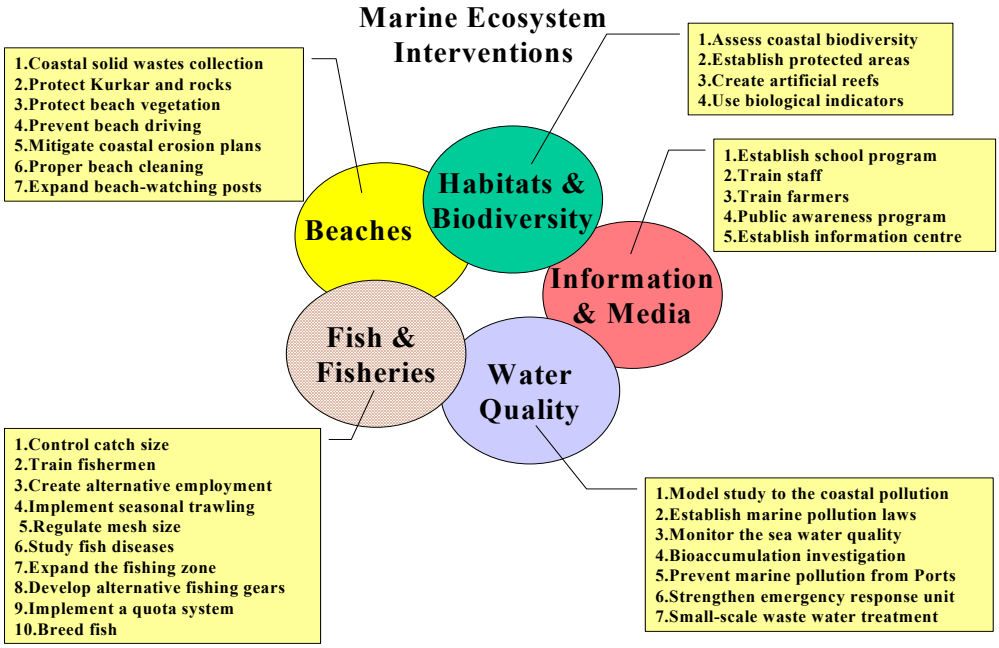
These above mentioned interventions to be discussed and formulated, where posible, in a more clear and detailed way.
Then they must be subjected to the list of ranking criteria
The results to be presented during the Workshop on August 23

5.3 Marine and Coastal Ecosystem

This section identifies a long-list of interventions that can be made to address the marine themes. These interventions may be cross-sectoral and may relate to structural measures as well as non-structural measures. The long-list may also contain actions that have already been identified previously by MEnA or others.

The possible interventions together with the themes of the marine ecosystem of Gaza strip are presented and illustrated in Figure 5.1.

Figure 5.1. Themes and interventions for the marine and coastal ecosystem of Gaza strip.



Possible interventions with regard to fish and fisheries

1. *Control seasonal catch.* Many countries at the Mediterranean sea as in Egypt control the fishing season which usually closed in summer, during July and August. This measure can also be introduced in the Gaza strip, but the implication is that the trawler-fishermen are out of work for a period of two months. A possibility is to create other, seasonal work for the fishermen, or to pay them their loan for a two month period. A Gaza-

fisherman earns about $10 per day, in total there are 15 trawlers and each trawler has a crew of 12 man. For a period of 60 days the total costs for their loans will be $108,000. Additional costs will include the write-off of the investment, maintenance and other costs. Before this measure is implemented it should also be investigated whether July and August are the best months to close the fishing season.

2. *Alter the bottom-trawlers in pelagic trawlers*. Another possibility is to use the trawlers to catch pelagic fish, such as Sardines. This species is a migratory fish and is not so much dependent on the local circumstances and habitats as the demersal and benthic species. One of the aims of the DANIDA project is to promote the pelagic trawlers.

3. *Prohibit beach purse seine fishing*. A GEF-project is currently undertaken to prohibit this method, and instead give the fishermen gill nets as an alternative.

4. *Prohibit the catch of undersized fish*. At this moment there is no working law on the catch of undersized fish. There is a law from 1937 that proclaims a certain legal size, but nobody pays attention to it. The Fisheries Department has therefore prepared a new law, the Fisheries Law for the State of Palestine, that is currently under the attention of the Ministry of Justice.

5. *Regulate fishing gear (mesh size)*. At this moment nets are used that have very small mesh sizes. Using these nets leads to the catch of small, juvenile fish and also to a relatively large by-catch. Specific data on the quantity of the by-catch is not known at present. The Fisheries Law for the State of Palestine issues regulations on mesh-sizes, but this law is not yet implemented.

6. *Reduce the number of fishermen and vessels*. The intensity of fishing is very high. Fishermen must put a great effort in catching enough fish for their living. This means that the fish populations are under pressure. A reduction of the number of fishermen and vessels is necessary to protect the fish populations and the marine environment.

7. *Reduce the fishing costs, number of men and vessels and fish pressure by using other techniques and methods*. Less fishermen and less vessels are necessary when for example cheaper rafts are used instead of fluka's to carry the lights for purse seine fishing. Another possibility is to promote possibilities for deep sea fishing or to deploy new fishing methods, like floating lines or a combination between trammel nets and drift nets. However it must be emphasised to beware of negative side-effects. Other techniques may be useful in decreasing the number of fishermen and effort, but a more efficient fishing may lead to a further deterioration of fish populations.

8. *Implement a quota system for Maximum Sustainable Yield*. At present, knowledge on maximum sustainable yield of the commercial fish species is lacking. For some species it is obvious that the maximum yield has already been exceeded, other species, such as Sardines, seem to do well, although large quantities are caught each year. Firstly the maximum sustainable yields for the most important commercial fish species have to be defined. This means that the stock sizes and stock growth rates have to be assessed. Secondly quota may be defined to ensure that fish stocks are not depleted. For some species, especially migratory fish, this means that the stock assessment needs international co-operation between a large number of countries, such as Marocco, Algiers, Libya, Egypt and Israel.

9. *Issue a law against the use of poisons for fishing*. The Palestinian Coastal Police are paying attention to people (not necessarily professional fishermen) that use poisons for fishing. When they arrest such a person, his penalty is the shaving of his head, in absence of a legal punishment. This will also be arranged for by the Fisheries Law for the State of Palestine.

10. *Monitor fish catches*. The statistics of 36 groups of species are monitored by the Fishery Department. It is important to obtain as much information as possible within conditions of time and money. Regular sampling is recommended to measure fish age, size, weight, sex, species type, health (autopsy), and other information.

11. *Train staff of Fisheries Department*. The Fisheries Department is a young organisation that has grown from two people in 1994 to a total staff of 50 people at present. Not all staff members are properly trained in fisheries techniques and marine ecology.

12. *Establish centre for breeding fish*. For valuable fish species a breeding centre may be developed to breed fish and subsequently introduce these fish into the sea. Promising species may be Sea bream and Sea bass, groupers or other valuable threatened species.

Possible interventions with regard to marine pollution

The Palestinian Environmental Strategy has already defined a number of required initiatives with regard to coastal and marine pollution. These include (MEnA, 1999):

1. Prevention of discharge of untreated waste water in the sea
2. Setting waste water treatment guidelines and effluent standards
3. Development of a coastal land use plan
4. A solid waste management plan should give special emphasis to prevention of waste dumping along the shoreline and to closing the old dumping sites
5. EIA requirements, including, among others, of brine effluents impacts
6. An early warning system and an emergency action plan have to be developed with regard to potential oil and hazardous chemical accidents; this includes international arrangements with Israel and Egypt
7. Studies on the assimilative capacity of the coastal sea for pollution inflow and setting standards for maximum emissions.
8. Monitoring the seawater quality and emission loads into the sea
9. Formation of a committee on the national level from the various ministries and institutions which are dealing with the shoreline and marine environment

Possible interventions with regard to habitats

The Palestinian Environmental Strategy has already defined a number of required initiatives with regard to nature and biodiversity. These include (MEnA, 1999):

1. Assessment of the current biodiversity through a comprehensive inventory to set up priorities of actions.

2. Declaration of natural reserves.

3. Protection of the wild animals through enforcement of a hunting or fishing law, especially to protect rare and threatened species and migratory birds.

4. Facilitation of some studies to evaluate the contribution of flora and fauna to the national economics.

Other possible interventions can be suggested to meet unpredictable changes on the habitats of the biodiversity of Gaza strip as the following:

1. *Issue a law for the regulation of rock removal*. Rock removal is a direct threat to the habitats in the shallow coastal waters.

2. *Issue a law against beach sand mining*. Although not done anymore, this activity must be prohibited, to prevent future beach sand mining.

3. *Issue a law against driving on the beach*. This recreational activity is deteriorating coastal habitats.

4. *Carry out an EIA for proposed coastal structures*. Specific focus on marine environment and coastal erosion and sedimentation.

5. *Cultivate and protect beach vegetation.* Planting plants and shrubs for the stabilisation of dunes.

General interventions

It was found worthy to introduce general possible interventions for more than one theme, which are not exclusively for a specific theme.

1. *Improve education and public awareness on marine ecosystem*. The Palestinians should be made more aware of the precious ecosystem they live in and are dependent upon.

2. *International co-operation in research*. Much more research of the sea is needed. This research must not be carried out in the isolated environment of the Gaza strip, but international co-operation should be looked for.

5.3. List of interventions

For each theme a number of interventions are defined and presented in Table 5.1. while Table 5.1 summarises the interventions. Subsequently each intervention is worked out on an intervention sheet, which are presented in Appendix II.

Table 5.1. Evaluation scores for each intervention.

Themes and Interventions:	Environmental aspects	Technical aspects	Cost / Financial aspects	Socio-economic aspects	Legal / Institutional aspects	Total score
Water quality						
1.Model study to the coastal pollution	++	+	+	+	++	**7**
2.Establish marine pollution laws	++	++	+	+	+	**7**
3.Monitor the sea water quality	++	+	0	+	++	**6**
4.Bioaccumulation investigation	+	+	0	++	++	**6**
5.Prevent marine pollution from Ports	++	+	0	+	+	**5**
6.Strengthen emergency response unit	+	+	0	+	++	**5**
7.Small scale waste water treatment	++	0	0	+	+	**4**
Fish & Fisheries						
1.Control catch size	++	++	++	+	++	**9**
2.Train fishermen	++	++	+	+	++	**8**
3.Create alternative employment	++	+	+	++	+	**7**
4.Implement seasonal trawling	++	++	+	+	+	**7**
5.Regulate mesh size	++	++	0	+	++	**7**
6.Study fish diseases	+	++	+	+	++	**7**
7.Expand the fishing zone	+	++	++	++	0	**7**
8.Develop alternative fishing gears	++	+	0	+	++	**6**
9.Implement a quota system	+	+	+	+	+	**5**
10.Breed fish	+	0	0	+	+	**3**
Habitats & Biodiversity						
1.Assess coastal biodiversity	++	++	+	+	++	**8**
2.Establish protected areas	++	++	+	+	+	**7**
3.Create artificial reefs	++	+	0	+	+	**5**
4.Use biological indicators	+	+	0	+	++	**5**
Beaches						
1.Coastal solid wastes collection	++	+	0	++	++	**7**
2.Protect Kurkar and rocks	++	++	+	+	+	**7**
3.Protect beach vegetation	++	+	+	+	++	**7**
4.Prevent beach driving	+	++	++	+	+	**7**
5.Mitigate coastal erosion plans	++	0	+	+	++	**6**
6.Proper beach cleaning	++	0	0	++	++	**6**
7.Expand beach-watching posts	++	+	+	+	+	**6**
Information & Media						
1.Establish school program	++	++	+	++	+	**8**
2.Train staff	++	+	+	++	++	**8**
3.Train farmers	+	++	++	+	++	**8**
4.Public awareness program	++	+	0	++	+	**6**
5.Establish information centre	++	+	0	++	0	**5**

6 Institutional Development of Coastal & Marine Environmental Protection

The purpose of this chapter is to maintain a national integrated (Government-local community) institutional framework capable of effective response to environmental pollution incidents in the coastal and marine environment and to manage associated activities and training programs to support National Plan activities.

In this regard , three task forces have been established to develop protection plans for the selected themes: sand exploitation, coastal erosion and marine pollution. These task forces are responsible to plan the necessary protective measures at a technical level. Also, at a policy/strategy level a **C**oastal and **M**arine **E**nvironmental **P**rotection **C**ommittee (C&MEPC) has been established to approve the proposed protection plans before they are submitted to the Ministry of Environmental Affairs, as well as to monitor and co-ordinate the implementation of the plans.

During the project period the following activities in the field of institutional development have been performed:

- Three Environmental Protection Task-Forces,
- Draft Environmental Action Plans (for three environmental areas),
- Coastal and Marine Environmental Protection Committee,
- Legal framework for C&M Environmental Protection.

6.1 Environmental Protection Task Forces (EPTF)

The Environmental Protection Task forces (EPTs), instituted by the Coastal and Marine Environmental Protection Committee (C&MEPC). During the regular meetings of the task forces, three main themes have been addressed (sand exploitation, coastal erosion, marine pollution) .The themes are not directly interrelated and each concern a different group of stakeholders. Therefore, the main responsibility of the task forces was to design the protective measures that are required and come up with an Environmental Action Plan for each theme.

6.1.1 Objectives of the task forces

The objectives of the task forces for coastal and marine environmental protection are as follows:

1. To identify and to prioritize which protective measures needed to be taken and to determine the division of labour between the institutions and agencies that may implement them.

2. To jointly analyze the environmental situation with regard to sand exploitation, coastal erosion and marine pollution respectively.

3. To identify and to prioritize a combination of physical, administrative and enforcement measures to protect and to improve the coastal and marine environment.

4. To assist the Ministry of Environmental Affairs (MEnA) to monitor the impact of the environmental protection projects.

5. To anticipate in selecting the socio-economic developments that have been affecting the coastal and marine environment (each EPTF in its respective area) and proposed some recommended interventions to the C&MEPC.

6.1.2 Composition of the Task Forces

The composition of the task forces is given in Table 6.1:

Table 6.1- Task Forces

Task Forces	Stakeholder Organizations	'Auxiliary Members'	Chairmanship/ Secretariat
Coastal Erosion Task-Force	-Ministry of Local Government + -Ministry of Environmental Affairs (MEnA) + -Central Planning Committee + -Ministry of Public Works + -Ministry of Transport -Ministry of Agriculture -Palestinian Coastal Police + -Gaza Municipality + -Khan Younis Municipality **Seaports Authority *** + -UNRWA -Islamic University -Bait Lahia Municipality	❑ Islamic University ❑ Ministry of Transport ❑ Ministry of agriculture ❑ UNRWA ❑ Khan Younis Municipality ❑ Other organizations	**chairmanship:** Ministry of Public Works **Secretariat**: MEnA
Sand Exploitation Task Force	-Ministry of Local Government + -Central Planning Committee + -Ministry of Agriculture -Ministry of Housing -Ministry of Finance; Land Reclamation **-Sand Directorate ***; General Security + -Ministry of Environmental Affairs (MEnA) + -Ministry of Tourism	❑ Ministry of Agriculture ❑ Ministry of Tourism ❑ Ministry of Finance, Land Reclamation ❑ Other Organizations	**Chairmanship:** Sand Directorate/ General security **Secretariat**: MEnA
Marine Pollution Task- Force	-Ministry of Public Works + -Ministry of Agriculture; Fisheries -Ministry of Transport -Ministry of Environmental Affairs (MEnA) -Ministry of Local Government -Ministry of Industry -Gaza Municipality + **-Palestinian Water Authority *** + -Civil Defense -Palestinian Coastal Police + -Fishermen Association -Ministry of Health	❑ Ministry of Industry ❑ Ministry of Transport ❑ Ministry of Health ❑ Civil Defense ❑ Other Organizations	**chairmanship:** Ministry of Agriculture/ Fisheries Dep. **Secretariat**: MEnA

*) Representative of Task-Force in the Committee
+)Member in two or more of the task forces

6.1.3 Role of the Task Forces

The Ministry of Environment is the initiator to jointly address the environmental protection of the coast and marine. The envisaged role of the Ministry is to convene the task-forces meetings and prepare the minutes. The role of the Ministry is to highlight the environmental concerns in each area and to suggest a list of interventions.

As the coastal and marine environmental issues in Gaza are of an international nature, it is important to involve the neighbouring countries, such as, Egypt and Israel. The Ministry, especially its Division for Marine and Coastal Management, with the assistance of the consultants, obtained information from neighbouring countries regarding development projects that may affect the coastal & Marine environment of Gaza.

The key stakeholders who have been identified in the early phase of the project and who are involved in solving (or causing) the environmental degradation have taken up an active role and have participated regularly in the meetings that were dealt with the coastal and marine environmental problems. Local authorities, including regional councils and municipalities have played an important role in the prioritisation of the proposed EAP elements and their related measures.

Coastal Erosion & Sand Exploitation Task Forces:

The role is to discuss the driving forces that cause negative impacts (pressures) on the coastal erosion, sand resources and other related environmental measures. Of the issues that were raised during the meetings:

- main coastal erosion and protection problems
- themes and targets
- long list of interventions,
- current status of the sand resources and exploitation,
- major environmental problems related to sand quarrying,
- -pressures and impacts on the coastal sand resources,
- to propose emergency natural resources protection plans,
- interventions for sand conservation and exploitation,
- -proposed pricing of sand.
- socio-economic, technical and institutional aspects of the coastal erosion and sand exploitation.

Marine Pollution Task Force:

The role is to discuss the driving forces and that cause negative impacts on marine ecosystem. Of the key issues raised during the meetings:

- habitat & biodiversity (Habitat destruction, habitat disturbance and lack of knowledge),
- beaches (solid waste on the beach, erosion, sewage and oil spills),
- fish and fisheries (over-fishing, by-catch, fishing gears, limits of fishing zones and lack of laws),
- water quality (sewage, solid waste, chemicals and oil spills),
- information and media (lack of awareness and lack of training).

Area of Activities of the concern institutions

Stakeholders and other parties who deal with the coastline and marine environmental protection and their area of activities are shown in Table 6.2:

Table:6.2 ***Different organisations that play role in the coastal and marine protection of Gaza strip.***

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 issues licenses and develops fishing technology. - Landing site administration includes the collection of fish landings statistics - Hatchery and fishing activities not yet implemented.
Ministry of Local Governments	Member of the three task forces	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 Cornish 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	Member of the Marine Ecosystem and Pollution Task Force	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 Ports Authority	Under the Ministry of transport	Co-ordination of construction of Sea Port
Palestinian Coastal Police(PCP)	Member of the Marine Ecosystem and Pollution Taskforce	The role of the naval police in fisheries sector is: • –Controlling the security within the fishing port. • – Checking access to the fishing ports. – Security approval for the fishermen's licenses
Civil Defence	Member of the Marine Ecosystem and Pollution Taskforce	Emergency response
Gaza Municipality	Member of the Marine Ecosystem and Pollution Taskforce	Land use planning and regional development over Gaza city.
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 cooperative building, stores and ice plant.	Services include fuel, ice, fishing gear, and a health/accident insurance scheme. The co-operative 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	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). The association also promotes practical training and initiatives such as the establishment of a 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

6.1.4 Community participation and Public awareness

Involvement of the public and private sector in the implementation of the proposed Environmental Action Plans (EAPs) and their related measures is very important. Any proposed measures that may have an impact on these sectors, or certain target groups within the society, early communication, explanation of the measures and the direct consequences have to be communicated. During the meetings and workshops, many interesting issues raised the need to arrange for community participation and public consultation. The task forces considered this sector and agreed on some activities in this regard. Moreover, some relevant community groups were identified and some representatives have participated in the task forces.

6.2 Environmental Action Plans (EAPs)

The implementation of the proposed EAPs elements and measure require that the infrastructure is taken fully into account, special attention has to be given to :

1. Realistic and clear division of tasks and responsibilities among the involved authorities, ministries and municipalities,

2. Ensuring that knowledge and manpower will be available to prepare and implement the measures. Institutional development and capacity building measures might therefore be necessary prior to the implementation of the environmental measures. It will be the

responsibility of MEnA to monitor the impact of the measures on the coastal and marine environment.

Financial and economic aspects have to be taken into account during the preparing and implementing the environmental action plans. These EAP include, for instance, total cost for investment, operation and enforcement, the environmental and economical benefits that are associated with the measures and the option of cost recovery. " The polluter pays" principle is one of the methods that might be applied to realize the cost recovery. Aspects that are important here are:

1. There should be a clear link between the pollution that is caused and the polluter ,
2. The capability of the target groups to pay the fees,
3. The possibilities to enforce the system in practice. One of the sectors in which this "polluter pays" principle might be applied directly is the industry.

These financial and economic aspects have to be elaborated. This is essential for including the sequence environmental measures on the annual Palestinian Development Plans. Further more, it will ease the search for local, bilateral or multilateral financial resources.

Cost recovery is important to implement, operate and provide follow up for all sorts of environmental measures. For direct "line" responsibilities and work loads of MEnA and other authorities, cost recovery might be considered if a direct link can be identified between these work loads on one hand, and their direct environmental benefits for public target groups on the other hands.

Environmental Action Plan (EAP), consisting of a prioritized list of protective measures, described in the form of a number of smaller or larger projects which can be presented for funding. These projects are as follows:

Coastal Erosion:

1. Coastal Erosion Protection in the North Sector of Gaza Coastal Area
2. Action Plan for the Gaza Southern and middle Coastal Area
3. Hydrographic Monitoring and Offshore Sand Inventory of Gaza Coastal Area

Sand Exploitation :

1. Crushing Plant For Construction Waste and Kurkar For reuse As construction Material
2. Plant For Making Of Bricks Made Of Clay For Construction

Marine Ecology:

1. Monitoring Sea water quality of Gaza Strip
2. Gaza Fisheries Management
3. Solid Waste Collection

4. Habitat and Biodiversity

6.3 Coastal &Marine Environmental Protection Committee (C&MEPC)

The Gaza coastal zone is experiencing a rapid growth of its population and economy, which evidently is resulting in a steadily increasing stress of the coastal and marine environment. To address this matter the Ministry of Environmental Affairs has taken the initiative to establish a Coastal and Marine Environmental Protection Committee (C&MEPC). The Committee members have been appointed after the 2nd regional workshop that was held in August 2000 and a presidential decree has been prepared by MEnA and the decree needs to be approved by the Chairman of the Palestinian National Authority.

Objectives
The overall objective of the committee is to protect and improve the coastal and marine environment of Gaza, of these objectives:

1- To advise the cabinet regarding timely and adequate coastal and marine environmental protection measures.

2- To get a feed back from MEnA and the other task forces regarding the proposed and the ongoing activities in coastal and marine protection.

3- To entitle and to take part on an equal footing in any system of research and regulation for purposes of conservation of the living resources of the coastal and marine protection.

6.3.1 Roles and responsibilities

The Coastal and Marine Environmental Protection Committee has been assigned with the following roles and responsibilities:

1. to monitor the environmental status of the coastal zone and marine waters, which information is to be kept up-to-date in the Gaza Coastal and Marine Environmental Management Information System (GAMIS) at the Ministry of Environmental Affairs,

2. to initiate studies and research to gain a better insight in the trends and alternative solutions to emerging coastal and marine environmental problems,

3. to prepare strategies and polices to protect and to improve the coastal and marine environment, which will be submitted to the Cabinet for approval,

4. to recommend any administrative measures or additional legislation which will improve the protection of the coastal and marine environment,

5. to coordinate, monitor (and enforce) the implementation of appropriate coastal and marine environmental protection measures by the stakeholder organizations concerned,

6. to initiate specific environmental protection programs or projects and secure funding for implementation,

7. to generate public awareness and to stimulate community participation on the issue of coastal and marine environment protection.

6.3.2 Composition & Membership of the Committee

The committee members have been finally approved during the 2nd workshop (11 members), names of the committee are shown in Table 6.3.

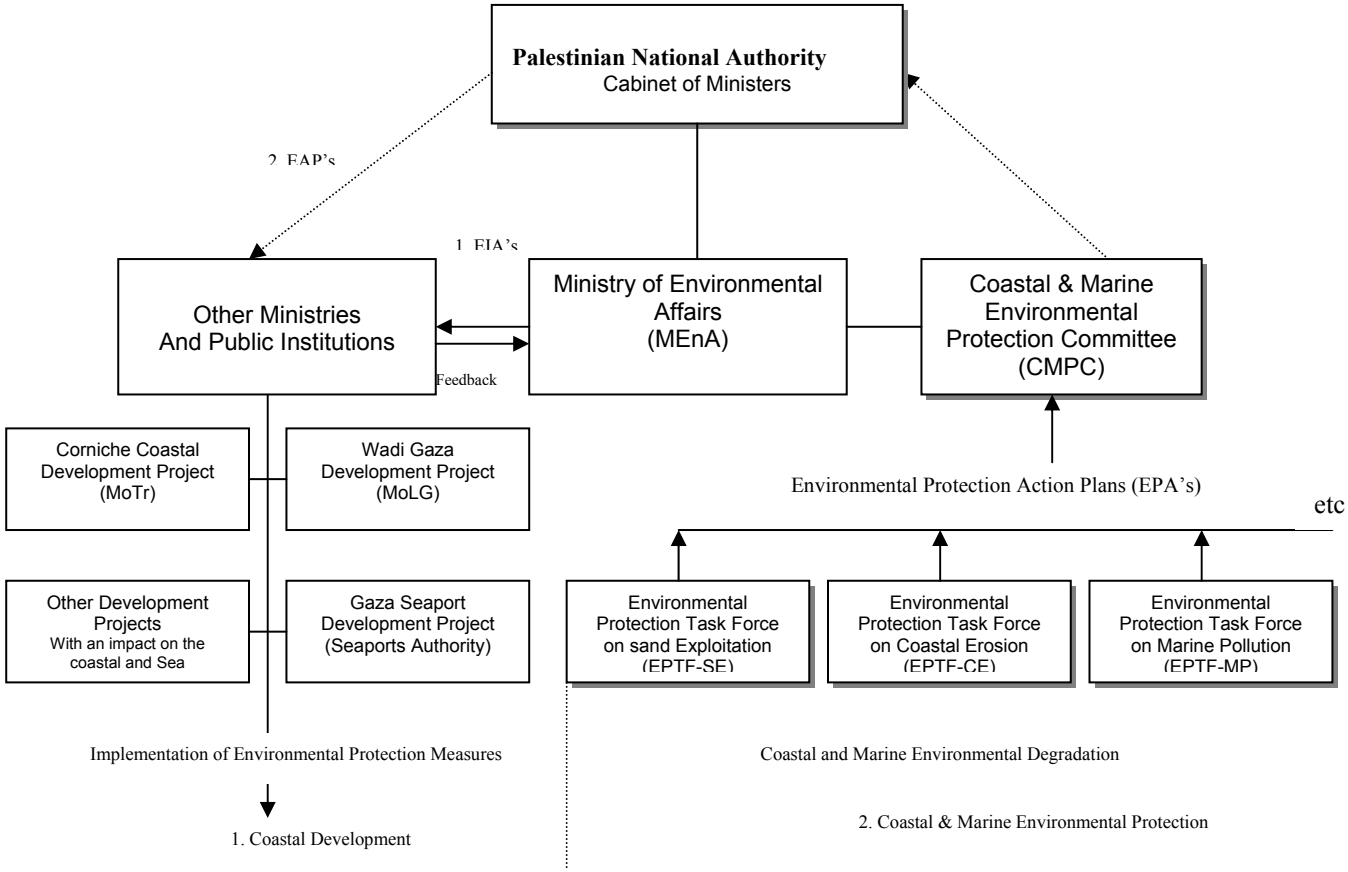
***Table 6.3:** Committee members of the C&MEPC*

Name	Post
-Ministry for Environmental Affairs	Chair
Ministry for Local Government	Vice-chair
Ministry of Planning and International Cooperation	Member
Ministry of Finance	Member
Ministry of Agriculture	Member
Ministry of public Works	Member
Gaza Municipality	Member
Seaports Authority	Member
Sand Directorate; General Security	Member
Palestinian Water Authority	Member
Palestinian Coastal Police	Member

- The Chairman of the Committee is the Minister for Environmental Affairs or his designated representative.
- The Vice-Chairman of the Committee is the Deputy Minister for Local Government or his designated representative.
- The Secretary to the Committee is the Director General of the Ministry for Environmental Affairs.
- The Members of the committee are at the level of Director-General or equivalent.

The institutional framework for the Coastal and Marine Environmental Protection Committee is given in the Figure 6.1. The task forces recommended protection measures that may minimize the threat on the marine and coastal environment in Gaza. Moreover, for developmental activities, Environmental Impact Assessment (EIA) unit has been established at MEnA. Adequate protection measures defined by MEnA would be a condition to granting environmental approval.

Figure 6.1: Institutional framework for coastal & marine environmental protection



Internal Regulations

- The committee may invite other institutions, agencies, stakeholders to attend meetings as a co-opted member (= no vote), depending on the issue.
- The committee will prepare the by laws for its internal procedure.
- The committee may install (and end) Task Forces, to investigate coastal and marine environmental issues and to prepare recommendations.
- The committee will formulate the assignment of each task force, their composition, expected output and envisaged time frame.
- The committee will advise the Cabinet, on request or on its own initiative, on any matter to protect /improve the coastal and marine environment.
- The required quorum will be more than half (six out of eleven) of the members.
- The decisions shall be taken by the majority of the members present. In case of a draw, the vote of the chairman will be decisive.
- The Secretary of the committee is the Director General of the Ministry of Environmental Affairs.

- The committee will meet once every three months.
- The approved EAPs (C&M environmental plans) must be implemented.

6.4 legal framework for C&M Environmental Protection

In addition to the institutional arrangements, also the legal basis of protecting, improving and developing the environment in the coastal zone and the marine waters are required. As an elaboration of the approved Environmental Law further legislation has been formulated to better cater for the coastal and marine environment.

Currently, the roles and responsibilities of MEnA with regard to the marine environment, as described in the Environmental Law of October 1999, are reflected here below:

- Set standards for the quality of sea water (article 31)
- Specify the necessary environmental conditions for coastal or off-shore construction (33)
- Set rules and regulations for the prevention of pollution, preservation and control of the marine environment, caused by economic activity at land or in the sea (art. 35)
- Set rules and regulations for the prevention of pollution, caused by dumping (art. 36)
- Set rules and regulations for the prevention of pollution, generated by ships (art. 37)

The other articles in the Environmental Law's chapter on Marine Environment state:

- It is forbidden to cause sea pollution (art. 32)
- It is forbidden to affect the natural track of the beach, unless Environmentally Approved (34)
- All entities, including ships, are forbidden to discharge oil or other pollutants (art. 38)
- All companies authorized to undertake digging or exploration, production, manufacturing or exploitation of oil or other marine resources shall abide to the environmental conditions (art. 39).

Particularly article 35 regarding the Ministry's mandate and responsibility to set rules and regulations for the prevention of pollution, preservation and control of the marine environment, caused by economic activity at land or in the sea, provides the legal basis to take the initiative to devise environmental protection action plans. And it should be stipulated that in this context MEnA is creating the Coastal and Marine Environmental Protection Committee.

The present legal framework for the three task forces that have been established by MEnA is reflected in the relevant articles as shown below.

1. EPTF- Sand exploitation:

- All companies authorized to undertake digging or exploration, production, manufacturing or exploitation of oil or other marine resources shall abide to the environmental conditions (art. 39).

EPT F- Coastal erosion:

- Specify the necessary environmental conditions for coastal or off-shore construction (33)
- It is forbidden to affect the natural track of the beach, unless Environmentally Approved (34)

EPT F- Marine pollution:

- Set standards for the quality of sea water (article 31)
- Specify the necessary environmental conditions for coastal or off-shore construction (33)
- Set rules and regulations for the prevention of pollution, caused by dumping (art. 36)
- Set rules and regulations for the prevention of pollution, generated by ships (art. 37)
- It is forbidden to cause sea pollution (art. 32)
- All entities, including ships, are forbidden to discharge oil or other pollutants (art. 38)
- All companies authorized to undertake digging or exploration, production, manufacturing or exploitation of oil or other marine resources shall abide to the environmental conditions (art. 39).

6.4.1 By-laws

In the course of elaborating the environmental protection measures it becomes apparent that some of the administrative measures, especially with regard to licensing and law enforcement, there is a need to contain them in a set of by-laws for coastal and marine environmental protection. The Legislation Division has taken this up, with the assistance of the consultant and with inputs from the respective task forces.

Preparation of the by-laws depends on the concrete protection measures that were recommended by the respective task forces. The structure of a legal framework for this, based on the related legislation in Egypt and Israel, has already looked into.

6.4.2 Preparation of a Memorandum of Understanding

The mandate of the C&MEP Committee has been described in as follows:

- to jointly assess the environmental status of the coastal zone and marine waters,
- to install task-forces for different environmental aspects, which will be assigned to prepare an Environmental protection Action Plan within a given time frame,

- to initiate studies and research to gain a better insight in the trends and alternative solutions to emerging coastal and marine environmental problems,

- to approve the Environmental protection Action Plans prepared by the task-forces, taking into account any cross-sectoral issues or physical planning concerns, before submitting them to the Minister for Environmental Affairs,

- to advise the Minister for Environmental Affairs on required initiatives to protect, to improve the coastal and marine environment,

- to provide a forum to coordinate and to monitor the implementation of the coastal and marine Environmental protection Action Plans (EAPs),

- to recommend to the Minister any adjustments or additional measures to be taken, and by which party, on the basis of the monitored outcome and impact of the implemented protection projects.

7 GAMIS - Gaza Coastal and Marine Information System

The Gaza coastal and marine information system used in supporting the actions and interventions in the coastal and marine environment, which included information on the status and progress of coastal development. GAMIS also supported the preparation of the coastal and marine management plan itself. The system will be based on easy access to up-to-date information. The information, which inserted in GAMIS, was collected from a wide range of different sources and organisations.

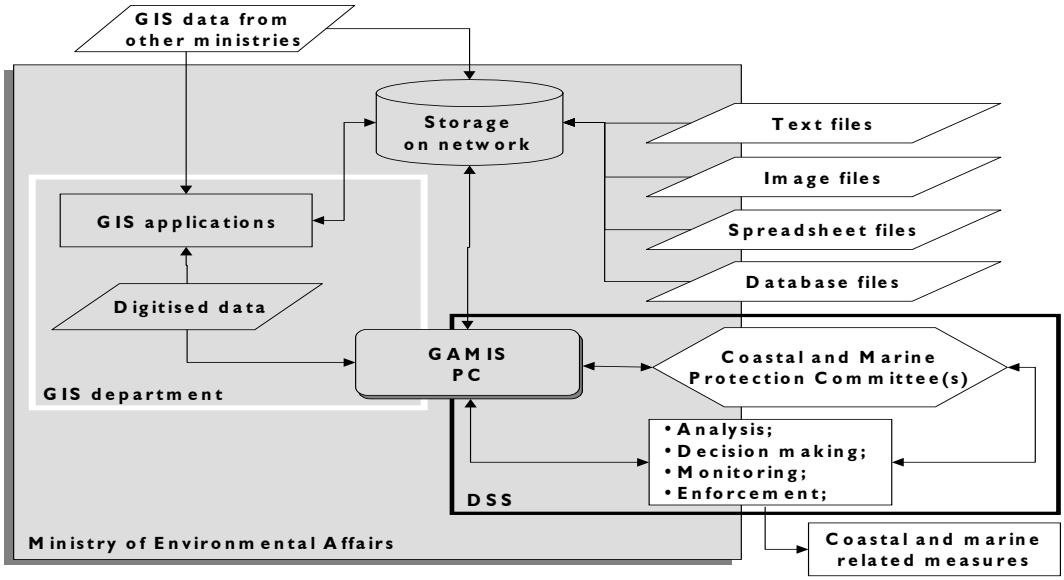
The Coastal and Marine Management Information System was designed to meet the following requirements:

- group and store existing digital coastal information;
- create access to coastal information by means of an intuitive and logical user interface (maps);
- assign real world co-ordinates to digital images, orthophotos and/or maps;
- visualise existing GIS files (ArcView shapefiles, ArcInfo coverages, CAD export files etc);
- generate user defined data by drawing objects on the map;
- attach and store information about these objects, like meta information or attached text documents.
- retrieve information about objects, including attached documents, by means of queries on the basis of criteria or spatial relationships.

7.1 Organisational Framework and data structure

GAMIS playing an important role in the decision making process. Based on available data interventions and measures will be defined. The position of GAMIS in the Ministry of Environmental Affairs as well as part of the DSS is given in figure 7.1.

Figure 7.1: Organisational framework for GAMIS



The grey block represents the Ministry of Environmental affairs. The white rectangle is the GIS department, an important data supplier to the system for GIS data. Other data to supply to the system is the, so-called additional data. Several types of digital available data were stored. Data is stored on a network drive. On a central personal computer the first working version of GAMIS was installed. This data source, the Coastal and Marine Protection Committee and the process of Analysis, Decision making, Monitoring and Enforcement in total is the Decision Support System. All this results in taking coastal and marine related measures in the coastal area.

7.1.1 Data structure

Depending of the availability of data an agreement reached about the data stored in GAMIS. The following steps were followed:

Base maps

Base maps are necessary to add to the system. The following base and thematic maps were needed:

- Topographical Map;
- Land Use Maps
- Coastal Structures;
- Bathymetrical maps;
- Archaeological maps;

Geographical data according to the problem areas (themes)

According to the work plan the following classification were made:

- *Sand exploitation theme*
  - Sand exploitation locations;
  - Sand dunes locations;
- *Coastal Erosion theme*
  - Erosion locations;
  - Erosion patterns;
- *Marine Ecology theme;*
  - Fishery areas, locations and see ports
  - Habitats;

The system was very flexible and easily extendible with e.g. other environmental themes like:

- *Coastal Ecology;*
- *Wadi Gaza;*
- *Depletion of water resources;*
- *Deterioration of water quality;*
- *Locations of public health and ecological hazards (like solid waste dumping and wastewater outlets in the coastal zone);*

Additional data

Additional data was explanatory for the spatial related data. Examples of this additional data are: text files, pictures, movies etc. For the three main themes in this study additional data were localized, collected and digitized. Below a list of possible files that can be 'linked' to the geographical object describing the problem themes.

Sand exploitation theme:

- spreadsheet file(s) describing quantities;
- text file(s) describing features of the quarry (quality and texture of the sand, area of the quarry etc.);
- text file(s) describing license information about the quarry (owner, address, phone number, quantity, destination etc.);
- text file(s) describing the legislation/policy about sand quarrying;
- image file(s) about the quarry location;
- movie about the way of quarrying;
- text file describing current and previous projects involved in coastal and marine (sand) management (project name, owner and objectives, type of activities, outputs, project extent, costs and time period)
- other;

Coastal erosion theme:

- text file(s) describing the coastal erosion situation for that specific location;
- file(s) with monitoring results;
- spreadsheet or database file(s) describing the current situation;
- image file(s) about the location of (local) erosion;
- other;

Marine Ecology theme:

- Fisheries
    - text file(s) describing the fishery situation;
    - spreadsheet file(s) describing species composition;
    - spreadsheet file(s) describing catches;
    - text file(s) describing monitoring programs;
    - image file(s) about harbours, fishing boats species etc.
    - other;

- Fish
    - text file(s) describing species composition;
    - spreadsheet file(s) describing species composition;

- Marine Fauna (other)
    - spreadsheets describing macrobenthos;
    - spreadsheets describing marine mammals, reptiles and amphibians;

- Marine Flora
    - text file(s) describing species composition;
    - spreadsheet file(s) describing species composition

8 Conclusion and Recommendation

8.1 Conclusion

8.1.1 Marine and Coastal Ecosystem

The marine and the coastal ecosystem of Gaza strip were studied in details during nine months period of the Life project. The ecosystem identified into four major themes the water quality, the fish and fishing, the habitats and biodiversity and the beaches. Additional comprehensive theme the information and media introduced for the benefits of the above themes. The problems of each theme have identified in details to conduct actions and interventions for the ecosystem. For each theme a number of interventions have been suggested and introduced to meet the environmental requirements of the ecosystem. Moreover the interventions translated into four major projects. Both the interventions and the projects prioritirized on the bases of created ranking criteria, and accordingly the projects are divided into two groups; the first group consists of two projects firstly the monitoring of the seawater quality and secondly the fishing management while the second group consists of solid wastes collection, habitats, and biodiversity.

The current status showed that the marine and the coastal ecosystem of Gaza strip encountered sever pressure and threats. The seawater is highly polluted by both the swage flow and the solid wastes dumping, although work on the monitoring of the seawater quality appears to be limited. Therefore the coastal, the marine habitats, and the biodiversity are already threatened.

The beach habitats and biodiversity are under threats and pressure from constructions, erosion, and crowds of the beach users, sewage flow, and solid wastes dumping and use improper environmentally friendly cleaning machines.

The fish and fisheries was found one of the major problem in the marine ecosystem of Gaza strip as a result of very small fishing zone, over fishing, lacks of fishing laws, little use of fishing technology and use small size of mesh and hooks. The fishing gears and the fishing methods were also found not well improved and well developed causing a lot of destruction and damage to the marine ecosystem including the fish and the seabed fauna and flora.

The habitats and the biodiversity of the ecosystem are already threatened and in contrast few efforts have been paid on conservation and protection as establishing of protected areas, breeding and research centers, artificial habitats, use of technology, issue environmental laws and establish emergency response units.

Moreover the study shows that few efforts have been paid on the public education, public awareness programs, training programs on bio-conservation and protection in addition to the limited regional cooperation in this field.

8.1.2 Beach Erosion

When looking to the entire shoreline of the Gaza Strip, it is clear that there are great differences between the situations in the north and in the south (where we assume the boundary just north of the Wadi Gaza).

North of Wadi Gaza the situation (including the Gaza Seaport) is very complicated. The Beach Camp, and the fast near-coastal developments in Gaza City itself and between Gaza City and the N-border, show many examples where developments have already taken place right on the beach. In the entire area North of Wadi Gaza the coastline will in the near future completely be 'engineered' in the sense that the entire coastline will be artificially protected against erosion which is a direct consequence of the construction of the Fishing Port and the proposed Gaza Seaport.

In the southern part of the Gaza Strip in contrast, the coast is still relatively free of major sand-interrupting structures. The near-coast built-up areas are confined to the Deir El Balah camp (which is a difficult point anyway). Although numerous scattered small-scale tourism facilities etc. are found along the dune ridge and on the beach, these are mainly temporary, restricted to the summer season.

The Wadi Gaza is one of the very few land areas of the Gaza Strip which used to have an important role in biodiversity. Its original function of a natural 'Wadi' has been compromised by an Israeli built dam just outside the border, and the continuous barbed wire fence around the Gaza Strip has effectively stopped the options for fauna migration into and through the Wadi.

It might therefore be interesting to investigate the possibility to permanently open up the Wadi on the seaside, in an attempt to re-vitalise it.

8.1.3 Sand Quarrying

Summary of analysis of present situation.

- Projected sand volume needed for housing/construction is 1 million m3/yr up to 2010.
- Much additional sand is needed for coastal protection (Gaza Sea Port etc.)
- At present, allowable sand volume to be exploited on land in the Gaza Strip is less than 8 million m3 in total. This available volume will further decrease due to natural resources protection policies.
- More work is needed in making detailed analysis of present and future Demand and Supply of sand, rock, clay and kurkar.

Conclusion 1: Serious sand shortage (deficit) will appear within 5 years from now.

Conclusion 2: Interventions are needed to guarantee sufficient supply for the construction of houses and the improvement of beaches, while at the same time protecting the environment and safeguarding the natural sand resources in a sustainable way.

8.2 Recommendations

8.2.1 Marine and Coastal Ecosystem

Avoid sewage and solid waste pollution by preventing the untreated sewage flow into the sea or on the beach, and collect the solid wastes and prevent dumping. Establish monitoring system for the seawater quality and use biological indicators for this system.

Mitigate the pressure and threats on the present fishing area of Gaza strip by regulate and develop the fishing methods and the fishing gears, as using reasonable sizes of meshes and hooks, use fishing technology and expand the fishing zone.

Protect the beach from pollution, erosion and improper cleaning by preventing beach constructions as buildings and beach driving. clean the beach by environmentally friendly machines, protect the beach and the marine habitats as kurkar, rocks and plants, create beach watching system for observation and reporting on the status of the ecosystem and establish structures as waves and wind breakers.

Protect the beach fauna and flora and encourage them to develop by established protected areas one at Gaza valley and two beside the borders one at the north and one at the south; train the staff, farmers and fishermen on protection and conservation, establish breeding and research center for study and development, preferably to be at Gaza valley, establish environmental law for protection of the threatened species as some immigrant birds, establish environmental emergency response units, encourage model environmental studies and use biological indicators, establish special unit or department at the ministry or at the university for coastal and marine environmental studies and use coastal and marine environmental technology as equipments, data and programs and train the stuff and the workers on their use.

Establish regional cooperation programs with other countries for research, studies, meetings and held conferences on the coastal and marine environment of the Mediterranean Sea.

Moreover it is worthy to establish media and information centers for observation, reporting, education and public awareness.

8.2.2 Beach Erosion

Establishing and enforcing a 'Set-Back-Line' or SBL

Not only Roads, houses, hotels, restaurants, but also agriculture and horticulture infrastructure, should simply stay away from the dune face and cliff edge, behind a safe limiting line. This is called the 'set-back-line'. The principle to stay behind such 'Set-Back-Line' or SBL with all future coast-related developments, small and large, public and private, is nowadays widely accepted and welcomed as a major Coastal Zone Management principle.

The sooner such SBL is implemented the better. Any delay will cause extra trouble, because people simply tend to stake their (private or commercial) claims very close to the shoreline as soon as they feel it is profitable to do so.

In principle, all existing structures seaward of the SBL should be removed as well. There may be exceptions to this principle, but in exceptional circumstances only , e.g. if high public interests demand so. The more exceptions are tolerated, the weaker the SBL is as an instrument of coastal zone policy, and the faster public support for this principle will erode.

A number of important questions are to be addressed before a SBL is defined and made effective:

- how far should this SBL be from the cliff edge? (This could be in the order of 100 m.)
- how can this distance be determined in a scientific and socially acceptable way?
- should the SBL be everywhere the same, in built-up areas and in rural areas?
- how must the SBL be established legally
- should the SBL be visible on the ground?
- can nothing be built seaward of the SBL?
- can the SBL be used as a major public leverage to help establish and strengthen CZM?
- may the 'Corniche' play a role in establishing the SBL?
- can the SBL be implemented very soon, maybe in a preliminary form to start with?

These questions should be addressed soon, beit only because the plans for the alignment of the Corniche will be detailed soon.

Establishment and enforcement of a SBL is a major intervention and should be carefully planned. A broadly composed Committee, representing all stakeholders, should be called for advice in order to secure a qualitatively sound, widely acceptable, and effective result.

We recommend that something like establishing a SBL should happen fast to prevent the **further creation of enormous erosion-related problems**, where there would only be a minor problem (i.e. the generally slow natural coastal retreat), if one had enforced a 'no-build zone' parallel to the beach.

Waves at the Gaza coastline have never been recorded in a systematic way, it is strongly recommended to conduct this type of wave measurements offshore Gaza itself.

A detailed bathymetric survey along the entire Gaza coast is expected soon to be made and detailed survey of sea bed characteristics which will show areas of sand, mud, Kurkar ridges and possibly areas covered with sea grass is planned by the Fisheries Department in the framework of a Danish fishery project. It is recommended to establish a coordination team between the fishery department and other organisation related to marine environment for maximum benefit of the information obtained.

Keep the mouth of Wadi Gaza open

A set of two specially designed jetties might keep the mouth open. That must first be checked in a preliminary feasibility phase. If that is possible, the tidal in- and outflow but especially the tidal range in the mouth and the lower stretch of the Wadi will certainly add to the dynamics of the habitat. The alternating flow might be increased through the excavation of some land at MSL, which measure would simultaneously increase the physical area where new micro-tidal colonisation of flora and fauna could occur. The excavated sand might be sold to support the cost of constructing the jetties.

8.2.3 Sand Exploitation

A first 'long list of interventions' showing 17 items has been recommended during the previous months by the Task Force for the sand exploitation problem. These (and possibly additional) items may be reshuffled into two groups with a different character:

Group 1 Interventions which are in the first place aiming to relieve the future sand deficit: **increase the Supply, and decrease the Demand**

Group 2 Interventions which primarily **aim at protection of the environment**, and therefore are likely tending to increase the future sand deficit.

Both groups are needed, and much creativity will be asked to define a balanced set of interventions.

Group 3 is defined as an additional group containing actions **to generate the needed additional quantitative information regarding future Demand and Supply**

Group 1

- Open new quarries (but in an environmentally acceptable setting)
- Use existing quarries more effectively
- Reduce sand Demand (in various ways: pricing policy; new techniques; public information)
- Reuse construction waste
- Use crushed rock (kurkar) instead of sand
- Introduce clay bricks for construction
- Use offshore sand
- Import sand (from West Bank/Egypt/Israel)
- Reclaim sand stolen by Israel

Group 2

- Define good engineering practices for sand exploitation
- Define terms and conditions for sand exploitation, focused on environmental protection
- Define rules and regulations for sand exploitation, focused on environmental protection
- Define institutional reforms for sand exploitation
- Implement land use plans
- Enforce regulations
- Define professional monitoring and inspection plan for sand exploitation
- Establish 'sand fund' to finance quarry site rehabilitation

Group 3: additional information and analysis related to Supply and Demand

- Supply: Full inventory to assess the present stock of sand (clay; kurkar) available, both on land and in the sea
- Supply: Assess the environmentally allowable exploitation of sand (clay; kurkar)
- Supply: Assess potential supply from alternative sources (construction waste)
- Supply: Assess potential supply from abroad
- Demand: Full assessment of sand (clay; kurkar) demand for individual classes of users
- Demand: Assessment of potential demand for alternative materials (construction waste)
- Demand: Assess potential reduction of demand due to pricing regulation

Recommended Institutional set-up for sand quarrying

With the creation of the sand directorate, the central committee and the ministry of environment with its active monitoring department we propose that:

- The applications for sand quarrying licenses should be through the central planning committee as per law and more professionalism, where all stakeholders are represented and meet regularly in the CC meetings.

- The role of the sand directorate should be enhanced in the field of monitoring of sand mining and other environmental issues; in this regard the ministry of environmental affairs should use to its best the human resources available in the sand directorate for monitoring and enforcement of environmental regulations.

- The environmental concerns should have a vito power over issues related to sand quarrying licensing through environment representative in central committee.

- A sub committee should be formed to review the sand exploitation plan every now and then.

The sand directorate should be nominated as a central committee member.

Recommended Pricing for sand and other quarried materials

Table 8.1- Proposed Prices for Sand

Type of Material	Government Tax Per cubic meter		Consumer Price Per cubic meter		Price of a truck Of 10 CUM	
	current	proposed	current	new	current	new
Clean sand (G)	6.3	19	25	40	250	400
Mixed sand (G)	4.5	14	20	30	200	300
Kurkar (G)	3	9	20	25	200	250
Clay (G)	3	9	20	25	200	250
Fill (G)	3	9	20	25	200	250
Clean sand (P)	3	15	25	40	250	400
Mixed sand (p)	2.8	9	20	30	200	300
Kurkar (P)	2	5	20	25	200	250
Clay (P)	2	5	20	25	200	250
Fill (P)	2	5	20	25	200	250

The effect of increase of sand prices on the construction sector will be marginal and the cost for one housing unit of 140 sq. m. is estimated by 26,000 US $. The unit consumes 50 cupric meters of sand, with current price equals 1250 NIS or 300 $, while in the proposed prices it will cost 2000 NIS or 500 $. The 200 $ increase in building a housing unit of 26,000 $ contribute to less than 1 % of the total cost.

Another benefit of that policy is to increase the government revenue and to minimize sand extraction and less sand is wasted at deferent sites.

Recommended Terms and conditions for Licensing

It is not possible for any one to open a Quarry or invest in it or operate it ether in his land or in others land except with a license issued specially for him in accordance with the Palestinian

mining law act number 109 for the year 1934 and all other regulates developed later by the PNA .

It is not possible for any one to extract from any quarry any material except that indicated in the license issued for opening of the quarry in accordance with the Palestinian mining law act number 109 for the year 1934 and all other regulates developed later by the PNA.

The license applicant must obey all other rules and regulations and procedures, as well as all terms and conditions specified for him in the quarries site and in case of violation of any of them the quarry license will be immediately cancelled.

The applicant has the full responsibility (public or private) and he is the in charge of applying all terms and conditions, all other violations may occur during or after quarrying activities is his responsibility.

Each site will have specific engineering and environmental conditions to be put before licensing and must be implemented, they deal with the following items:

- Amount of sand to be excavated
- Height of sand to be excavated
- Type and quality of sand to be excavated
- Height of sand to be left
- Contour of the area after excavation
- Surface inclination after excavation
- Landscape rehabilitation measures after excavations

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