Report on the baseline situation for IMAP common indicator 15 “Location and extent of the habitats potentially impacted by hydrographic alterations” in Egypt

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Preparation of this report

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Preface

The Ecosystem Approach (EcAp) is a strategy for the integrated management of land, water and living resources that promotes conservation and sustainable use in an equitable way, as stated by the Convention of Biological Diversity. EcAp goes beyond examining single issues, species, or ecosystem functions in isolation. Instead, it recognizes ecological systems for what they are: rich mixes of elements that interact with each other continuously. This understanding is particularly important for coasts and seas, where the nature of water keeps systems and functions connected. The Ecosystem Approach is also a way of making decisions in order to manage human activities sustainably. It recognizes that human's activities both affect the ecosystem and depend on it. Thus, it aims to improve the way human activities are managed for the protection of the marine environment. This understanding is particularly important for coasts and seas, where the nature of water keeps systems and functions connected.

At their 19th ordinary meeting (CoP19), held in Athens (Greece) from February 9 to 12, 2016, the Contracting Parties to the Barcelona Convention adopted the IG decision. 22/7 on the Integrated Monitoring and Assessment Program (IMAP) of the Mediterranean Sea and Coasts and related assessment criteria. This decision includes a specific list of 27 Common Indicators (CI) for the 11 Environmental Objectives (Eos° which will allow an integrated and quantitative analysis of the state of the marine and coastal environment to be achieved in order to achieve “Good Ecological Status”, encompassing both OE in three main clusters: pollution, including marine litter or litter, biodiversity, including non-native species; and the coastline and hydrography.

Ecological Objective 7 is dedicated to assess permanent alterations in the hydrographic conditions due to new developments. By definition, the term ‘hydrography’ is meant to include depth, tidal currents and wave characteristics of marine waters, including the topography and morphology of the seabed.

EO7 Common Indicator 15 considers only new developments, since existing structures have already changed the hydrographic conditions and potentially impacted the habitats. Since the baseline conditions before the construction of existing structures are unknown, the monitoring of CI15 for existing structures is not possible.

There is a clear link between EO7 and other ecological objectives, especially EO1 (Biodiversity). By definition of functional habitats under EO1, the priority benthic habitats for consideration in EO7 are to be selected. Ultimately, the assessment of impacts, including cumulative impacts, is a cross-cutting issue for EO1 and EO7. The guidance document on how to reflect changes in hydrographical conditions in relevant assessments was prepared in 2015, aiming to define a methodological approach for assessing alterations of hydrographical conditions and the impact this may have on habitats due to permanent constructions and activities on the coast or at sea (UNEP/MAP/PAP, 2015).

As for Protocols of the Barcelona Convention relevant for the EO7, the Protocol Concerning Specially Protected Areas and Biological Diversity in the Mediterranean (UNEP/MAP/PAP, 1999) calls to Contracting Parties of the Barcelona Convection for continuous monitoring of ecological processes, population dynamics, landscapes, as well as the impacts of human activities (Article 7b). In addition, it calls to Contracting Parties to evaluate and take into consideration the possible direct or indirect, immediate or long-term impacts, including the cumulative impact of the projects and activities, on protected areas, species and their habitats (Article 17).

Another Protocol of the Barcelona Convention, the Protocol on the Integrated Coastal Zone Management in the Mediterranean (UNEP/MAP/PAP, 2008), in its Article 9, calls for Parties to minimize negative impacts on coastal ecosystems, landscapes and geomorphology, from infrastructure, energy facilities, ports and maritime works and structures; or where appropriate to compensate these impacts by non-financial measures. In addition, the Article 9 demands maritime activities to be conducted “in such a manner as to ensure the preservation of coastal ecosystems in conformity with the rules, standards and procedures of the relevant international conventions.

The EC-funded EcAp MED III project (Full title: Support to Efficient Implementation of the Ecosystem Approach-based Integrated Monitoring and Assessment of the Mediterranean Sea and Coasts and to delivery of data-based 2023 Quality Status Report in synergy with the EU MSFD) will be implemented by UNEP/MAP in the framework of the GPGC Priority Area 1 – Component 4: International environment and Climate governance. It will support the delivery of a data-based 2023 Mediterranean Quality Status Report (2023 MED QSR) through support to the implementation of national IMAPs in the respective countries. It will also support harmonized assessment at national level through the preparation of national assessment factsheets. As such, the EcAp MED III project is directly linked to the implementation of the COP 19 Decision IG.22/7 on IMAP, of the COP 20 Decision IG.23/6, and COP 21 Decision IG.24/4 on the 2023 MED QSR Roadmap and Implementation Plan. Preparation of a baseline report on situation related to monitoring of CI 15 makes part of Activity 1.3.1 of the EcAp MED III Project.

The Ecological Objective 7 (Alteration of hydrographical conditions) addresses permanent alterations in the hydrographical regime of currents, waves and sediments due to new large-scale developments that have the potential to alter hydrographical conditions. An agreed common indicator “Location and extent of the habitats potentially impacted by hydrographic alterations” considers marine habitats, which may be affected or disturbed by changes in hydrographic conditions (such as currents, waves, suspended sediment loads).

For CI 15, the project will support the preparation of reports on the baseline situation in all eligible countries. It is not monitoring of a particular site/installation but rather gathering information on current situation as far as prerequisites for monitoring according to the agreed Guidance Factsheet. The methodology for the preparation of the report is therefore based on the existing guidance factsheet for CI 15, which specifies assessment criteria. Given that CI 15 concerns the development of new structures there are usually no fixed monitoring stations for CI 15. The monitoring needs to be based on the site selection for the new structure supported by monitoring stations (providing information that is statistically significant, during several years). Collection of information hydrographic parameters (such as currents, and waves, which are measured by buoys) are not always relevant to CI 15 since these can be in positions that differ from the locations of planned structures. Other hydrographic parameters are not measured through ‘fixed’ stations (such as bathymetry, which is done by sonar). Therefore, national activities related to this project component will be conducted in order to obtain information on planned structures/installations that could cause hydrographic alterations and potentially impact marine habitats as a consequence, and to identify specific sites for monitoring of CI 15. The information collected will provide the baseline for future monitoring of CI 15.

Objective of the assignment

This assignment is to prepare the report on baseline situation for IMAP common indicator 15 “Location and extent of the habitats potentially impacted by hydrographic alterations” for the Mediterranean coastal and marine areas of Egypt. It will be structured according to the contents presented in Annex 4 of the contract. As a reference document, also the Guidance Factsheet for CI 15 was taken into account.

The main output is a baseline situation for the common indicator 15 “Location and extent of the habitats potentially impacted by hydrographic alterations in the Egyptian Mediterranean coast”. The team preparing this report have communicated and worked in close contact with all relevant stakeholders (ministries, agencies, etc.) to gather all required information.

Deliverables

1. First, draft of the report on the baseline situation for the common indicator 15 “Location

and extent of the habitats potentially impacted by hydrographic alterations in Mediterranean coast of Egypt will be delivered by 15th of November 2021.

2. Final version of the Report will be delivered by 15th of December 2021 after comments received by the PAP/RAC secretariat

Duration of the assignment

The elaboration of the report on the baseline situation for the common indicator 15 "Location and extent of the habitats potentially impacted by hydrographic alterations in Mediterranean coast of Egypt will be conducted for a fixed period of fifteen (15) working days. It will start immediately after signing the contract, and long until the provision of the final version based on the comments made on the first draft of the document.

Assessment methods (CI15)

The methodology for assessment of this indicator is described in detail in Indicator Guidance Fact Sheet on Common Indicator 15. In brief, the methodology to assess the indicator can be divided in three main steps:

i) Baseline hydrographical conditions characterisation (monitoring and modelling of actual conditions without structure);
ii) Assessment of hydrographical alterations induced by new structure (comparing baseline conditions and with structure conditions, using modelling tools); and
iii) Assessment of habitats impacted directly by hydrographic alterations (by crossing hydrographical alterations and habitat maps).

Among hydrographical conditions, at least waves and currents changes should be assessed, with changes in sediment transport processes and turbidity in case of sandy sites, and salinity and/or temperature changes in case of structures that involve water discharge, water extraction or changes in fresh water movements.

The monitoring should focus on habitats of interest around new permanent constructions (lasting more than 10 years). At first, the spatial scale (in cross-shore and long-shore directions) to be used should be about 10 to 50 times the characteristic length of the structure, and should be enlarged depending on the first results obtained for this area.

To correctly assess changes in time on habitats induced by constructions, the monitoring should be performed: before construction (baseline conditions); during construction; and after construction - short term changes 0 to 5 years after (at least yearly up to 5 years), midterm changes 5 to 10 years after (at least biennium to 10 years), and long-term changes (10 to15 years after construction).

Since there has been no systematic monitoring on this particular indicator at the regional level until now, examples of intersection of modeled area of hydrographic alterations with habitat area were not found. The methodology applied in some partial examples consisted mostly in measurement of trends for certain hydrographic parameters (temperature, salinity, waves, currents, marine acidification etc.) and limited - mostly qualitative - analysis on impacts on habitats at the national level.

Review of the existing literature

Common Indicator 15

The EO7 Common Indicator 15 reflects location and extent of the habitats impacted directly by hydrographic alterations due to new developments. The major challenge on deriving concluding remarks for this indicator at the regional level is that the national monitoring programmes are currently being developed for most Mediterranean countries. Therefore, assessment results on this indicator (as proposed in indicator guidance fact sheet) were not available at the national, nor regional level.

The findings here were mostly based on literature review of technical assessments on EU countries' reports on hydrographic alterations. However, these reports mainly focus on 15 measurements of trends for certain hydrographic parameters, which is not completely in line with requirement for common Indicator. However, the measurement of baseline hydrographic conditions can serve as a baseline for more detailed assessments in the future. Two local scale projects are presented as case studies namely, LNG terminal in Monfalcone Port, Italy; and container terminal Haifa Bay in Israel.

Many countries have focused on specific hydrographic parameters, most of them on temperature and salinity (e.g. Croatia, Cyprus, Italy), while some countries also assessed other parameters such as wave/current regime (e.g. Malta, France) and marine acidification (e.g. Cyprus, Greece). The proportion of the assessment area affected by hydrological processes was reported for some countries (Cyprus, Greece, Italy, Slovenia, Spain) although numbers quite varied due to the different methodologies used. For example, this proportion varied from less than 1% in Cyprus and Spain to 75-100% in Greece. However, in case of Greece the high percentage is justified by the fact that changes due to climate change were also taken into account.

Several countries indicated different drivers behind pressures on hydrographic conditions (France, Greece, Malta, Slovenia). In addition, countries also estimated the impact of hydrographic alterations on marine habitats, such as Cyprus (impacts on macroalgae), Greece (impacts on seabed habitats), and Malta (impacts on algae and seagrass). Common Indicator

(CI) 15 is expressed in km² of each habitat type directly impacted by hydrographic alterations (induced by man-made structure) and as a proportion (percentage) of the total extent of the habitat type in the assessment area. Assessment of this CI requires two different sources of data:

- Extent and location of the assessment area hydrographically altered by the structure;
- Extent and location of benthic habitats in the assessment area.

<u>Extent and location of the assessment area hydrographically altered by the structure</u>

Assessment of extent and location of hydrographical alterations is very complicated and can be done by several approaches, more or less accurate, more or less complex and more or less costly. Assessment of alterations of hydrographical conditions, and their impacts on benthic habitats, still raise lots of methodological and knowledge questions.

Considering these facts, CI15 Fact Sheet proposes to focus, at least, on the main and strongest hydrographic alterations and recognized impacts on benthic habitats. These alterations are generally induced:

1. by the structure itself (footprint/dimension on seabed and in water column) that will definitively alter existing benthic habitats;
2. by anthropogenic activities related to the structure and its uses: permanent changes of bathymetry or sediment nature that will also alter existing benthic habitats (basin/channel dredging, sediment disposal…), but also water discharges inducing changes in salinity and temperature;
3. by the structure on its neighborhood: changes in currents regime and agitation, inducing changes in sediments transport and in deposition/erosion rates that could alter more or less benthic habitats (depending on the intensity of changes of hydrographical conditions and on the resilience, resistance and state of the considered habitats).

The assessment of the extent and location of these alterations (some or all) can be done by different tools:

- Before and during construction, mainly using “administrative” documents (SEIA, EIA or at least authorization request for the construction of the structure);
- After construction, through different approaches, depending on means and data available: by analysis of EIA or regulatory environmental monitoring, by existing database on human activities, by aerial and satellite observations, by field measurements, by modeling.

Extent and location of benthic habitats in the assessment area

To assess CI15, the needed data on benthic habitats in the assessment area must represent the situation before the construction of the structure.

These data can be available or have to be acquired (indeed before the beginning of construction work). At this subject, EIA should normally carry out an initial environmental state and should so be able to provide these data.

At present, the inventory of existing data on benthic habitats at local, regional, national or global scales is not realized. We do not have a clear vision on what is available or not. Nevertheless, in the absence of sufficiently detailed data, EMODnet broad-scale seabed habitat map, that covers the entire Mediterranean Sea, can be used as a first level of information.

In any case, the question of benthic habitats (existing data and maps, monitoring…) concern mainly EO1 Biodiversity and cannot be dealt with and resolved in this report, dedicated to EO8 and EO7's Common Indicators

Key messages from 2017 Mediterranean Quality Status Report

1. The location and extent of the habitats impacted directly by hydrographic alterations (CI 15) reviewed existing information on marine habitats which may be affected or disturbed by changes in hydrographic conditions (currents, waves, suspended sediment loads) due to new developments. There is no sufficient data to derive conclusions/observe trends on regional, sub-regional or even national level.
2. The EO7 CI 15 considers marine habitats which may be affected or disturbed by changes in hydrographic conditions (currents, waves, suspended sediment loads) due to new developments. Identifying the priority benthic habitats for consideration in EO7 together assessment of impacts, including cumulative impacts, is a cross-cutting issue of high priority for EO1 and EO7. In addition, effort needs to be given to detect the cause-consequence relationship between hydrographic alterations due to new structures and habitat deterioration.
3. The national monitoring in Mediterranean countries regarding EO7 has not been initiated yet (except for the Contracting Parties that are EU member states, and their obligation of implementing Descriptor 7 of the Marine Strategy Framework Directive), or it is just being initiated. There is a need for more rigorous monitoring as to be able to undertake regional and sub-regional assessments whilst there is evidence of impact of coastal developments, mainly based on European studies. Such an integrated assessment of impacts calls for additional research efforts on habitat modeling, pressure mapping and cumulative impacts, along with monitoring of potentially affected areas.
4. Assessments that estimate the extent of hydrographic alterations (knowing conditions before and after construction) and its intersection with marine habitats are currently rare in the Mediterranean, except for some local studies of Environmental Impact Assessment

(EIA) /Strategic Environmental Assessment (SEA). There is certainly a lack of hydrographic data with detailed temporal and spatial scale in the Mediterranean Sea (bathymetric data, seafloor topography, current velocity, wave exposure, turbidity, salinity, temperature, etc.), which is one of the main challenges to implement this indicator, in particular to define the base-line conditions. To identify these gaps, a clear inventory of existing and available data in Mediterranean Sea should be done. Other difficulties come from the use of numerical model to assess hydrographic alterations before the structure is built.

5. Regular reporting for all Ecological Objectives should be established/strengthened.

Knowledge gaps for hydrography:

There are significant knowledge gaps on implementation of the CI 15.

1- It is a complex multi-parameter indicator. The main knowledge gaps are related to insufficient surveys and monitoring of this indicator on all geographical levels, and lack of sound assessment methodologies. Assessments that estimate the extent of hydrographic alterations (knowing conditions before and after construction) and its intersection with marine habitats are currently rare in the Mediterranean, except for some local studies of Environmental Impact Assessment (EIA) /Strategic Environmental Assessment (SEA).
2- There is certainly a lack of hydrographic data with detailed temporal and spatial scale in the Mediterranean Sea (bathymetric data, seafloor topography, current velocity, wave exposure, turbidity, salinity, temperature, etc.), which is one of the main challenges to implement this indicator, in particular to define the base-line conditions. To identify these gaps, a clear inventory of existing and available data in Mediterranean Sea should be done.
3- Other difficulties come from the use of numerical model to assess hydrographic alterations before the structure is built. These tools need substantial data (bathymetry, offshore hydrodynamics data, field data); which can be costly and time-consuming; and their use requires experience and knowledge about the processes and theories involved.
4- The link to EO1 is so essential, as map of benthic habitats in the zone of interest (broad habitat types and/or particularly sensitive habitats) is required. Therefore, identifying the priority benthic habitats for consideration in EO7 together assessment of impacts, including cumulative impacts, is a cross-cutting issue of high priority for EO1 and EO7. In addition, effort needs to be given to detect the cause-consequence relationship between hydrographic alterations due to new structures and habitat deterioration.

To conclude, such an integrated assessment of impacts calls for additional research efforts on habitat modelling, pressure mapping and cumulative impacts, along with monitoring of potentially affected areas.

Integrated coastal zone management in Egypt

Coastal environments are generally characterized by both value and threat. They are among the highest biodiversity value environments with most vulnerable ecosystems, as well as the most being impacted by human activities. The current threats on coastal and marine ecosystems are mainly the results of pressures from anthropogenic activities and hence more attention to their management and control is needed. Land-based activities (urbanization, industry and agriculture) represent the main threats. Urban development results primarily from rapid population growth. Pressure from tourism requires also effective management to avoid any further degradation of the marine and coastal environment. In addition to climate change and sea level rise due to global warming threatens Egypt's Mediterranean densely populated coastal strip. It could have grave consequences for the country's economy, especially agriculture and industry.

National Institutions / organizations responsible for managing coastal and marine ecosystems along the Egyptian Mediterranean Sea according to the national committee for integrated coastal zone management (ICZM) include Ministries of Environment, Agriculture and Land Reclamation (General Agency For Fish Resource Development), Transportation, Tourism, Water Resources and Irrigation, Interior, Health, Planning, Petroleum, and Defense. In addition to Coastal Governorates, uuniversities and research centers (National Institute of Oceanography and Fisheries – Coastal Research Institute - Institute of Climate Change Research, General Authority for Remote Sensing). The secondary stakeholders include relevant NGO's, Fisheries Cooperatives, local communities and many others. Several laws with mandates towards CZM exist, assigning roles and responsibilities to different governmental entities which share the process of coastal management in Egypt including the Egyptian Constitution (2014), law 4/1994 for environmental protection and its amendments, law 102/1983 for nature protectorates, law 124/ 1983 for fisheries amended by new law this year, law 48/1983 for Protection of Water Bodies and its amendments, law 146 / 2021 for wetlands protection and fisheries development as well as relevant international and regional conventions signed by Egypt.

Various Egyptian agencies and institutions have regular monitoring programmes for coastal and marine different parameters including (water level, land level, ocean currents, ocean waves, salinity, temperature, shoreline position, bathymetry, others), thus integrated monitoring and assessment system with harmonized database is still required.

I. **General Characteristics of Egyptian Mediterranean Coast (source:** Impacts and Implications of Climate Change for the Coastal Zones of Egypt Report Title: Coastal Zones and Climate Change Stimson Center (2010)

The northern Nile delta coastal region comprises six administrative governorates namely (from west to east): Alexandria; Behaira; Kafr El-Sheikh; Dakahlyia; Damietta; and Port Said. The main land cover in the northern Nile delta governorates comprises cultivated land, built-up area, wetlands, and undeveloped areas. Figure 1 The map shows the area of land uses in the coastal governorates of the Nile delta.

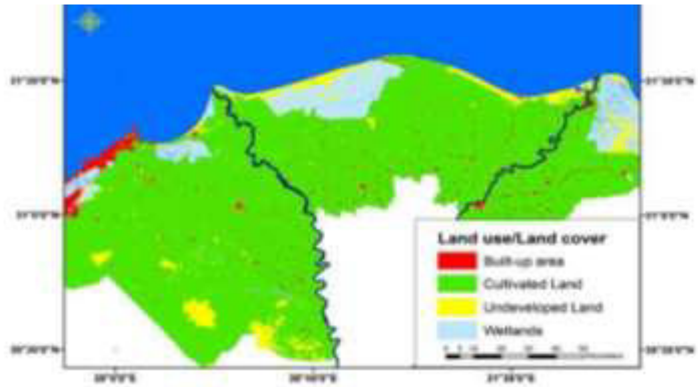


Figure 1 Land use in the Nile delta coastal governorates
Source: Hassaan and Abdrabo (2013)

The Nile Delta region in the Mediterranean coastal zone represents the major industrial, agricultural, and economic resource of the country. It is home to over 50 percent of Egypt's population of 80 million and to about 70 percent of the nation's industrial and commercial activities. The region is characterized by relatively low land elevation, which leaves it severely exposed to rising sea levels. In addition, it suffers from local land subsidence, compounding the effects of rising seas. Some estimates indicate that the northern delta region is subsiding at a rate that varies from about 2 millimeters annually at Alexandria to about 2.5 millimeters annually at Port Said. The Nile Delta shoreline extends from Alexandria in the west to Port Said in the east, with a total length of about 240 kilometers. This zone consists of sandy and silty shores of greatly varying lateral configurations, depending on where the old branches of the Nile have had their outlets. The coastline has two promontories, Rosetta and Damietta, and three brackish lakes—Idku, Burullus, and Manzala—are connected to the sea. There are five harbors located on the coast: Idku, New Burullus, and El Gamil are for fishing; and Damietta and Port Said are commercial ports as in Figure 2. Alexandria and Port Said are the main economic centers of the coastal zone. These cities are vulnerable to sea level rise as a result of the low elevation of adjacent land.

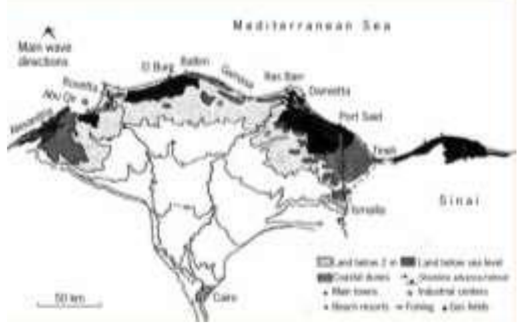


Figure 2 Topography of the Nile Delta Region
Source: M. El Raey, A. Nasser Hassan, R. J. Nicholls, and A. C. de la Vega-Leinert, eds., Proceedings of SURVAS Expert Workshop on African Vulnerability and Adaptation to Impacts of Accelerated Sea-Level Rise (ASLR), Cairo, November 5–8, 2000.

The Mohamed Ali Seawall, built in 1830, protects the lowland area southeast of Alexandria against inundation by water from Abu Qir Bay, and narrow strips of elevated land protect the southern area of Port Said. Many smaller towns and villages on the northern coast are also vulnerable to sea level rise and saltwater intrusion. Like other deltaic regions worldwide, the Nile Delta is subject to shoreline changes resulting from erosion and accretion, subsidence, and sea level rise resulting from climate change. Since early studies by Sestini, various analyses have evaluated the impacts of rate change on the Nile Delta using various sea level rise scenarios, concluding that a large percentage of the Nile Delta is directly vulnerable to inundation and saltwater intrusion that could drive millions from their homes.

Fanos (1995) provided the erosion/accretion pattern along the Nile Delta coastline and showed that the coastline of the Nile Delta can be divided into 9 physiographic units 3. The shoreline east of Burullus area is classified as stable coastline with accretion and erosion pockets. Analysis of the coastal process west of the Dameitta Port showed that, although the gross longshore sediment transport is about one million m^3 /year, the net longshore sediment transport is found to be negligible. These will result in a dynamically stable coastline although it may be exposed to seasonal erosion or accretion. Fanos (1995) classified the shoreline at this site to be stable with accretion and erosion pockets, as in Figure. Therefore, the coastline of the proposed site seems to be dynamically stable with accretion and erosion pockets.

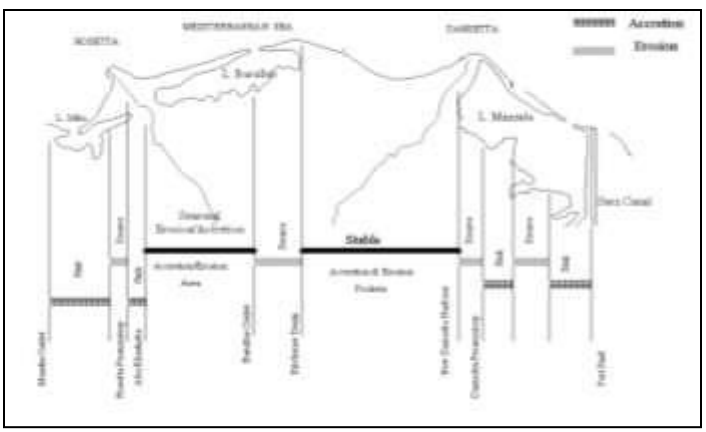


Figure 3 Erosion and accretion pattern along the Nile delta coast.
Source: Fanos (1995)

II Vulnerability of Egyptian Mediterranean Coast to Climate Change (source: Egypt's National Strategy for Adaptation to Climate Change and Risk Reduction, 2011)

One of the most important emerging issues is the impact of climate change where the Mediterranean is one of the region's most sensitive to climate. Climate change and sea level rise threaten low-lying areas, biodiversity and vulnerable ecosystems causing degradation, and fragmentation. The Egyptian Mediterranean coast can be classified according to their vulnerability to disasters and the potential harm resulting from rising sea level and extreme events as follows:

- The North-West coast

Most of North-West coast areas, stretching from the west of Alexandria to Saloum, are considered as being safe from the impact of rising sea levels, due to their high altitude. It ranges between +2 and +3 meters above sea level, with the exception of low-lying areas, such as natural and artificial lakes and beaches. This is also due to the presence of continuous and parallel groups of ridges, rocky lime hills and sand dunes near the coast, with heights ranging from +5 and +10 meters above sea level. Emerged or submerged lime barriers function as natural barriers to sea water intrusion. The nature of these rocks protects the area from seawater penetration, which leads to land salinization or the compression of sediments. The fact that no subsidence or erosion rates have been registered for these areas confirms this view. Local erosion results from construction activities in the coastal zone.

- The coast of the city of Alexandria

The coast of the city of Alexandria is characterized by its diverse topography. Surveys have shown that Alexandria's seafront – represented by the narrow coastal strip extending from Abu Qir to Agamy – lays on a hill or a raised barrier of limestone, ranging from +2.5 to +11 meters (on average +4 meters) above sea level. Although this barrier forms a natural shield against sea encroachment or the risks of sea level rise, there are areas at a lower altitude that may risk being submerged as a result of rising sea levels, or incidental events such as earthquakes, or high waves and extreme events accompanied by hurricanes or tsunamis (such as beaches, Lake Marriout, coastal areas, the south-eastern area neighboring the region of Al Tarh, which extends eastward towards the Delta until Kafr El Dawar, with a surface area close to 650 km^2 , and bordered in the North by the wall of Mohammad Ali, which is considered the safety valve for this depression.). Most of the coast of Alexandria is considered naturally safe from sea level rises, as the city is constructed on a high lime barrier. This barrier is naturally supported over a distance of 60 km, approximately 66% of the total length of the coast, with the exception of some low-lying areas. One should note that engineered protection measures are relatively few (8.2 km, about 20% of the total length of the coast). Vulnerable areas represent about 13% of the total length of the coast.

- The Nile Delta coast

The coastal area of the Nile Delta is one of the areas that are most prone to flooding as a result of expected sea level rise. This may be accompanied by soil subsidence at varying rates, depending on the conditions of each region, the topographical and geological characteristics, as well as the current protection means of each area. It is more preferable to divide this region into three different areas according to the previously stated criteria, rather than consider it as one geographical unit. The length and percentage of naturally and artificially protected shores to the total length of the Delta shores, from Abu Qir up to Sahl El Tina, which is estimated at about 301.57 km as shown in Table 1.

Table 1: Length and percentage of naturally and artificially Protected shores to the total length of delta shores

Length of delta coasts (km)	Length of naturally and artificially protected coasts				Length of unprotected coasts	
	Natural protection		Artificial protection			
	Km	(%)	Km	(%)	Km	(%)
301.57	128.3	42.54	52.61	17.45	120.66	40.01

Source: Egypt's National Strategy for Adaptation to Climate Change and Risk Reduction, 2011

Accordingly, the Delta coastal zone is divided into three sub zones depending on the degree of exposure and vulnerability to the risk of erosion and sea level rise.

- Sub-Zone one: this includes areas that are subject to high risks. They are usually low-lying coasts or coasts that are vulnerable to subsidence or erosion at high rates. This is the case for the Manzala Lake shore, the Tarh area behind the wall of Mohammad Ali, the two areas east and west of the Rosetta City, the area between Gamasa and the port of Damietta, Al Gamiel, and the Al Tina Sahl on the Sinai coast. The Tarh area, south of Alexandria's coastal strip and extending behind the wall of Mohammad Ali – (1,243m long) eastward between Abu Keer and the Edko outlet, till Kafr El Dawar south – is considered as one of the most vulnerable areas to the risk of inundation due to land levels falling to less than 3 meters below the current sea level. This area is, indeed, subject to inundation in the event of any natural disaster. Consequently, this would lead to the destruction – even if partially – of the wall of Mohammad Ali. The area located along the narrow sand barrier separating the Mediterranean Sea from Lake Manzala is also under threat. In this particular area, the land level is one meter above sea level only, and in addition to its potential exposure to subsidence due to the compression of its mud sediments and erosion beneath and erosion, which may in turn be caused by a sea level rise, or sea currents and waves. Studies have confirmed that the relative sea level east to this barrier, at the Port Said harbour, rises at the rate of +4 millimeters every year as a result of land subsidence and rising sea level.
- Sub-Zone two: the shores in this zone are relatively safe. They are not exposed to the risk of inundation, as the presence of sand dunes creates a natural defense line to the area located between Burullus, Baltiem, and West Gamasa. In addition, the majority of the accretional shores are subjected to sedimentation between the projections and headlands of the Delta at Gamasa, Abu Khashaba and the middle of Abu Qir Bay, as well as opposite the Port Said, coast where sedimentation rates towards the sea range from 3 to10 meters every year. These rates – assuming they remain stable and constant – offer natural protection to this sub-zone, being areas of sedimentation acting as a defense line.

- Sub-Zone three: This includes naturally and artificially protected shores. It is also comprised of shores that are protected by concrete or hard structures, for example the sea walls parallel to the shore in Baltiem, or the sea walls in Tarh, the headlands in Rosetta and Damietta, or the basaltic reinforcements at Borg Al Burullus. It should be noted that these artificial constructions and barriers contribute to the protection of about 17% of the Delta shores, where they rise about +2 - +6 meters above sea level, including the wall of Mohammad Ali.

II. Current knowledge of Coastal and Marine Benthic Habitats in Egypt

The updated list of habitat types in the Egyptian Mediterranean Sea published in 2019 was sent to experts to be implemented. It seems this updated list needs training to produce an overview on the main habitat types in Egypt. Therefore, it was decided to provide available information on the important habitats in Egypt, representing shallow and deeper areas.

One of the typical marine ecosystems of the eastern basin of the Mediterranean Sea including the Egyptian coast is the ***Posidonia oceanic*** **ecosystem**, which form large meadows in the infra littoral zone. Along the western part of the Egyptian Mediterranean coast that sea grass predominates, along with patches of *Zostra*. Belts of the sea grass *Posidonia oceaica* along with strands of the brown algae *Sargassum spp.* And patches of the green algae *Caulerpa prolifera* occur in the inshore water of that part of the Egyptian coast. The green algae *Caulepra Codium, Halimeda* and *Udotea* also occur in that area. Other species of *Padina* and *Halimeda* are quite rare.

Red algae, particularly calcareous species of Lithothamnion and Lithophyllum frequently occur in the offshore waters. Other less abundant red algae species include the genera *Grateloupia, Vidalia, Gigartina, Peyssonnelia, Botryocladia* and *Opuntiella.* Algal growth generally increases during spring and summer.

Information on coralligenous habitats is almost lacking either due to the absence of experts or their locations. This will require capacity development on coralligenous species and habitats, as well as financial resources. This could be one of the priorities for habitat mapping and conditions.

The relationship between benthic macroalgae and associated polychaetes was studied monthly from October 2014 to October 2015 along the Alexandria coast, Egypt. A total of 56 polychaete species were found among 28 macroalgal species, which belonging to green, brown and red algae. The red algae hosted pronouncedly higher number of polychaete species than the brown and green algae, particularly during winter and spring, while green algae were associated with higher number of polychaete species in January, April, August and October 2015. In contrast, the average count of polychaete individuals associated with the green algae was higher in winter and autumn than that recorded with the red algae, while low with both red and green algae in spring and summer, and very poor within the brown algae. The present study revealed that the structure of algal species my affect the diversity and abundance of the associated polychaetes and the diversity of these worms varied among the hosting algal species.

Shallow hard bottom and intertidal soft bottom polychaete assemblages of the Alexandria coast, south-eastern Mediterranean (Levantine Sea), were studied during a complete annual cycle in order to analyze spatial temporal patterns of variation in assemblages, and relevant factors related to polychaete distribution. The present study recorded a total of 73 species, belonging to Syllidae (22 species), Nereididae (9 species), Serpulidae (6 species), Eunicidae (5 species) and another 19 families. The assemblages experienced pronounced spatial and temporal variation throughout the study area, but spatial variation appeared more important in determining the observed patterns. Polychaete distribution related to variation of grain size and sessile macrobenthos cover suggesting that these structural variables accounted more than the physical-chemical ones (namely BOD, dissolved oxygen, organic carbon, organic matter, salinity, temperature, pH) in influencing the patterns of assemblage distribution. A total of 9 alien polychaete species were found solely on hard substrata, of which *Pseudonereis anomala* and *Linopherus canariensis* formed dense population in the area. The present study is the south-eastern-most one dealing with the ecology and distribution patterns of hard bottom polychaetes from the Mediterranean Sea, as well as one of the few studies dealing with intertidal soft bottom polychaetes in the Levant Basin.

Nineteen benthic polychaete species were recorded for the first time in the intertidal zone of the Alexandria coast.They belong to Syllidae (7 species), Hesionidae (3 species), Serpulidae (2 species) and 7 other families (one species each). Of these species *Eunice miurai* Carrera-Parra & Salazar-Vallejo 1998 appears to be new to the Mediterranean Sea, while four of the alien species earlier recorded in the Mediterranean were found for the first time in Egyptian waters: *Opisthosyllis brunnea* Langerhans 1879, *Loimia medusa* Savigny 1822, *Syllis schulzi* Hartmann-Schr¨oder 1960, *Phyllodoce longifrons* Ben-Eliahu 1972. The newly recorded species demonstrated markedly different patterns of frequency of occurrence and numerical abundance. *Spirobranchus triqueter* Linnaeus 1758, *S. schulzi*, *L. medusa* and *Salvatoria clavata* Clapar`ede 1863 were permanent

Infralittoral Sandy Mud: This biotope is present along most of the Egyptian Mediterranean coastline. Although, this biotope does not typically support high diversity communities its benthic fauna may provide food for a number of commercially important fish species. This biotope may also provide important feeding and nursery grounds for marine birds and fish. It is listed as endangered natural habitat type.

Circalittoral Sandy Mud: This biotope is widespread across the offshore area and the only epifauna identified was one mantis shrimp. Other sites in the Mediterranean with this biotope are known to support a variety of species, which includes a rich epi- and infauna. Species composition at a particular site may relate, to some extent, to the proportions of the major sediment size fractions. Greater quantities of stones and shells on the surface may give rise to more sessile epibenthic species, some of which are important in the diets of many commercially important fish and invertebrate predators. Circalittoral biotopes may be less susceptible to human impacts related to coastal alteration when they occur at large distances from the shore. However, due to the relatively stable conditions that characterize this biotope, recovery from disturbances may be particularly slow. It is listed as endangered natural habitat type.

Deep Circalittoral Mud: The epi- and infauna of this biotope may be rich and diverse and may serve as food for several demersal fish species. Circalittoral biotopes may be less susceptible to human impacts when they occur at large distances from the shore. However due to the relatively stable conditions that prevail in these biotopes, they may show slow recovery in the case of serious disturbance. They are commonly subjected to many human activities related to oil and gas exploration and exploitation. It is listed as endangered natural habitat type.

Circalittoral Mixed Sediments: The presence of benthic invertebrates in this biotope increases habitat complexity through the creation of tubes and burrows. Few marine sedimentary habitats have been thoroughly sampled and it has been argued that the biological diversity of this biotope is often underrepresented since it appears to support a relatively diverse and abundant benthic fauna Particularly, the high densities of infaunal polychaete and bivalve species that exist here have been attributed to the relatively low rate of natural physical disturbance and the heterogeneity of the habitat. It is listed as endangered natural habitat type.

Maerl Beds Maerl: is a slow growing coralline alga which aggregates to form beds. Maerl is longlived and is associated with localized increased biodiversity and is the most sensitive habitat identified within the West Nile Delta area, offshore of Abu Qir Bay. Live maerl beds consist of a top layer of live maerl where photosynthesis occurs and beneath the live maerl the beds normally consist of dead maerl. The calcareous structures that remain once the maerl is dead provide substrate for colonization by invertebrates and shelter. Accordingly, dead maerl beds also provide important habitat on the seabed. The extensive beds (live and dead) are slow growing so are sensitive to physical damage and they are considered to be of ecological importance due to the very high diversity of associated organisms. Maerl beds are found throughout the Mediterranean Sea, and in Egyptian waters maerl beds have been recorded off the Nile Delta on the outer shelf between the Damietta and Rosetta. Moreover, maerl beds were identified at a number of locations offshore of Abu Qir Bay. The survey samples that contained maerl were taken between 60-200 m depth contours. The survey identified areas of live and dead maerl. The marine survey identified areas of dead maerl where it is assumed the top layer of live maerl is also dead. Seabed photography indicated that the maerl is patchy in distribution and it is likely that the patchiness will exist across the entire maerl area.

Infralittoral Rocks: Hard substrate on a predominantly sandy seabed creates complexity in the benthic environment and attracts colonizing organisms by providing niches for species to inhabit. The faunal communities colonizing the rocky surfaces will enhance biodiversity by attracting predators and species that can use the structure as shelter. Stable rocky surfaces within this biotope were densely covered with epilithic sessile fauna such as sponges and hydroids. Two areas of rocky seabed were recorded offshore of Abu Qir Bay. These areas contrasted strongly to the surrounding soft sediments and are thought to be cemented sand features. Large polychaetes (Eunicidae) were also regularly seen.

Seagrass Meadows: Seagrass is an important habitat, providing food and shelter for a wide diversity of flora and fauna, including young turtles, prawns and fish. Some turtle species, including Loggerhead Turtle (*Caretta caretta*) also use seagrass meadows as nurseries. Seagrass is also important as a primary producer providing food for plant grazers and detrivores both in the local area and through sediment transport, offshore. Since seagrass beds have not been systematically mapped in Egyptian waters, there are no definitive data on their distribution. Generally, seagrasses are most commonly found in water depths to 20 or 30 m. On the other hand, large parts of the seabed in El Salloum Bay are covered with seagrass. These include *Posidonia oceanica*, which is reported at 6-26 m depth forming monospecific aggregations, as well as *Cymodocea nodosa*. Both are found on sandy or rocky substrates.

Deep Sea Ecosystems: Deep-sea ecosystems include the waters and sediments found approximately 200 m below the surface. The deep-sea is recognized as a highly complex and heterogeneous ecosystem comprised of several different and contrasting habitats. The deep-sea biosphere also includes the Earth’s largest regions partially or completely devoid of free oxygen (i.e., hypoxic and anoxic environments), which include the oxygen minimum zones (expected to expand significantly in tandem with the ongoing global change), the deep hypersaline anoxic basins, and the deep Black Sea (the single largest anoxic region in the world). Until today, researchers have documented life every- where in the deep sea, with active metabolic life from -2 to >100 °C, even in sediments at a depth of 10,000 m and microbial life at 1,000 m below the seafloor.

Recent studies by Farag *et al*, 2019 on the biodiversity in deep water more than 200 meters close to the continental edge off Alexandria, have bottom varies from hard rock to very fine silt. The eastern part includes terrigenous Nile sediment origin, whereas the western side has biocalcarious sediments with shell fragments richness, coastal limestone ridges origin. The identified species were 94 fishes, 64 invertebrates, 6 benthic flora, and 304 zooplanktonic species. The ichthyofauna included 5 Chondrichthyes species (5.3% of the fish species), while Osteichthyes fishes were 89 species (94.7%) belonging to 48 families and 72 genera. The most abundant family was Sparidae (13 species). The highest abundance of fishes occurred in the summer (68 fish species 72.34%), while the lowest abundance occurred in the spring (49 species, 52.13%). Regarding the demersal and benthic biota, the most abundant phylum was Mollusca (31 species) and represented by three classes (Bivalvia, Cephalopoda, and Gastropoda). Gastropoda was the most abundant class (18 species), while the lowest Phyla was Chordata (1 species of Ascidians) and Annelida (1 species). The number of lessepsian fish species were 17 (18.1%) of the total number of species caught by the bottom trawl net. In addition, *Aulopareia unicolor* (F): Gobiidae) was recorded for the first time and considered the second time in Egypt. The benthic flora was represented by 6 species belonging to three phyla (Tracheophyta, Chlorophyta, and Rhodophyta). Sea grasses were represented by three species (*Posidonia oceanica, Cymodocea nodosa, and Halophila stipulacea*). The highest abundance of benthic species occurred in the summer (53 species with 75.7%), while the lowest one was in autumn (27 species, 38.6%). In the continental shelf, zooplanktonic community was represented by 304 taxa, belonging to 12 phyla, 6 phyla (Arthropoda, Tintinnida, Chordata Bfish eggs and larvae^, Cnidaria Foraminifera, and Radiozoa) were dominant. Copepods were the dominant group (71.59%); its annual average abundance was 1271 ind./m^3 . Its most diversified season was the winter (175 No/m^3) and its average abundance was 1892.9 ind./m^3. However, in spring, 118 species were recorded presenting the highest average abundance (2419.4 ind./m^3). The lowest diversified season was summer (85 organisms) with density of 1150 ind./m^3.

Deep sea habitats (example: Nile Delta Fan)

The ecological and biological significance of the Nile Delta Fan (NDF) in the Eastern Mediterranean Sea stems the geological features and natural phenomena (Nile silt sedimentation, physical and biological oceanographic and climatic characteristics). NDF belong to the Levantine Sea where important geomorphological features are located including highly active mud volcanoes, canyons (Alexandria canyon), fan, escarpment, continental shelf. Deep-sea benthic habitats knowledge is scarce however significant and peculiar habitats related to gas hydrocarbon chemsymbiotic communities are known. It includes of mollusks and polychaete endemic species which represent vulnerable ecosystems. In addition, deep-sea corals communities are predicted in the area. Biodiversity index in the region is quite high (38 out of 50) with a major component of pelagic and benthic communities. Small pelagic fisheries are very important and Blue Fin Tuna (BFT) fishery as well, furthermore the NDF is known as one of the few spawning grounds in the Mediterranean Sea for BFT. Regarding pelagic species, marine turtles aggregate in feeding grounds in the shelf which is equally used as breeding areas for birds.

Salloum area (example of shallow sea grass meadows)

The Gulf of Salloum supports a wide range of ecosystems, from the rich sea grass meadows and rocky reefs of the coastal zone, to the little seamounts. It is thus considered as a great resource for many economic fish species. Seagrass meadows were found forming from scattered small areas to dense vegetation that covered extended areas of the sea floor. The macrobenthic community consisted of 57 species belonging to seven groups, while fish populations contained more than 90 species. Species Richness was closely correlated to depth, organic matter concentrations and sediment characteristics. Some invasive polychaete and introduced fish species were also recorded. Moreover, few species were considered as threatened species. Using GIS analysis to the survey result showed that diversity of seagrass beds, benthic fauna and fish species in the Gulf could be divided into two sections. First section lies to the west of 25º 30'E longitude; contains the highest species composition, while second section (eastward of 25º 30' E) contains the lowest species composition. It was highly recommended, therefore, to declare the first section as a marine protected area (MPA). As the results of this study, the Gulf of Salloum was declared as the first marine Egyptian protected area in the Mediterranean Sea by the Egyptian Prime Minister's decision No. 533 for the year 2010.

Bardawil Lake (Hyersaline habitat)

Lake Bardawil is so far the cleanest hyper saline marine water body in Egypt as well as in the entire Egyptian Mediterranean Sea. It is an important source of local fishery in North of Sinai and the country. The lake covers an estimated area of about 650 km^2, with a maximum length of along the east-west axis, of 90 km, and a maximum width, along the north-south axis, of 22 km. It is extremely shallow; its depth ranges from 0.5 m to a rather rare 3 m. A long narrow sandbar of about 100 km long, with a maximum width of 2 km, separates Bardawil Lake from the Mediterranean Sea. Three inlets connect the lake with the sea; two artificial in the westand on eastern natural one at Zaranik.

Bardawil Lake has witnessed a considerable change in the ecological conditions of the lake, resulted in changes in the structure of its fishery from sea bream and mullets to shrimps and crabs that arrived in recent years from the Suez Canal, and became the main dominant commercial catch (about 60 %). Furthermore, marine turtles, mostly green and loggerhead became abundant in the lake due to the presence of their preferred feeding habitats in the lake.

There are three species of flowering submerged sea grasses: *Ruppia cirrhoas*, *Cyamodocea nodosa* and *Halodule universis*. They are widely distributed in the lake. The last species seems to arrive from the Suz Canal. Meoibenthic community consists of 20 species belonging to foraminifera (4 species), ostracoda (2 species), nematoda (3 species), nemertinea (one species), copepod (4 species), polychaeta (2 species), oligochaeta (one species), and mollusca (3 species). Nature of sediment and organic matter were the main factors affecting the meifaunal abundance and distribution. Anthrpogenic activities (intensive fish trawling and artificial inlets) seem to affect the distribution of total abundance.

Species composition, distribution of macrobenthic invertebrates in Baradwil Wetland were studied during the last 30 years., where the number of species has increased from 30 species into 52 species belonging to phyla; Coelentrata, Nemertina Annelida, Arthropoda, Mollusca, and Echinodermata. The abundance of benthic invertebrate species was closely correlated with nature of bottom sediments, organic matter, salinity and anthropogenic activities. The standing crop of macrobenthos decreased during the last two decades due to changes in fish community structure. A remarkable increase in the population density of Mollusca was noticed because of the declining of the fish, *Sparus aurata* which was mainly a bottom feeder depending on molluscan animals in its diets. This change in fish community, which consequently changes the whole ecosystem of the lake, encourages us to recommend establishing a monitoring program to follow up changes in the lake ecosystem, especially the benthic fauna that will be of great help in the management of such important water body.

Thus, it can be said that our present state of knowledge of the marine and coastal biodiversity in the Egyptian Mediterranean Sea is reasonably adequate. Species lists covering most animal and plant groups are available. Numerous publications covering taxonomic, distributional and ecological aspects of the biodiversity of the country are well documented. However, the levels of available information vary considerably among taxonomic groups, geographical areas and types of habitat. Therefore, our information on biodiversity of the Mediterranean marine environment is less than complete. Considerable information on marine habitats and biota is also available, but these data are far from being geographically comprehensive.

Macro benthic fauna include many phyla, where Annelida, Mollusca and Echinodermata are most abundant. Arthropoda, Brachiopoda, Ascidians, Nemertini and Sipunculida are much less abundant. Brachiopoda are only restricted to offshore waters. The structure of the macrobenthic community is greatly influenced by depth. In the inshore zone (10 to 50m depth parallel to the coastline), macrobenthic fauna is numerically dominated by molluscs, echinoderms, and polychaetes. In the offshore zones that extend to a depth ranging between 50 and 100m, macrobenthic fauna is dominated by polychaetes, mollusks and echinoderms. The remaining macrobenthic phyla are mostly restricted to deeper, off shore waters. Diversity for microbes is substantially underestimated, and the deep-sea are still poorly known. In addition, the introduction of alien species is a crucial factor that will continue to change the biodiversity of the Mediterranean, due to the warming of the Mediterranean Sea.

The Mediterranean Sea has seen successive waves of introductions. Its biota consists of a mosaic of formally alien species of different biogeography affinities, reflecting its eventual geological history. Non-Indigenous Species (NIS) continues to be a major threat to the coastal and marine ecosystems and species in Egypt. Several attempts have been made to record different taxonomic groups of NIS, however, most of them did not apply or acknowledge the appropriate international criteria used to evaluate them. Available information about NIS in Egypt is still insufficient and exerted efforts are still limited. Three major works on NIS have been completed in Egypt during the last 6 years: preparing a national action plan for marine alien invasive species in the Mediterranean Sea, a survey of 2 years on alien invasive species in the Gulf of Suez and the eastern Mediterranean, and engineering work of diverting the agricultural drainage water and freshwater sources from better lakes into Sinai via a tunnel under the Suez Canal. In addition, several interesting works on the biology and ecology of NIS were published recently. Many publications are available on new records and distribution of NIS in Egypt.

Red algae, particularly calcareous species of Lithothamnion and Lithophyllum frequently occur in the offshore waters. Other less abundant red algae species include the genera *Grateloupia, Vidalia, Gigartina, Peyssonnelia, Botryocladia* and *Opuntiella.* Algal growth generally increases during spring and summer. Information of the coralligenous habitats and also deep-sea habitats are almost lacking.

Important vulnerable ecosystems are: *Pocidonia medaws*, Coralline algae habitats, Depleted fisheries in all Egyptian Mediterranean Sea, Coastal lagoons connected to the sea (where fish fries are caught for aquaculture purposes), Deep sea ecosystem particularly Nile Delta Fan, Sea bird habitats, marine mammals and marine turtles habitats, and, hypersline coastal habitats such as Bardawil Lake, important coastal habitats exposed to erosion, and human urbanisation (salt marshs, sandy, rocky and muddy beaches, and sand dunes).

III. Economic activities affecting Egyptian marine ecosystems

Major threats to marine ecosystems are unsustainable economic activities e.g. unregulated tourism, exploitation of marine resources, overfishing and fishing in illegal areas (e.g. breeding grounds) and coastal pollution, oil spills from maritime activities and accidents, pesticides and chemical fertilizers used in agricultural activities, and aquaculture activities. At present, 20% of Egyptians live in coastal areas, which are also visited annually by millions of tourists. In addition, more than 40% of industrial activity occurs in the coastal zone. Enhanced visual counting technique coupled with combustion analysis and differential scanning calorimetry (DSC) was applied to assess microplastics (MPs) contamination in fish digestive tracts from Eastern Harbour, Egypt, to provide a simple and economic method for MPs assessment. This was the first study in Egypt to quantify MPs in fish. Plastic particles were detected in all fish samples, represented by seven thermoplastic polymers. The average number of MPs was at its highest level in *Siganus rivulatus*, *Diplodus sargus*, and *Sardinella aurita* (7527, 3593, and 1450MPs fish^{-1}, resp.) and the lowest in *Sphyraena viridensis* and Atherina boyeri (46 and 28MPs fish^{-1}, respectively). The average weight of MPs as measured by combustion ranged from 302mg kg^{-1} in S. rivulatus to 2mg kg^{-1} in *Terapon puta*. In compliance with IMAP metadata for monitoring and assessment of marine litter indicators, a national programme for "regular monitoring and assessment of marine litter in the Northern beaches of Egypt" was prepared by EEAA.

One of the major difficulties facing the management and conservation of marine-biodiversity in the Egyptian Mediterranean Sea is the lack of detailed, geographically comprehensive database. In addition, information available on marine species, habitats and ecosystems are not consistent, perhaps due to unclear spatial and temporal patterns. Meanwhile, human activities in the coastal and marine environment have made considerable changes leading to depletion of fish stocks, pollution in all different forms (oil pollution, debris, plastics, noise), fragmentation of habitats, increase of number of invasive species, and the possible impacts of climate change.

Therefore, a detailed, geographically comprehensive database on marine habitats, ecosystems and biota is required to develop a sound management plan for marine biodiversity. This will require field surveys on marine biodiversity to gather information on the geographical distribution, status, and exploitation levels of marine habitats, ecosystems and species. The collected data will be assessed into a GIS database, which will be accessible to biodiversity managers and decision makers. Targets include: 1) establish a marine database on the basis of recent, geographically comprehensive field-collected data; 2) develop and implement an integrated marine biodiversity management plan; and 3) develop economic valuation methodologies for ecosystem services of coastal ecosystems.

Although many institutions hold knowledge on marine biodiversity, decision makers have difficulties to find the type of answers they need. This situation can be challenged by representing a one-entry for questions and collecting all available knowledge in the best possible manner (depending on means and timeframe). The network will integrate available knowledge and process it in a sound and reliable way to provide answers to decision makers in a format that they can readily use. Thus, creating better links between knowledge holders and users will bring significant changes to the way short and long-term impact on marine biodiversity changes are tackled.

Based on the above survey on the benthic habitats, it can be said that the extent and location of the assessment area hydrographically altered by the structure as well as the extent and location of benthic habitats in the assessment area still need further detailed studies. It is hoped that IMAP/EU projects will provide Egypt with technical and financial assist to start mapping of benthic habitats impacted by coastal structures and hence hydrological alterations.

IV. Socioeconomics of coastal areas in Egypt

Eight sectors were identified to be the main focus of the study. These were sectors that mainly depend on the Mediterranean Sea for their activities, and with deteriorating conditions of the Mediterranean Sea; the sustainability of these activities would be directly affected. Main socio-economic activities identified were fishing and marine aquaculture, maritime transport, cruising and pleasure boating, coastal tourism, energy production, extraction of marine aggregates, offshore oil and gas industry, and sub-marine telecommunication and electric cables.

More than 20% of Egypt's total population lives along the northern coastal zone of the country, with more than 40% of its economic activities concentrated along the coast. Main economic activities in the northern coastal area include industry, agriculture, tourism, petroleum and mining activities, and urban development. Information regarding the exact contribution of the sub region to the national economy is unfortunately not available.

The Mediterranean Sea and the area surrounding it represent the grounds for the majority of fishing activities taking place in Egypt. In addition to the coastal belt along the Mediterranean Sea in the north of Egypt, there are a number of Egyptian Mediterranean brackish water lakes and lagoons situated along the Nile Delta, those are Manzala, Burullus, Edku and Mariout, and to the east of the Suez Canal, Port-Fouad and Bardawil.

Tourism is one of the more important sectors in Egypt contributing 11.3% of GDP and with 12.6% of the total labour force employed in the sector. Tourism in the Egyptian Mediterranean is characterized by the dominance of internal tourism as opposed to foreign tourism. Apart from the traditional destination cities such as Alexandria, Port Said, Matrouh and Al-Arish, the north coast extending from Alexandria to Matrouh has emerged as a main attraction for local tourism during the last two decades. About two million Egyptians visit the north coast in the summer season extending from May to September. This has been accompanied by extensive developments of resorts along the Mediterranean coast thus representing an increased pressure on the coastline and the ecosystem. It is the intention of the Government to further develop the north coast to absorb the future population growth in the country and to make it an attraction for foreign tourists and investors.

The environmental impacts on coastal areas will be further exacerbated by increased levels of urbanization, volume of transport and consequently fuel consumption and CO_2 emissions, cruising and pleasure boating, as well as increased levels of ground water consumption and wastewater and solid waste generation and disposal.
The agriculture, irrigation and fisheries sector contributed 14.7% to GDP. Average GDP growth was estimated at 2.1% in both years. More than 250,000 fishermen are employed in the fisheries sector in Egypt. A disruption in the sector is therefore likely to have an impact on direct and indirect employment.

In recent years, Egypt has experienced a boom in fish production, where it has increased from 790,000 tonnes in 2001 to 1.8 million tonnes. This increase in fish production has been mainly attributed to the expansion of aquaculture, which represented 74% of the total catch. This is in comparison to a decline in fish catch from other sources, with a percentage decrease of 30%. Main reasons for the decline in fisheries from other sources (excluding aquaculture) have been identified as over fishing, illegal fishing, overlap between coastal and offshore uses, lack of planning, pollution, and lack of regulations regarding fishing periods to take into account breeding seasons and the use of non-selective fishing gear. This is in addition to other unsustainable fishing practices, including the use of trawls and other mobile bottom gear, the use of dynamite and poison, and the disposal of debris such as food containers and plastics, and vessel debris. It should be pointed out that the size of four of the northern lakes, namely Manzala, Burullus, Edku, and Mariout have drastically declined reaching up to 95.5% reduction in size in some cases, as is the case for lake Edku. Moreover, the northern lakes have been exposed to serious environmental degradation due to the disposal of industrial and agricultural waste, as well as municipal waste. Climate change is also expected to impact fisheries in Egypt as a result of the potential increase in seawater temperature and pH.

Maritime Transport represents another import sector in Egypt. The strategic location of Egypt and with the Suez Canal connecting the Mediterranean Sea with the Red Sea linking East to West attracts a great deal of maritime traffic along the Egyptian Mediterranean coastal zone. Major ports in Egypt are located in Alexandria, New Damietta and Port Said. These ports also have oil and natural gas terminals. Smaller fishing ports are located at a number of designated fish landing facilities in addition to most major ports. Naval port facilities are also found along the Mediterranean coast. Egypt has 6 commercial ports on the Mediterranean out of a total of 15 ports, 3 petroleum ports out of the total 11 and 3 out of the 4 fishing ports. There are no mining or tourist ports on the Mediterranean.

Oil shipping through the Suez Canal and along with the Egyptian oil terminals makes the Egyptian Mediterranean coast among the most important oil shipping routes in the Mediterranean basin. The importance of this facility has enhanced with the completion and inauguration of the new parallel canal in August 2015. Seaports are considered to be the backbone of the state's foreign trade and its access to the world.

About 10% of total employment in Egypt is in the transportation sector. However, there are no data available on the total number employed by the sector in the Egyptian Mediterranean coast. Based on the share of ports in the Mediterranean coast, number of workers employed in the Mediterranean maritime transport sector is about 4000 workers. The number of ships passing through the Suez Canal has increased more than 20 000 ships. The transport sector as a whole has been a positive contributor to GDP, with an average share of 5% in the past several years. There have been however, negative impacts on the ecosystem due to maritime transport and pleasure boating. Some of these causes are more specifically, illegal dumping of waste, marine accidents, ship and vessel maintenance resulting in changes in water quality, introduction of alien and invasive species, and sound pollution to name a few.

Increased maritime transport due to an increase in the volume of trade and tourist activities is likely to further increase pressures on the Egyptian coastal areas. The Egyptian Government introduced necessary measures to address the negative impacts resulting from maritime activities. These include the introduction of standards, monitoring and enforcement measures with respect to CO_2 emissions, the disposal of waste, oil spills and other harmful chemicals and waste. Moreover, the local capacity in terms of personnel and equipment were enhanced to adequately monitor, control and manage the sector.

It is evident that from current and expected future urban development in general and that which is associated with tourism along the Egyptian Mediterranean coast, that if proper measures and actions are not introduced, environmental damage to the coastal zone will continue with irreversible damage to some of the natural ecosystem. Policies therefore need to be developed and implemented to promote sustainable and ecotourism that recognizes the importance of the environment and natural resource as being the backbone for the economic viability and further development of the sector and the economy.

Regarding offshore oil and gas industries. Egyptian Mediterranean Sea, offers promising ground for gas discoveries, particularly in deep waters. Most activities of the sector are not located in the Mediterranean or the Delta, with only 7% of the rigs in Egypt located in the Mediterranean or the Delta and the majority located in the Western Desert. With increased stability in the country accompanied by the payment of arrears to foreign petrol companies, explorations have resumed with 53 exploration agreements signed. Fourteen of those explorations are in the Mediterranean Sea: West El Arish off shore, east Port Said, north Rommana, north Ras El Esh, west El Temsah, south Tennin, north El Hammad, and east Alexandria. Linked to the oil industry is the petrochemical industry, with plans to expand activities in this sector. The Government has plans to increase the production of lighter products, petrochemicals and higher-octane gasoline by expanding and upgrading existing facilities and promoting new projects.

Environmental safeguards are introduced to ensure that exploration activities as well as operations and petrochemical activities do not represent a hazard to the environment. Oil and gas companies operating throughout Egypt follow strict environmental standards that require the use of appropriate technologies and procedures to ensure the protection of the environment and the ecosystem. Contingency plans are put in place in order to deal with oil spills and accidents related to explorations, drilling and oil and gas transport.

The significance of the energy sector in Egypt to GDP is represented in its support to the different economic activities, particularly the industry sector that contributes 37.5% to GDP. The importance of this sector as far as the environment is concerned is with regards to the type of fuel used to generate electricity. Heavy reliance on fossil fuels for energy generation represents a problem in Egypt. Increased CO_2 emissions resulting from the burning of fossil fuels and their impact on climate change and sea level rise and the potential negative implications on coastal areas and the Delta is of particular concern to Egypt.

Due to its strategic location, Egypt is a hub for submarine cables. Cables passing through Egypt connect Asia with Europe and North America. There are four main landing locations for cables in Egypt: Zaafarana, Suez, Abu Talaat and Alexandria. The Egyptian Ministry of Communications and Information Technology (MCIT) is working on adding more cables and improving the already existing ones. Contribution of this activity to GDP is minimal.

Main environmental problems associated with the sector is the risk associated with the installation of the cables. However, this does not represent a significant problem for the Egyptian Mediterranean coast.

When it comes to the extraction of marine resources in Egypt, there is little or no data available specific to activities in the Mediterranean coast. It is safe to state that when it comes to the Mediterranean Sea, extraction activities with serious environmental implications are negligible. There are though a number of activities along the Mediterranean coast that have negative environmental impacts on the marine ecosystem. These include mining and quarrying, and drilling related activities.

It is apparent from the assessment that the identified socio-economic activities do have negative impacts on the Egyptian Mediterranean coast. This is mainly represented in increased air and sea pollution, pressure on the ecosystem, degradation of biodiversity and local habitat. This is mainly attributed to unsustainable physical development along the coast associated with internal tourism, the dumping of agricultural, industrial and municipal waste and urban encroachment on the northern lakes, increased surface and maritime transport, offshore and onshore drilling and oil and gas explorations and operations. Other environmentally negative practices include overgrazing, overfishing, hunting of wild animals, illegal bird hunting, over collection of plants, and the impact of invasive species.

In order to estimate the cost of environmental degradation resulting from the key identified maritime related socio-economic activities the cost-based method was used. This mainly involved estimating costs related to the protection of the marine environment and costs imposed on uses of the marine ecosystem due to its degradation. Though cost of CO_2 emissions resulting from surface transport to north coast destinations are not directly related to maritime activities, they were found to be significant. Cost to the economy was estimated at around LE. 10 billion annually. Other costs included cost of installing catalytic converters to curb car emissions resulting from surface transport of local tourists to the north coast was estimated at LE. 500,000,000.

According to the study annual costs are those related to loss of foreign tourists estimated at LE. 2.295 billion, costs related to loss of fisheries from the Mediterranean Sea and the northern lakes, estimated at LE. 20 million, costs of dealing with solid waste generated by urban centres along the coast estimated at LE. 134, 685, and cost related to the management and operations of coastal areas estimated at 23.5 million.

A number of recommendations are proposed to mitigate and eventually avoid the negative impacts of economic activities on the marine environment, local communities and the country as a whole. Those include ensuring the integration of environmental as well as social considerations in economic activities, and the adoption of sustainable practices and measures in tourism, fisheries, and marine transport sectors as well as in other activities such as urban development, industry, and agriculture. There is also a need to have in place a good governance system in order to ensure the strict adherence to environmental regulations, and an adequate and effective monitoring system that ensures compliance and adherence to environmental standards and regulations. Policy and decision makers should be made aware of the real cost to society and the economy of unsustainable economic activities and the need to ensure that environmental and social considerations are fully taken into account in the design and implementation of economic activities. Moreover, local capacities in the assessment and monitoring of marine related socio-economic activities and their potential impact on the marine ecosystem should be further strengthened.

Examples of the impacts of socioeconomics activities on benthic habitats

The distribution pattern of benthic foraminifera as sensitive bio-indicator is utilized to assess human-induced impact on the coastal area, at Alexandria, Port Said and Suez cites of Egypt. Twenty-two benthic foraminiferal genera were identified and complied by principal component analysis into four factors through cluster analysis. Cross correlation of the generic composition, distribution and relative abundance of common genera in the three investigated cores revealed three different coastal environments entities. The categorized environment ranged from light human impact as Alexandria site to heavily impacted by human activities as Port Said and Suez sites. Fauna of Alexandria site reflects an increase in unpolluted water activity revealing high-energy erosive environment. The second entity involves Port Said site, which represents a highly stressed coastal environment, corresponding to high-energy transport conditions influenced by fresh water flush from local Manzala Lake via Bougaz El Gamel outlet while Suez site is influenced by marine hypersaline water coupling with intensified levels of industrial and domestic pollution, attributed to the anthropogenic impact.

Sediment microorganisms were collected bimonthly from 16 sites over one year in the western coast of Alexandria. This area comprises different human activities (urban sewage, agriculture irrigation, industrial wastes, petroleum spill, tourist stress, fishing and commercial navigation). Macrobenthos communities are well indicators of water and sediment quality. Bottom invertebrate’s diversity, comparison of benthos communities at different sampling sites and the biomass were determined as well as the numerical abundance of benthos in comparison to the different environmental parameters. Discharging of chemical pollutants in coastal waters leads to significant degradation in the water quality that altered the macro invertebrates’ diversity indices. The most western sites are less stressed area indicating low diversity rather than the stressed area close to the main sources of pollutants discharge that has relatively high pollution and generally with good diversity. The benthic communities were dominated by few species of pollution tolerance which are used as indicators of polluted sediments such as free-living nematodes and polychaetes. The regional distribution of benthic invertebrate’s communities varied at different sites and over the period of collections that total abundance ranged from 959 to 8444 ind./m2 with an annual average of 3072 ind./m2 and seven benthos groups can be sequenced as follows: Nematodes 46% > polychaetes 22% > amphipods 13.8% >cirripedes 4.8% > oligochaetes 4% > gastropods 3.0% > bivalves 1.5%. On the other hand, biomass of benthic structure has an annual average of 155 g/m2 , where six predomination benthic groups can be ranked in the following sequence: Cirripedes 33.5% > Algae 30.6% > Gastropods 12.7% > Bivalves 9.1% > Sea grass 7.0% > Polychaetes 1.7%. At the different sites, the general structure of species number of benthos groups indicated that Polychaeta was the most common group comprising 27 species of 80 the total number of taxa. The values of species diversity (H`) had relatively moderate diversity (1.3 – 2.02) at most stations and in general the decline in diversity is primarily attributed to the uneven distribution of individuals among the species. On the other hand, the species diversity was only 1.6 at Site 2 though it was the richest that may be attributed to the number of species. Values of the evenness index indicated that sites 1, 8, 9, 10 were highly diverse in benthic communities. The Swartz's dominance index value indicated less stress with high diversity and number of species. The area located close to the outfall of the two main drains are characterized by having distinct eutrophication level leading to significant increase in the species richness and mean abundance of benthic communities of the tolerant species. Continuous monitoring and assessing of macrobenthic communities is needed to determine the short and long-term changes in the marine ecosystem that are essential for fisheries management along the coastal region.

Extensive commercial and residential development over past decades added to the list of anthropogenic disturbances to water quality along the coastal region of Alexandria.

Three sites were selected along Alexandria coast to maximize possible differences in seawater types. The floristic analysis has allowed the identification of 29 macroalgal species. Rhodophyta were the richest taxon (13 species), chlorophyta (10 species), and phyophyta (6 species). The algal flora was closer to cold, temperate nature than tropical. Quantitative differences in species richness across the three sites reflect their entity, and dependent upon frequency of abiotic measured parameters and geographic features. Nutrient concentrations introduced significant changes in macroalgal populations. Macroalgae overall growth was often nitrogen limited. The proportion of red species increased with increasing environmental quality, in contrast to green species whereby proportions increase with decreasing quality status. The high percentage of cosmopolitan species denotes a strong character of environmental instability. The different sites might be exclusive holder of some species. The percentage coverage (abundance) indicated Chlorophyta the main constituent (44.23-50.78%), followed by Rhodophyta (41.67–48.37%), and while Phaeophyta (2.46– 9.55%) exhibited restricted occurrences to relatively less polluted area.

Lake Manzalah-bottomed shallow (0.5-1m), brackish water (3-18‰ and is suffering from high nutrition (eutrophication) due to increased rates of nutrients and organic matter. So, some sources of wastes discharges such as sewage and industrial waste and agricultural activity pour directly into the lake, especially the southern region (Bahr El Baqar Drain). The distribution of benthic organisms in the lake and knowledge of the relationship between the types and aggregates benthic food ecosystem as the important food sources for some aquatic organisms, especially economic fish and crustaceans were studied. Results indicated the presence of 16 species of aquatic plants and invertebrates where empty calcareous shells were more frequent. The abundance of macrobenthic organisms at different sampling sites along Lake Manzala can be ranked as follows: Ostracoda (45.4%, 1010 ind/m2) >submerged plants (12.9%, 287 tufts/m2) > Amphipoda (9.2%, 207 ind ⁄m2) > Polychaetes (7%, 110 ind ⁄m2) Bivalves (5.9%, 132 ind ⁄m2). The biomass of benthic assemblages at different sampling sites can also be ranked as follows: at ST5 (18.1%, 4433 ind ⁄m2) > St6 (11.3%, 2772 ind ⁄m2) > ST8 (9.8%, 2405 ind ⁄m2) > ST3 (9.2%, 2247) > ST7 (8.7%, 2122 ind ⁄m2). The biomass of benthic assemblages at different sampling sites can also be ranked as follows: echinoderms (52%) > molluscs (27%) > crustaceans (16%) > polychaetes (2%) > other groups (3%). Due to the increase of pollutants extensively loaded into the drains are the possible factors having affecting the constituents‟ structure of benthos. The abiotic environmental effects in the lake are general to those generally observed in other areas influenced by organic wastes, namely, changes in the physical and chemical properties of the sediments and low oxygen.

I. Gaps, issues and way forward

So far, none establishment of a model tries to assess Mediterranean Biodiversity. A debate still exists on the possible adaptation measures to restrict the negative impacts by reducing the ecosystems vulnerability, and to exploit the positive aspects or opportunities in the best possible way. Biodiversity impacts of climate change include shifts in species distribution and range, and the impacts of mitigation activities and facilitates the spread and establishment of many alien species and creates new opportunities for them to become invasive. There is also concern that existing protected area networks may not be adequate for biodiversity conservation in a time of changing climate. Moreover, the Mediterranean Sea is becoming warmer; its salinity is increasing, and the rise in sea level is accelerating. In addition, the increase of precipitation levels, extreme events and sea acidity are witnessed recently. The Nile Delta is considered one of the most vulnerable sites due to climate change impacts. Other emerging issues that need to be considered are the recent activities in the EEZ: nature based solution; marine spatial planning; and technological advancement (geo-engeering, synthatic biology).

Ongoing project entitled "Enhancing Climate Change Adaptation in the North Coast of Egypt" funded by The Green Climate Fund (GCF) with cooperation of United Nations Development Program (UNDP) to be implemented by the Ministry of Water Resources and Irrigation with other relevant ministries with a total budget of $31.4 million over seven years, the project aims to protect the densely populated low-lying lands in the Nile Delta, the home of 25% of the

Egyptian population, which have been identified as highly vulnerable to climate change induced Sea-Level Rise (SLR).

The GCF project will expand the use of low cost dikes system to prevent the flooding of the low-lying lands from sea surges during extreme weather events. The dike system was first tested under the pilot level under the GEF Special Climate Change Fund (SCCF) project. The project has identified hotspots vulnerable to climate change as shown in Figure 4.

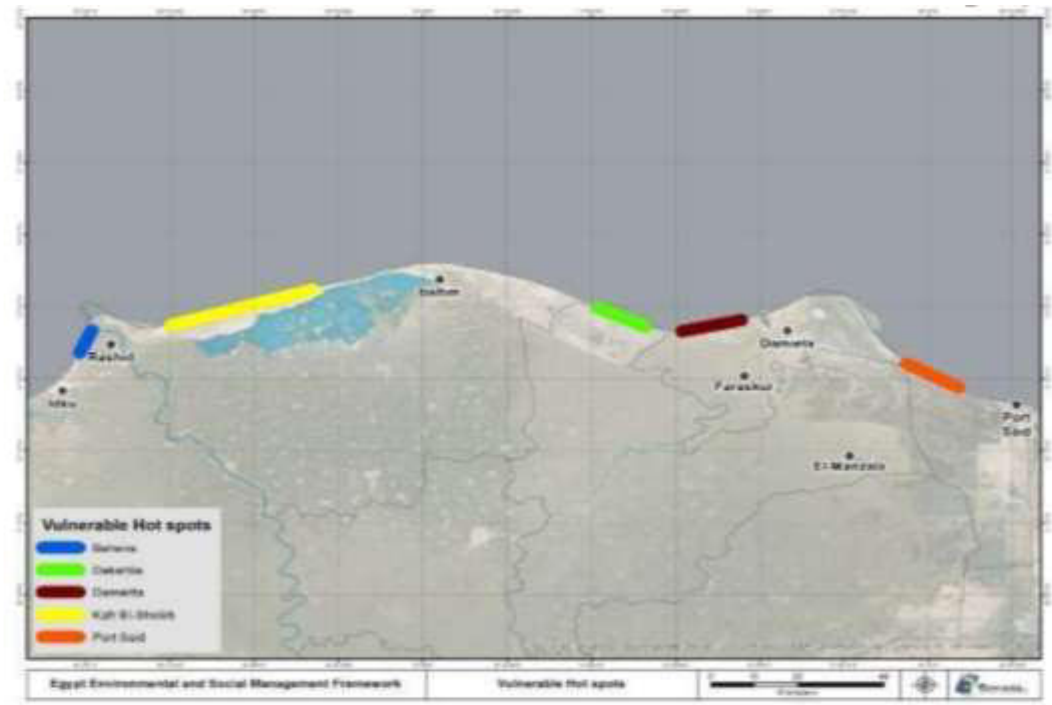


Figure 4 the Five Vulnerable Hotspots
Enhancing Climate Change Adaptation in the North Coast and Nile Delta Regions in Egypt
FP-UNDP-050617-5945- Annex VI (b) 12 Aug 2017.docx

The project will also support the development of an Integrated Coastal Zone Management Plan (ICZM) for the North Coast of Egypt that links the plan for shore protection from SLR with the national development plan of the coastal zones.

The ICZM plan will be associated with the establishment of a systematic observation system to monitor Oceanographic parameters changes under a changing climate as well as the impact of the different shore protection scenarios on the coastal erosion and shore stability.

It is expected that current governmental efforts over the last few years will improve the health of the northern lakes, as well as the coastal infrastructures along the Egyptian Mediterranean Sea. Green bonds, green economy, blue economy, green projects, climate change mitigation and adaptation became the governmental policies that started to be implemented. Around 700 billion Egyptian pounds are being invested in many projects, some have been completed such as Bahr El Bakar Drainage canal where the largest sewage treated system in the world exist in Egypt. Still many other many projects are ongoing, perhaps the most important one deal with environmental management along the Mediterranean Sea.

ANNEX 4

1. General characterization of the coastal area and marine environment

What are the types of coast that are present (e.g. rocky, sandy, cobble / gravel, artificial)? What is the proportion (%) of the different types of coast? What are the main (natural) characteristics of the marine environment?

The Egyptian Mediterranean coast has different geomorphologic aspects ranging from steep-slope-rocky cliffs to gentle sloping deltaic sediments. The landward limit may be several kilometres in sedimentary beaches and tens to hundreds of metres in rocky and cliffy beaches. The Nile Delta, which extends from Alexandria to Port Said, consists of deltaic sandy beaches of medium to very fine sand. It hosts the majority of the country's population and constitutes the bread basket of the country. Coasts along the Mediterranean Sea are relatively extended and comprise deltaic sediments, sand dunes, lakes and lagoons, salt marshes, mud flats, and rocky beaches.

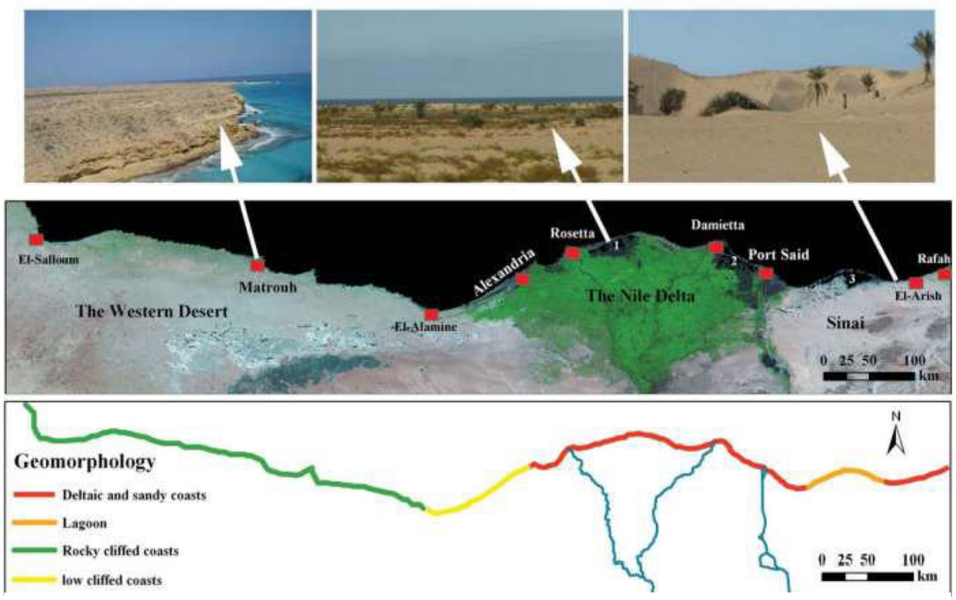


Fig. (1): The geomorphology of the Mediterranean Sea coast of Egypt. Top: ground photos of the different geomorphologic aspects.
Source: Mohamed and Hereher (2015).

The Egyptian Mediterranean coast is divided into three different geomorphologic regions the western region, which constitutes the coastal 550 km of the Western Desert (known as the North Coast); the middle region represents the Nile Delta coast with a length of 250 km; and the eastern region extends for 200 km in North Sinai.

The coastal geomorphology of the entire Mediterranean coast is:

- (rocky cliffed coasts) for the region extending from El-Alamine to El-Salloum along the North Coast (about 450 km);

- (low cliffs) for the region between Alexandria and El-Alamine (about 100 km);
- (lagoons) for the Bardawil Lagoon (85 km) in North Sinai; and
- (deltaic and sandy coasts) for the remaining coast (365 km), which represent the Nile Delta coast and the delta of Wadi El-Arish in North Sinai extending to Rafah.

Are there any areas of erosion and/or accretion?
The majority of the Egyptian Mediterranean coast includes stable coasts due to the rocky nature. The most dangerous and vulnerable locations to coastal erosion were observed in many locations either at the terminal parts of the Nile River branches (Rosetta, Damietta and the defunct Sebenetic branch along lake Burullus) or many touristic resorts along the coast particularly at the sandy beaches. Ten scenes of Landsat sensors (MSS, TM and ETM+) at unequal intervals spanning 35-year period between 1972 and 2007, were analyzed to quantify erosion and accretion pattern along the north-eastern coastline of Nile Delta, from Gamasa to Port Said. Rates of shoreline changes were calculated from automated waterline positions generated at 852 locations using a Digital Shoreline Analysis System (DSAS) version 3.2 programs. To assess impacts of coastal structures on the beach morphology the shoreline positions are divided into two groups. The first group (1972 - 1990) is designated to calculate rates of shoreline retreat approximately before protecting the coastline and the second one (1995 -2007) after construction protection works. Rates of shoreline changes estimated from three statistical approaches of DSAS (the end point rate, the Jackknife and a weighted linear regression) are validated with ground observations of beach profile survey data at the same corresponding positions. Comparison of shoreline rates of beach change obtained from Landsat data with that previously estimated from beach profiles shows that the method used is reasonably accurate with a correlation coefficient value of 0.76. Results indicate that the general alongshore erosion/accretion pattern is locally disrupted by the construction of protective engineering structures. The erosion at the tip of the Damietta promontory is terminated due to the construction of the 6 km seawall built in the year 2000; erosion was originally -43 m/yr before construction of this wall. The 8 km sand spit that has been formed from the eroded zones at the promontory tip before construction of the seawall is now under erosional processes due to deficiency of sediment supply. Further west and prior to protection of Ras El Bar resort, erosion (-10 m/yr) is spatially replaced by a formation of salient accretion (15 m/yr) following emplacement of the detached breakwaters between 1991 and 2002. However, local adverse erosion has been resulted in at the western end of the breakwater system, averaging -5 m/yr. This erosion

has resulted from the interruption of the westerly longshore sediment transport by these breakwaters. The seasonal reversal of the NNE waves is responsible for generating of this westward-flowing long shore current along Ras El Bar coastline.

Rosetta Promontory, Egypt has been suffering from continuous erosion problem. The dramatic retreatment was observed during the last century. It is basically due to the construction of Aswan High Dam in 1964, which reduced the flow and sediment discharges. In this paper, four Landsat images (two Thematic Mapper and two Enhanced Thematic Mapper) covering the period from 1984 to 2014 were used. These Landsat images were radio-metrically and geometrically corrected, and then, multi-temporal post-classification analysis was performed to detect land cover changes, extracting shoreline positions to estimate shoreline change rates of the Nile delta coast around Rosetta Promontory. This method provides a viable means for examining long-term shoreline changes. Four categories, including seawater, developed (agriculture and urban), sabkhas (salt-flat), and undeveloped areas, were selected to evaluate their temporal changes by comparing the four selected images. Supervised classification technique was used with support vector machine algorithm to detect temporal changes. The overall accuracy assessment of this method ranged from 97% to 100%. In addition, the shoreline was extracted by applying two different techniques.The first method is based on a histogram threshold of Band 5, and the other uses the combination of histogram threshold of Band 5 and two band ratios (Band 2/Band 4 and Band 2/Band 5). For land cover change detection from 1984 to 2014, it was found that the developed area that increased by 9% although the land in the study area has been contracted by 1.6% due to coastal erosion. The shoreline retreat rate has decreased more than 70% from1984 to 2014. Nevertheless, it still suffers from significant erosion with a maximum rate of 37 m/year. In comparison to ground survey and different remote sensing techniques, the established trend of shoreline change extracted using histogram threshold was found to be closely consistent with these studies rather than combining band ratio with histogram threshold.

The shoreline response due to the construction of the submerged breakwater using the Digital Shoreline Analysis System (DSAS) showed shoreline accretion along most beaches of Miami, the western part of Asafra, and the eastern parts of Mandara and Montaza. In contrast, areas of shoreline erosion were present at the eastern part of Asafra beach and the western part of Mandara beach (Salama et al, 2021). For example, the shoreline changes response to breakwaters in Baltim Site resulted as; digitized shoreline images of Baltim beach between 1973 and 2018 covered the interval before the construction of concrete breakwaters (17 years) from 1973 to 1990. Erosion increased, reaching an estimate of 0.59 km^2 (erosion rate being 0.0348 km^2/year). However, accretion decreased, reaching an estimated 0.17 km^2, with a rate of approximately 0.01 km^2/year. After construction from 1990 to 2018 (28 years), erosion decreased and was estimated to be 0.12 km^2 (erosion rate about 0.0043 km^2/year).

Table (2): Erosion and Accretion Rate for sites and their description of this study.

Region	Construction Date	Start Construction	Period/ Year	Erosion /km^2	E. Rate km^2 /Year	Accretion /km^2	A. Rate km^2 /Year
Baltim	1990	Before	17	0.59	0.034	0.17	0.01
		After	28	0.12	0.004	1.19	0.042
Rosetta	1990	Before	17	5.7	0.33	3.51	0.206
		After	28	9.45	0.33	0.07	0.0025
NIOF	2000	Before	16	0.016	0.001	0.024	0.0015
		After	18	0	0	0.03	0.001
Six October	2002	Before	18	0.022	0.0012	0.011	0.0006
		After	16	0.006	0.000	0.055	0.003
El-Dabaa	2003	Before	17	.35	0.0175	0	0
		After	15	0	0	0.037	0.0024

Source: Salama A., ELDamhogy K. El kafrawy S., Alabssawy A., and Abdallah H. (2021). Remote Sensing for Shoreline Response to the Construction of Breakwaters and Distribution of the Invasive Species *Brachidontes pharaonis* (Bivalvia, Mytilidae), Mediterranean Sea, Egypt. Egyptian Journal of Aquatic Biology & Fisheries Zoology Department, Faculty of Science, Ain Shams University, Cairo, Egypt. ISSN 1110 – 6131 Vol. 25(3): 689 – … (2021).

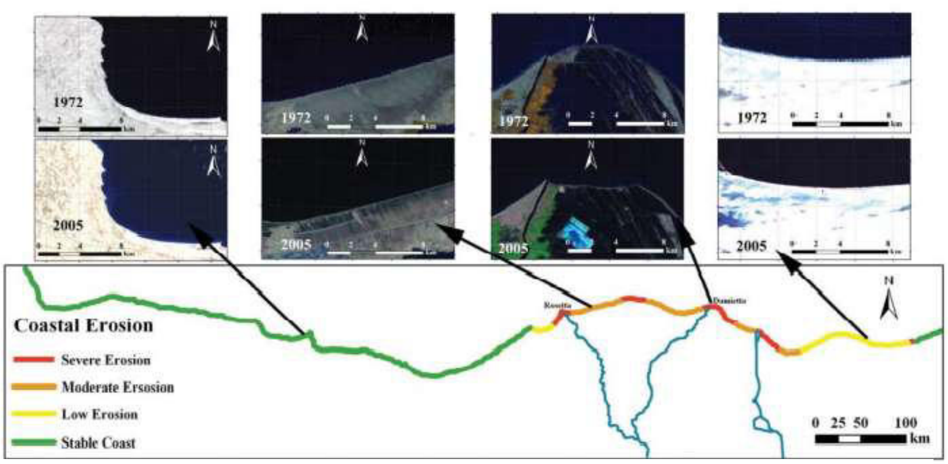


Fig (2): Shoreline position as extracted from MSS (1972) and ETM+ (2005) images, and the corresponding classification of coastal erosion pattern along Egypt's Mediterranean coast according to Thieler and Hammar-Klose (1999).
Source: Mohamed and Hereher (2015).

Fig (3): Shoreline changes in Baltim beach from 1973 to 2018.
Source: Salama et al (2021).

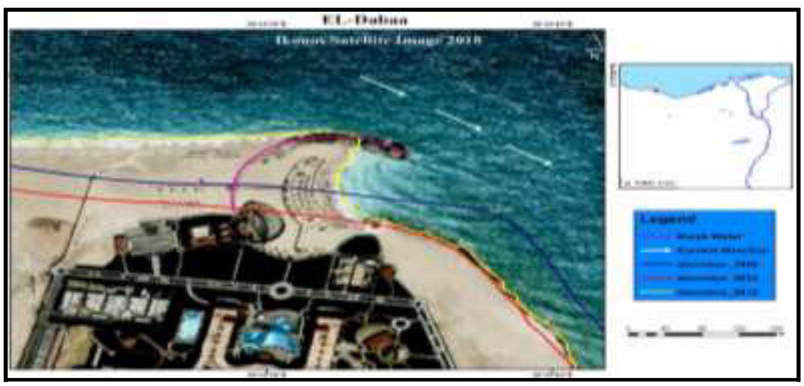


Fig (4): The shoreline changes at El-Dabaa from 1986 to 2018.
Source: Salama at al (2021).

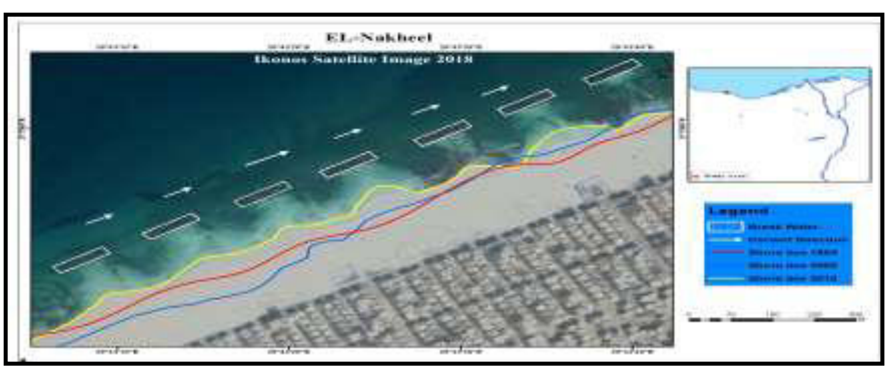
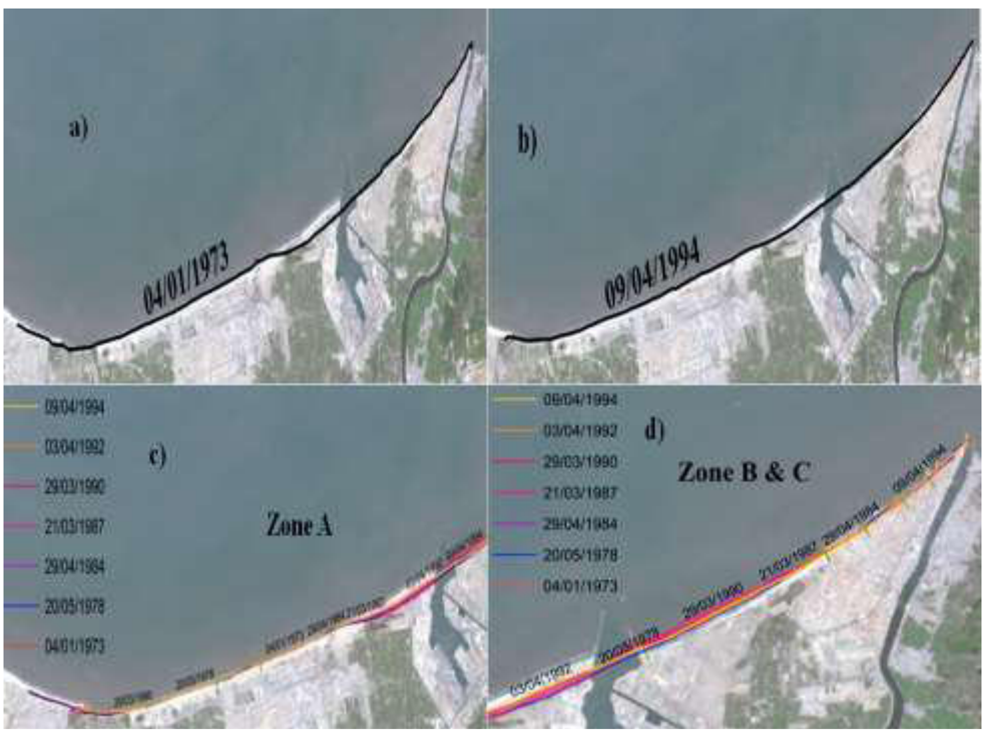


Fig (5): The shoreline changes at El-Nakheel beach from 1984 to 2018.
Source: Salama et al (2021).

Fig (6): The changes of the Rosetta Shoreline from 1973 to 2018.
Source: Salama st al (2021).



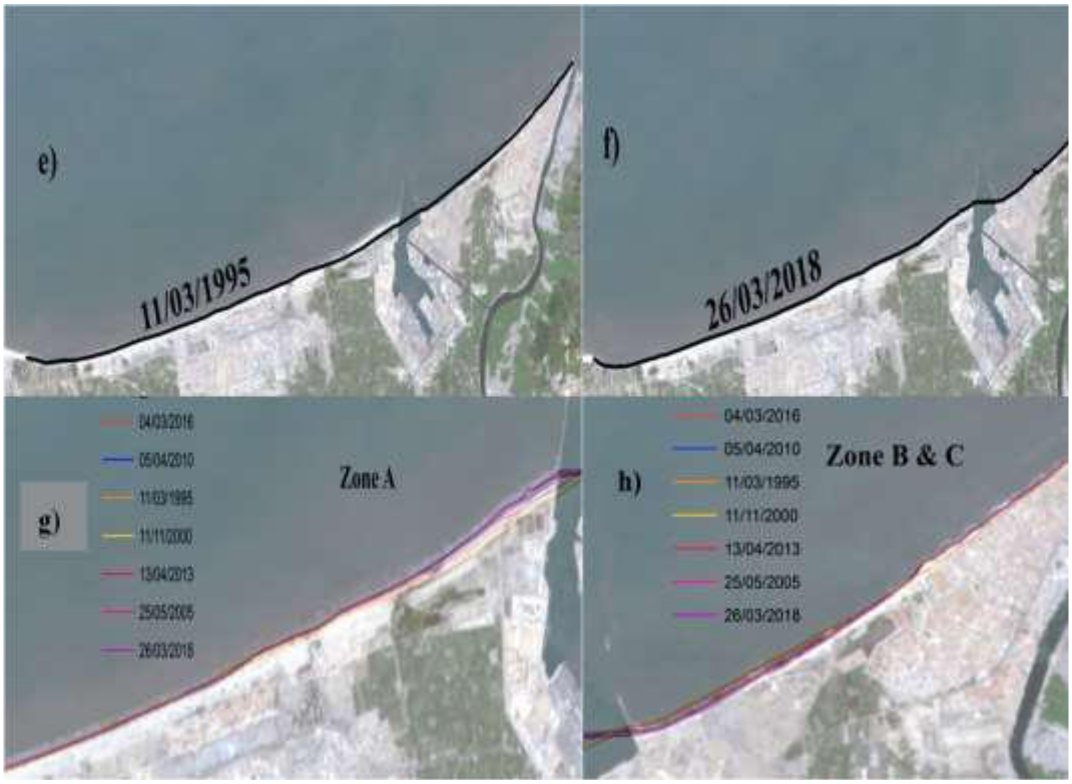


Fig (7). a,b) Satellite images for the two years 1973 and 1994, c) Extracted shorelines for the first period (1973–1994) For zone A, d) Extracted shorelines for the same period for zone B and C e,f) Satellite images for the two years 1995 and 2018, g) Extracted shorelines for the second period (1995–2018) for zone A, h) Extracted shorelines for the same period for zone B&C.
Source: Ezzeldin at al (2020).

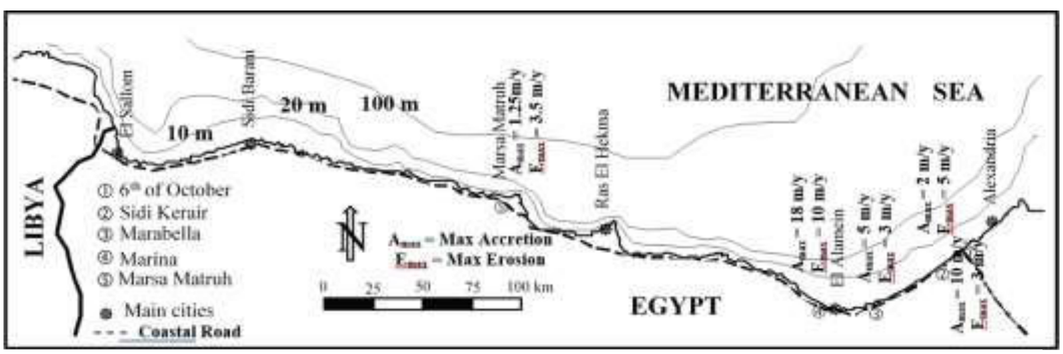


Fig (8): The northwestern coast of Egypt from Alexandria to El Sallom shows the most affected areas by human activities and the maximum accretion and erosion rate in front of these areas from 2004 to 2015, modified from, Iskander and El Kut (2014).
Source: Iskander (2021).

Do data and/or studies on the coast, its length, spatial position and its evolution/change exist? *If yes, describe the existing data and/or studies.*
Are the maps of marine habitats available?

Yes, several researches tackled the length, topography of Egyptian Mediterranean coast. The Egyptian coasts stretch over 3,500 km, of which about 1,200 km are on the Mediterranean Sea, extending from Saloum in the West, to Rafah in the East.

- The North-West Mediterranean coast: It ranges between +2 and +3 meters above sea level, with the exception of low-lying areas, such as natural and artificial lakes and beaches.
- The coast of the city of Alexandria: it ranging from +2.5 to +11 meters (on average +4 meters) above sea level.
- Sinai coast: it ranges from + 3 to +5 meters above sea level.

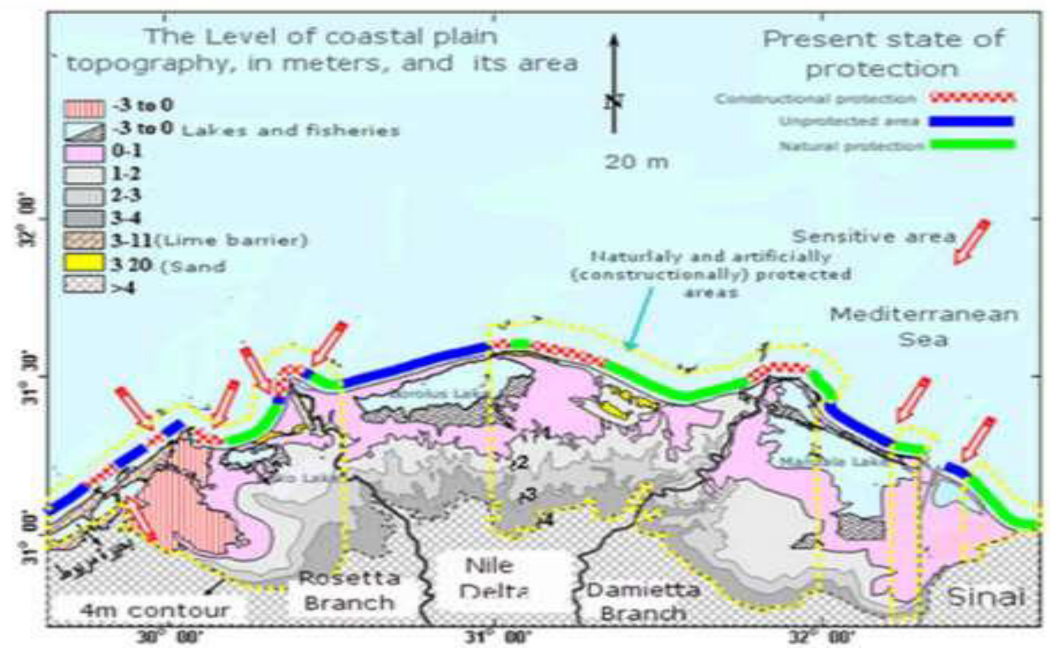


Fig (9): Current natural protection of the coastal area of the Nile Delta and Alexandria (accretional beaches, sand dunes, and long limestone ridges); constructional (protective sea walls and barriers) protection areas for the Nile Delta and Alexandria coastal zone, as well as the more vulnerable areas requiring future measures of adaptation (areas indicated with the arrows).
Sources: - Egyptian Authority for Coastal protection.2010

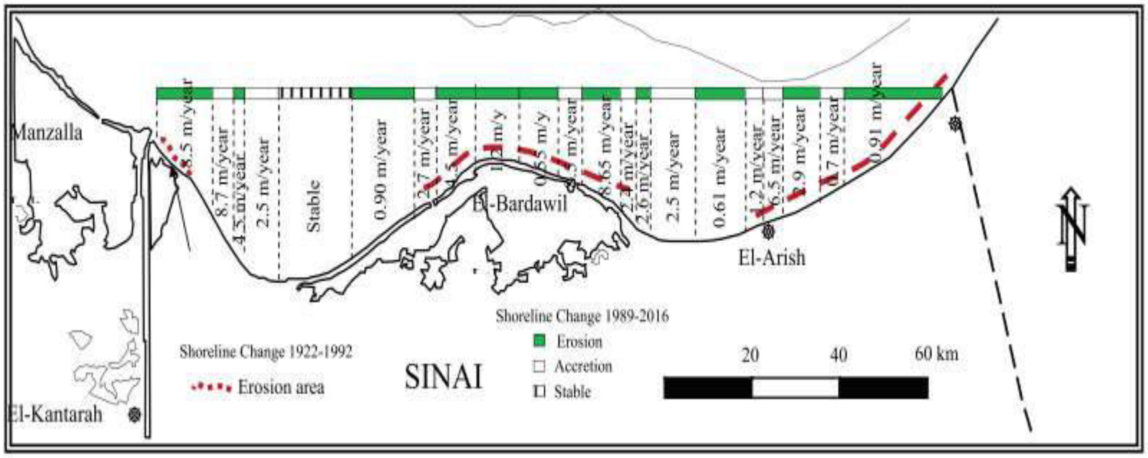


Fig (10): The north-eastern coast of Egypt from Port Said to Rafah shows shoreline reiterate zone.
Source: Stability of the Northern coast of Egypt under the effect of urbanization and climate change, Moheb Mina Iskander, Pages 1-10, 2020, modified from Frihy and Lotfy (1997) and Nassar et al. (2018).

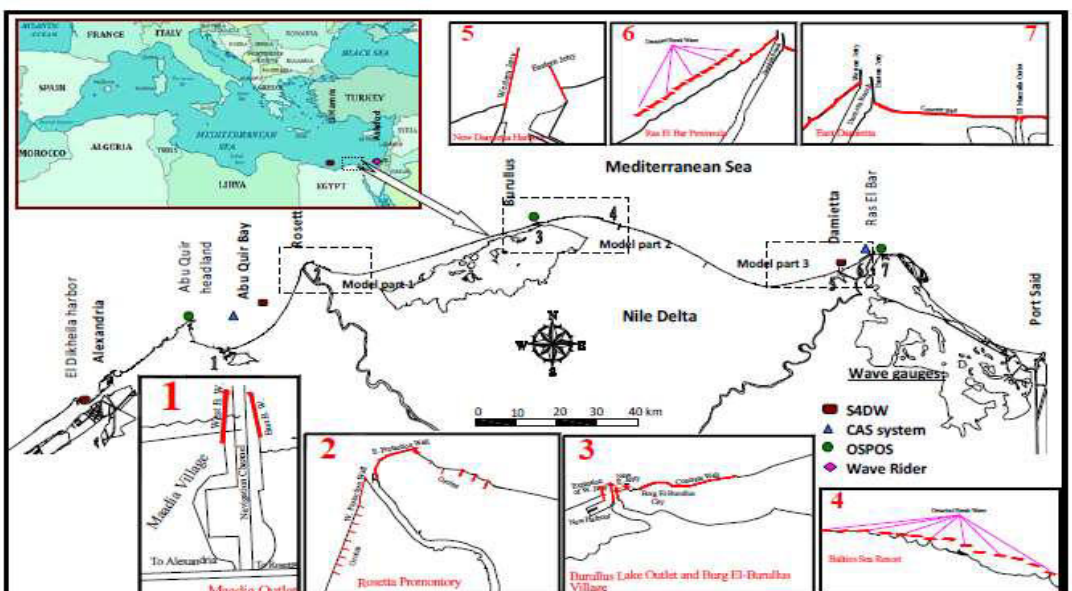


Fig (11): Map of the Egyptian Mediterranean coast showing the Nile Delta coast, wave measurement stations, selected areas for executing the numerical model and the coastal structures distribution along the area, modified from Silem (2008).
Source: Iskander (2013).

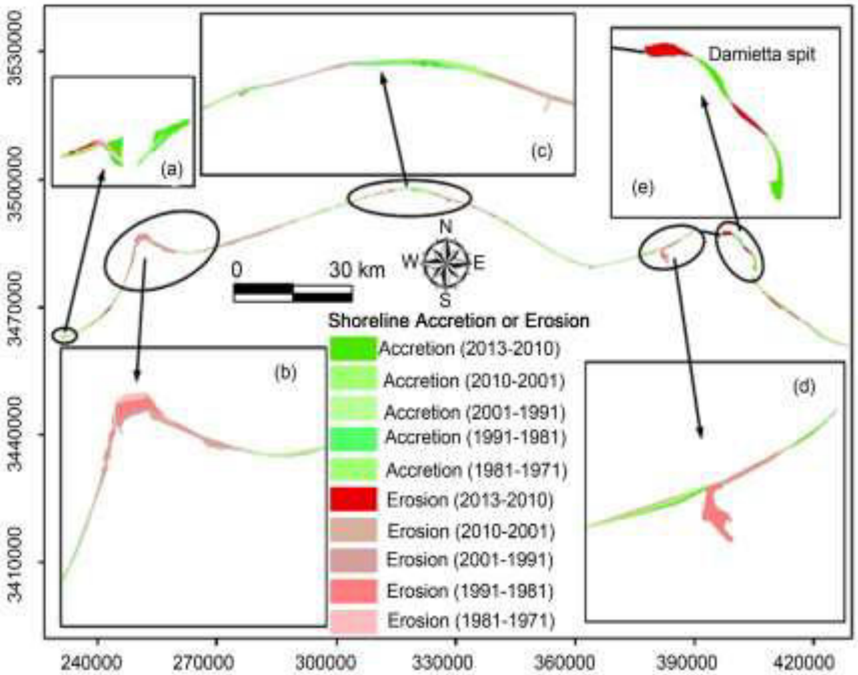


Fig.(12): The variation of surface area of back-shore along the study area, Nile Delta coast, over the period of
42 years (1971-2013).
Source: Deabes (2017).

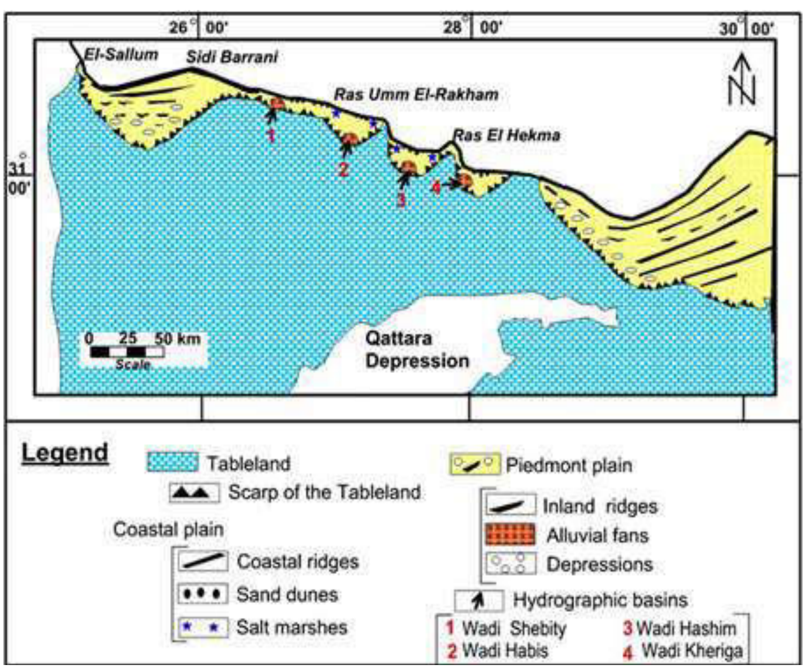


Fig (13): Geomorphic units in the study area.
Source: El Bably at al (2014).

2. Anthropogenic Activities Present in marine environment

Characterization of the marine environment: what are the main human activities present in coastal and marine environment of your country [e.g. ports (trade, travellers), marinas, industries, etc.] and likely to have an impact on the marine environment?
The effect of the human activities on the coastal area are enormous and include impacts on natural resources, coastal stability, environmental quality, and the cultural environment. The instability condition is the predominant feature of the Egyptian coastal zone due to natural and anthropogenic effect. Stability conditions of the sediment within the Egyptian Mediterranean coastal zone includes the sediment sources, degradation of resources, reasons and side effects, climate change effects, and recommendations to control the degradation. The research methodology depends on collecting and discussing the results of the previous related studies, collecting field data and observation along the Egyptian Mediterranean coastal zone as well as Satellite images within the last ten years. Sediment origin from territorial or sea resources, sediment transport, and interaction within the coastal zone were investigated to understand the sediment behavior and how to control erosion and siltation problems. Urbanization, coastal structures, removing sand dunes, controlling the floodwater and sediment, as well as climate change because severe shoreline changes within the coastal zone. Dramatically erosion along the Northern coast of Egypt, and migration of the sand spit inland along the Rosetta Nile branch document these unbalance conditions. Climate change will take place over the next century in spite of international efforts to reduce greenhouse gas emissions. This exacerbates existing environmental problems worldwide. As a result, climate change research is changing from understanding phenomena to impact assessment, mitigation and adaptation strategies for the future development of society. In general, the coastal zone is particularly vulnerable, with expected impacts of sea level rise, salt water intrusion and increasing storm events in addition to existing problems such as coastal erosion, subsidence, pollution, land use pressures, and ecosystem deterioration. Ocean waves and storm surges are considered among the dynamic side issues of climate change. Long-term changes of storm waves and surges are important for coastal disaster prevention and reduction. Moreover, stability of the coastal zone depends on wave characteristics. Few researchers have conducted the future wave climate projection by using wind-wave models, in-situ measurements and satellite data. These studies have shown that the averaged and extreme ocean wave climate changes have not a general trend on both global and regional level. Characteristics of Non-Indigenous fish Species (NIS) and analyses both atmospheric and

sea surface temperatures for the Mediterranean coast of Egypt weremade from 1991 to 2020, in relation to previous reports in the same areas. Taxonomical characterization depicts 47 NIS from the Suez Canal (Lessepsian/alien) and 5 from the Atlantic provenance. GenBank accession number of the NIS mitochondrial gene, cytochrome oxidase 1, reproductive and commercial biodata, and a schematic Inkscape drawing for the most harmful Lessepsian species were reported. For sea surface temperatures (SST), an increase of 1.2 _C to 1.6 _C was observed using GIS software. The lack of linear correlation between annual air temperature and annual SST at the same detection points (Pearson r) could suggest a difference in submarine currents, whereas the Pettitt homogeneity test highlights a temperature breakpoint in 2005–2006 that may have favoured the settlement of non-indigenous fauna in the coastal sites of Damiette, El Arish, El Hammam, Alexandria, El Alamain, and Mersa Matruh, while there seems to be a breakpoint present in 2001 for El Salloum. This assessment of climate trends is in good agreement with the previous sightings of non-native fish species.

The Gulf of Salloum supports a wide range of ecosystems, from the rich sea grass meadows and rocky reefs of the coastal zone, to the little seamounts. It is thus considered as a great resource for many economic fish species such as sardine and red mullet. Moreover, some benthos animals, e.g. Sponge, have been historically utilized. Endangered turtle species have also been recorded in the Gulf.

Seagrass habitat in Salloum Gulf is one of the least impacted and least polluted habitats along the Egyptian Mediterranean coast. Beds of *Posidonia oceanica* are more common than those of *Cymodocea nodosa* Species richness was highest in the western part of the Gulf, directly adjacent to the city of Salloum, and decreased eastwards. Species Richness was also closely correlated to depth, organic matter concentrations and sediment characteristics. Two endangered or threatened species have been recorded. These are the Echinoderm *Ophidiaster ophidianus* and the mollusk *Pinna nobilis.*

Diversity of benthic fauna, fish species and seagrass beds in the Gulf could be divided into two sections. The first section lies to the west of 25º 30’ E longitude and contains the highest species composition, while second section (eastward of 25º 30’ E) contains the lowest species composition.

The dominant feature of Egypt’s Northern Coastal Zone is the low lying delta of the River Nile, with its large cities, industry, agriculture and tourism. The Delta and the narrow valley of the Nile comprise 5.5% of the total area of Egypt but over 95% of its people of which 25% live in the Low Elevation Coastal Zone (LECZ) areas. Due to the concentration of much of Egypt's infrastructure and development along the low coastal lands and the reliance on the Nile delta for prime agricultural land, coastal inundation or saline intrusion caused by anthropogenic climate change induced sea-level rise will have a direct and critical impact on Egypt's entire economy. In addition to the current trends, Egypt's Mediterranean coast and the Nile Delta have been identified as highly vulnerable to climate change induced Sea Level Rise (SLR). It is proposed to integrate the management of SLR risks into the development of Egypt's Low Elevation Coastal Zone (LECZ) in the Nile Delta by strengthening the regulatory framework and institutional capacity to improve resilience of coastal settlements and development infrastructure, implement innovative and environmentally friendly measures that facilitate/promote adaptation in the Nile Delta, and establish a monitoring and assessment framework and knowledge management systems on adaptation.

The coastal areas of the Nile Delta have about 40% of Egypt's agricultural production, half of Egypt's industrial production, and large urban population centres. Egypt's population has reached ~100 million, with a growth rate of 2.0%/year, CAPMAS (2017). Of this number, more than 10 million people inhabit the northern coastal region. Population densities are extremely high (to 1000 or more/km^2), especially in the Nile Delta and Valley. The North western coast of Egypt extends for 500 km west of Alexandria city, along the Mediterranean Sea. It can be divided into two parts according to the urbanization; the undeveloped areas (70% of the total coastline extend) and the developed area (30% of the total coastline extend).

The North eastern coast of Egypt is extending from Port Said to Rafah along the Mediterranean Sea with length about 200 km. This zone consists of a western low sandy/silty section, El-Bardawil Lake, and an eastern sand dune coast.

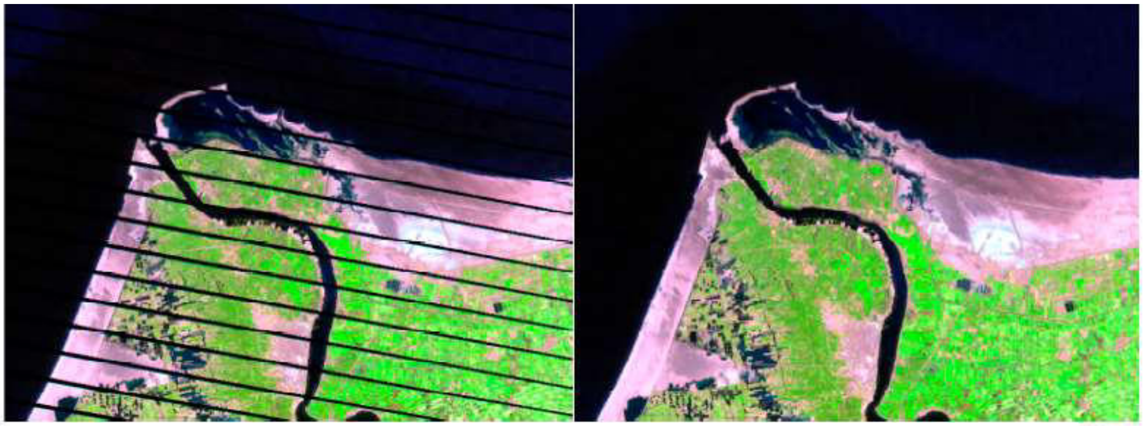


Fig (14): (**A**)Landsat image (2005) before striping removal; and (**B**) after striping removal.
Sources: Masria et al (2015).

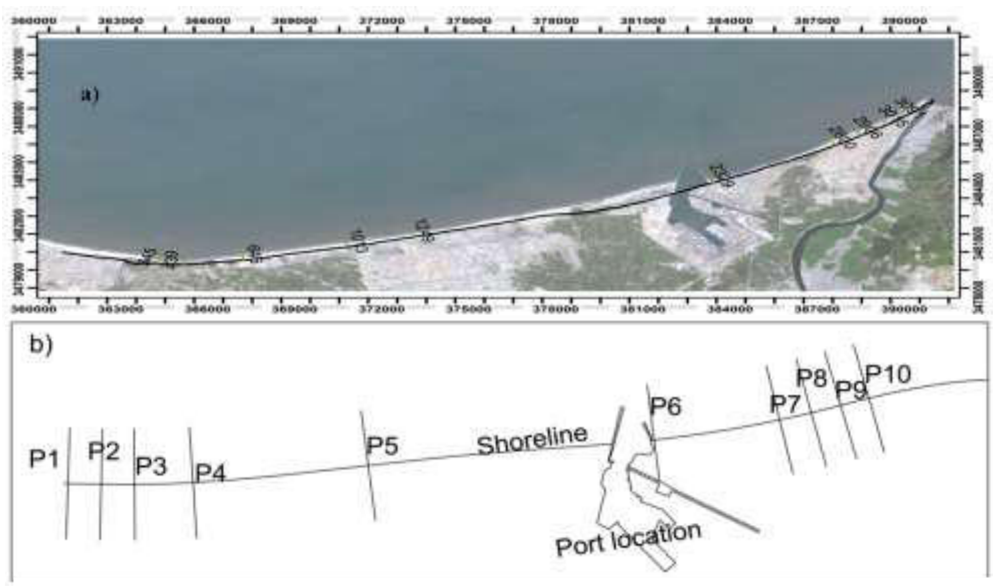


Fig (15): a) Location of transects used in the statistical analysis in the present study, b) Profile numbers and location of survey profiles by Frihy and Komar, (1993).
Source: Ezzeldin at al (2020).

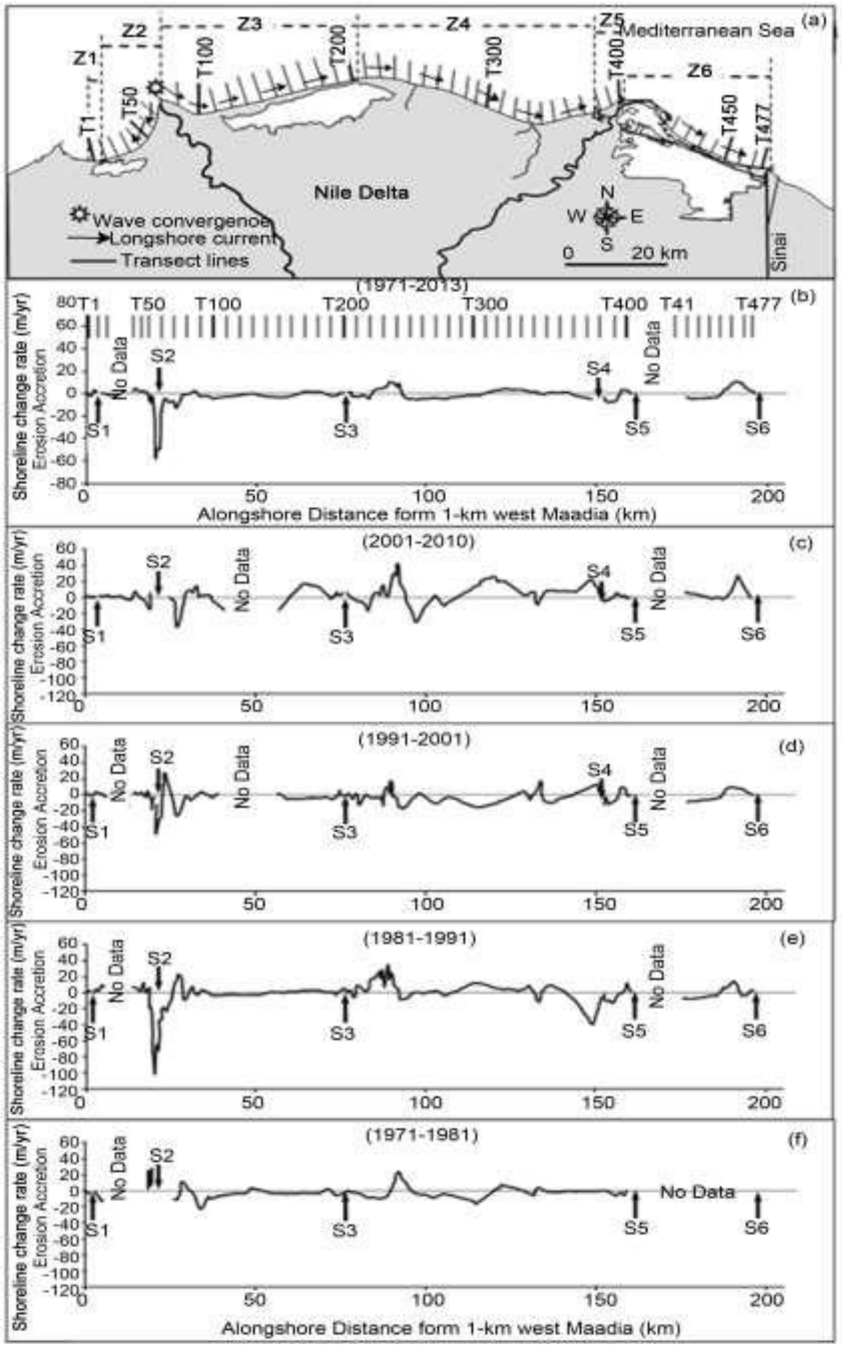


Fig.(16): The annual rate of shoreline change along the Nile Delta coast for the time periods; (f) 1971-1981, (e) 1981-1991, (d) 1991-2001, (c) 2001-2010, (b) 1971-2013. (a) The study area is divided into six zones, Z1-Z6, by waterways, S1 to S6 are the geographic boundaries of these zones.
Source: Deabes (2017).

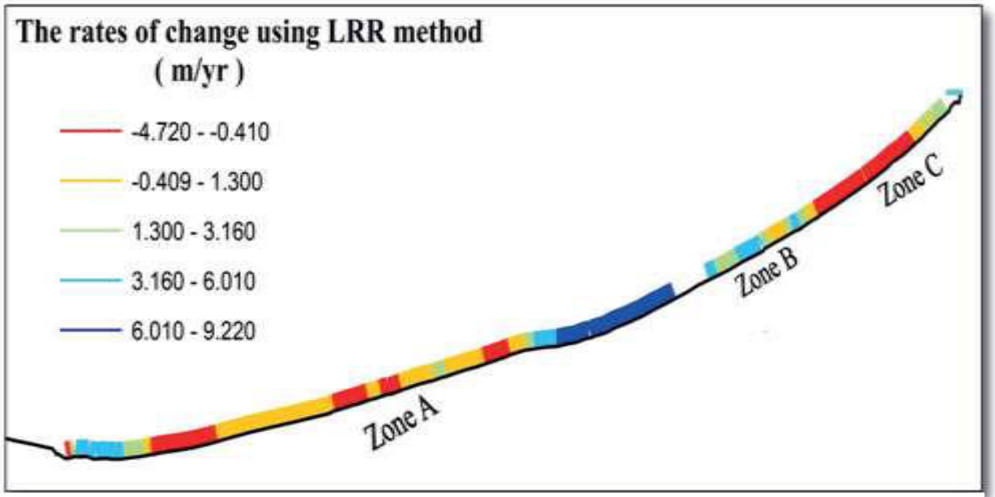


Fig (17): The rates of shoreline change using LRR method for the First period (1978 – 1994).
Source: Ezzeldin at al (2020).

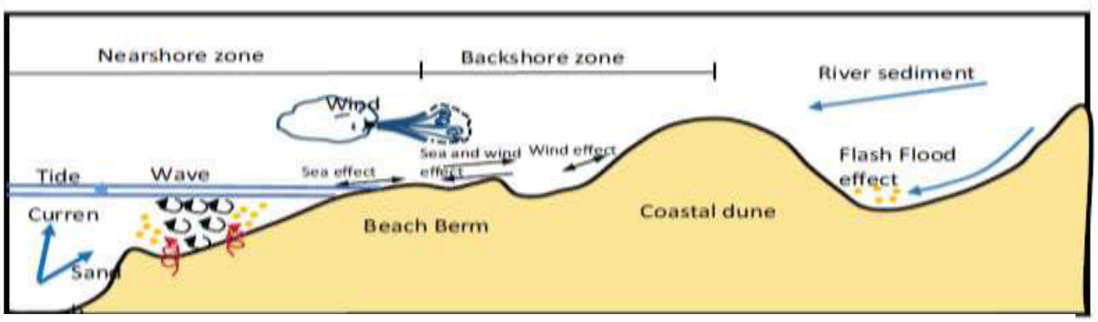


Fig (18): Schematic diagram showing the sediment movement between land and sea as well as the formation of coastal sand dunes under the effect of wave, current, tide, wind and flash flood.
Source: Iskander (2021).

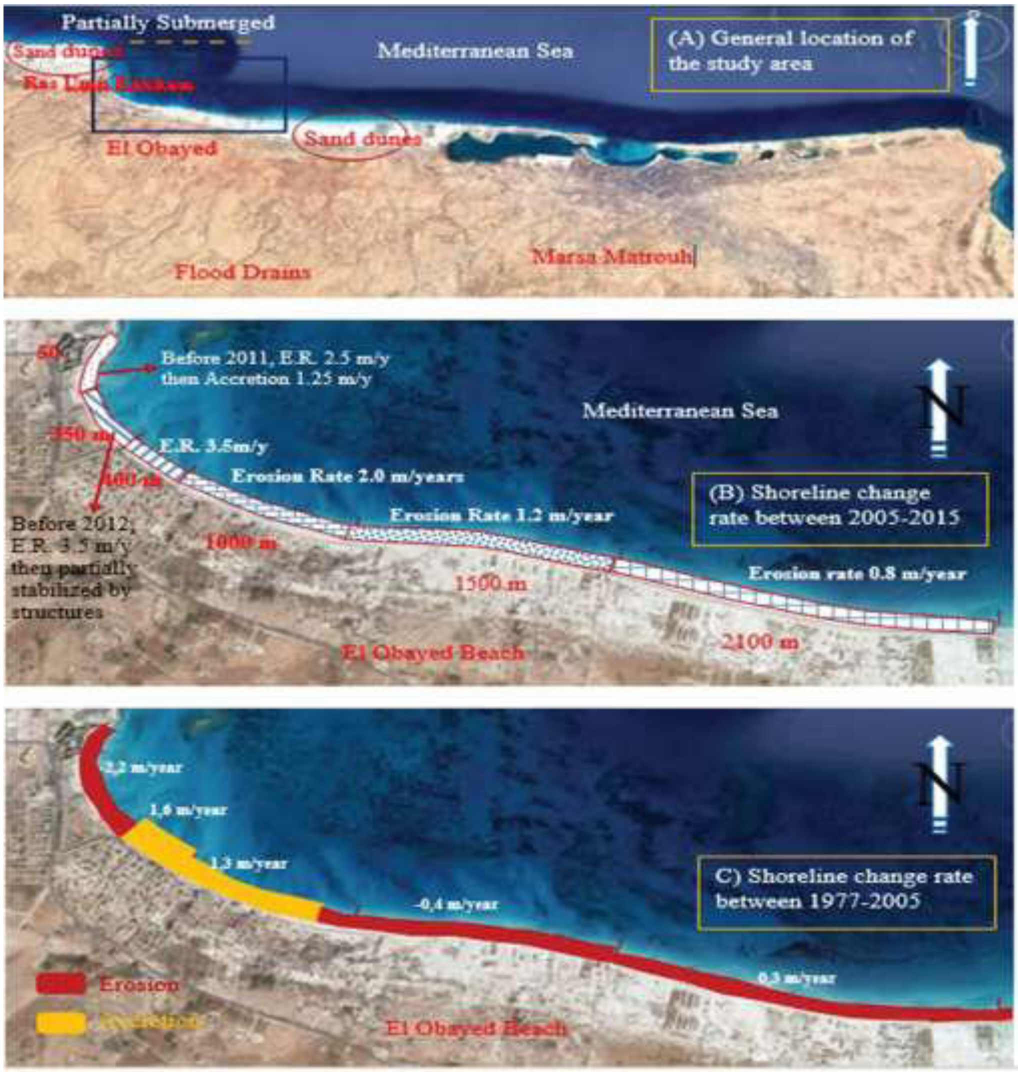


Fig (19): Shoreline change rate along El Obyed beach, Marsa Matroh, Egypt during the period from 1977 to 2015. Source: Iskander (2021).

Has your country seen recently (i.e. in the last 5 to 10 years), any new installation of structures in the marine/coastal environment (e.g. port structures, large marinas, sea defence structures, etc.)?
Many coastal structures have been erected to stop or mitigate coastal problems. 31 Landsat images were used to monitor the fluctuation of erosion and deposition along

many sites of the coast. The shorelines were extracted using standard techniques. Linear regression ratio (LRR) and end-point rate (EPR) were used with Digital Shoreline Analysis System (DSAS) software to determine the rates of beach changes; then forecast future shoreline changes. The accuracy of the model`s results was checked using the ground field measurements of several studies. This model also creates an estimate of the position uncertainty at each time step. The value of the uncertainty is low (approximately half a pixel) along the shorelines without coastal protection. Forecasting future beach evolution to the year 2041 was made to evaluate its sensibility and facilitate proposals for coastal protection for human safety and habitats if the coastal processes and climate change continue to worsen with time.

Although the western-Mediterranean coast of Egypt between Salloum and Alexandria, *550 km long, has maintained a considerable equilibrium throughout history, developers have built traditional protective structures in an effort to form sheltered recreational beaches without taking into consideration its geomorphologic characteristics, coastal processes and their harmful impact on the coastal environment and human safety. The improper practices in this environmentally valuable region have induced us to undertake an initiative to carry out a morphodynamic analysis to provide a framework for understanding the relationship between coastal morphology and the prevailing dynamic forces. Based on the degree of natural protection or wave sheltering, shoreline can be categorized into four distinct morphotypical stretches: (1)high-energy wave-exposed shores and the outer margins of the rocky headlands, (2) moderate to high wave-energy beaches along semi-exposed embayments and bays mostly downdrift of the rocky headlands, (3) low-wave energy at semi-exposed headland lee-sided and pocket beaches, and (4) calm wave-sheltered enclosing water basins for safe anchorages, moorings and recreation beaches. The results deducted will have practical applications for shoreline management initiatives regarding sustained sites suitable for future beachfront development such as safe swimming conditions, sport facilities, water intakes and sheltered areas for vessels. In addition, benefits realized by the understanding of the morphodynamic processes would enhance our awareness of the significance of the role of western coast morphodynamics in supporting sustainable development via shoreline management. As far as sustainability is concerned, the selection of appropriate sites would help avoiding or minimizing the formation of the hard structures needed for creating safe recreation beaches. On a national scale, results reached could provide reliable database for information that can be used in establishing a sustainable shoreline management plan, which is, in turn, an essential part when implementing an Integrated Coastal Zone Management Plan for this region of attraction.

For new natural based sea defence structures ongoing project “Enhancing Climate Change Adaptation in The North Coast and Nile Delta Regions in Egypt” funded by GCF is implementing a total of 69 km of soft coastal protection, in sections of the Nile Delta that currently experiences severe flooding, imminent risks of agricultural land loss and damages to coastal infrastructure. Soft coastal protection focuses on in constructing 69 km of artificial sand dune dikes along five vulnerable hotspots within the Nile delta that were identified during and engineering scoping assessment and technical visibility study.

The Egyptian Shoreline response to the construction of the Artificial Concrete Breakwaters (ACBs) and distribution of the invasive species *Brachidontes pharaonis* at the Mediterranean Sea from spring 2016 to winter 2017 was studied recently. For the estimation of erosion and accretion, the terrestrial satellite imagery was used, including multi-dates of MSS 1973, Landsat Thematic Mapper (TM) imagery of 1984, and ETM 1990, 2001, and 2018. Two main methods were adopted, treatment and interpretation, in all the sites studied, with the exception of Rosetta. During the period before the beginning of the construction of the Artificial Concrete Breakwaters (ACBs), erosion increased but accretion decreased. However, the exact contrary occurred after construction, where erosion decreased but accretion increased. *Brachidontes pharaonis* inhabits hard substrates. Temporal average densities were highest in spring and winter, but lowest in summer. On a spatial level, its maximum mean density occurred at the Baltiem Artificial Concrete Breakwaters (ACBs), while the minimum density was observed at the El Dabaa Artificial Concrete Breakwaters (ACBs). The highest absolute value was listed during autumn in the Baltiem Site, while the lowest one in El Dabaa concrete breakwaters (Salama, et al 2021)

The Northern Coast of Egypt (NC) from Marina El-Alamein recreational centre (MA) to Marbella resort (MR); located at a distance about 50 kilometres east of MA was suffering from a significant shoreline changes. A large stretch of the coast was modelled to attain the appropriate protection countermeasure. Firstly, shoreline change rates were calculated by analyzing the available shorelines extracted from satellite images using Digital Shoreline Analysis System (DSAS) tool in GIS. The shoreline changes were simulated using one-line numerical model. The model determines the shoreline changes due to wave induced long-shore sediment transport considering different types of coastal structures. The model was calibrated by field measurements and shorelines digitized from satellite imagery. The near shore waves used in the shoreline model were estimated using a phase average wave transformation model based on Energy Balance Equation (EBE). The proposed coastal countermeasure involves using system of groins, system of detached breakwaters or mix of them with some recommendations for each case.

In addition, and based on our observation, other coastal developments are being developed. This include urbanization structure along the coastline, touristic development, new cities such as Al-Alamin and Dabaa, ports such as El-Nekhaila along the western coast nearby Marsa Matrouh, and new power station along the coast of Kafr El-Shaikh.

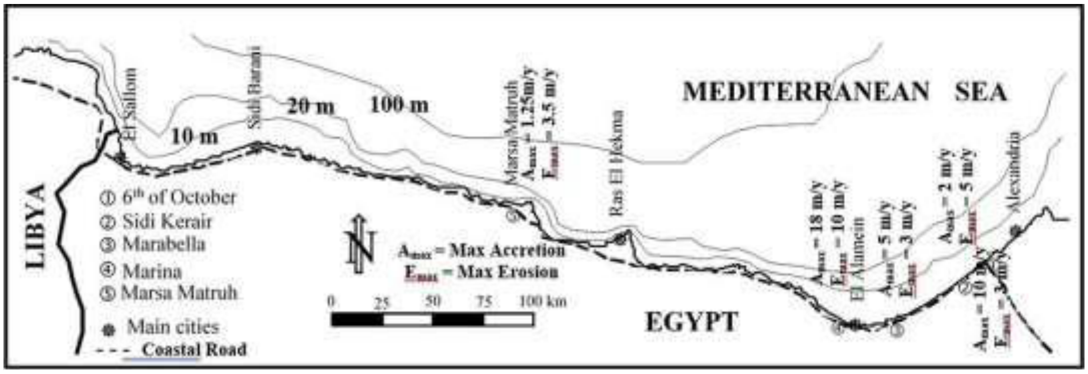


Fig (20) The north western coast of Egypt from Alexandria to El Sallom shows the most affected areas by human activities and the maximum accretion and erosion rate in front of these areas from 2004 to 2015.
Source: Stability of the Northern coast of Egypt under the effect of urbanization and climate change, Moheb Mina Iskander, Pages 1-10, 2020, modified from Iskander and El Kut (2014)

Are dredging and dumping activities present in the marine environment?

Yes, some dredging activities have been implemented mainly in Egyptian northern wetlands and their inlets for enhancing water circulation and thus quality.

Lake Burullus is an important coastal wetland and RAMSAR site on the northern coast of Egypt. Despite the status of Protectorate under Egyptian legislation, the environmental condition of Lake Burullus has dramatically changed over the past 40 years. Three processes can be held accountable; the unprecedented growth of aqua culture ponds (from close to 0 hectares in 1978 to over 40,000 hectares 12 years later in 1990), the expansion of urban area from nearly 2,000 hectares in 1973 to 8,500 hectares in 2011, and loss of open water from over 45,000 hectares in 1973 to about 25,000 hectares in 2011.

The aquaculture ponds have predominantly been built in the fringes of the Lake at the account of shore line vegetation (marsh vegetation and reed) and non-irrigated agricultural lands. The loss of marsh land (from 8,000 hectares in 1978 to a bit more than 3,000 hectares in 2011) in the fringes of the Lake due to the construction of aqua ponds is partly compensated by the development of new marsh land vegetation in the Lake. The surface of reed vegetation increased even despite the fact that reed vegetation along the shore lines was massively replaced by aqua culture ponds; due to the inflow of nutrients from upstream agricultural lands and untreated waste water from the new urban areas

reed invaded the open water. As a result the surface of reed beds increased from nearly 11,000 hectares in 1978 to nearly 17,000 hectares in 2011 (Zingstra, 2013).
The loss of open water, combined with the deteriorating water quality has had a damaging impact on the biodiversity (seven valuable fish species disappeared) and the livelihoods of about 50,000 fishermen living around the Lake.

The fish composition of Lake Burullus has also changed over the years due to the change in the environmental conditions of the lake.

Deep navigation channels have a great impact on adjacent beaches and crucial economic effects because of periodic dredging operations. The navigation channel of the Damietta harbor is considered a clear example of the sedimentation problem and deeply affects the North-eastern shoreline of the Nile Delta in Egypt. Monitoring shoreline for at least 45 years was made, using remote sensing techniques to evaluate the effect of Damietta harbor and its navigation channel. Also, the selected period was divided into two periods to illustrate the effect of man-made interventions on the shoreline. Shorelines were extracted from satellite images and then the Digital Shoreline Analysis System (DSAS) was used to estimate accurate rates of shoreline changes and predict future shorelines evolution of 2030, 2040, 2050 and 2060. The Damietta harbor created an accretion area in the western side with an average rate of 2.13 m year-1. On the contrary, the shoreline in the eastern side of the harbor retreated by 92 m on average over the last 45 years. So, it is considered one of the main hazard areas along the North-eastern shoreline of the Nile Delta that needs a sustainable solution. Moreover, a detached breakwaters system is predicted to provide shore stabilization at the eastern side as the implemented one at Ras El-Bar beach. Predicted shoreline evolution of 2060 shows a significant retreat of 280.0 m on average.

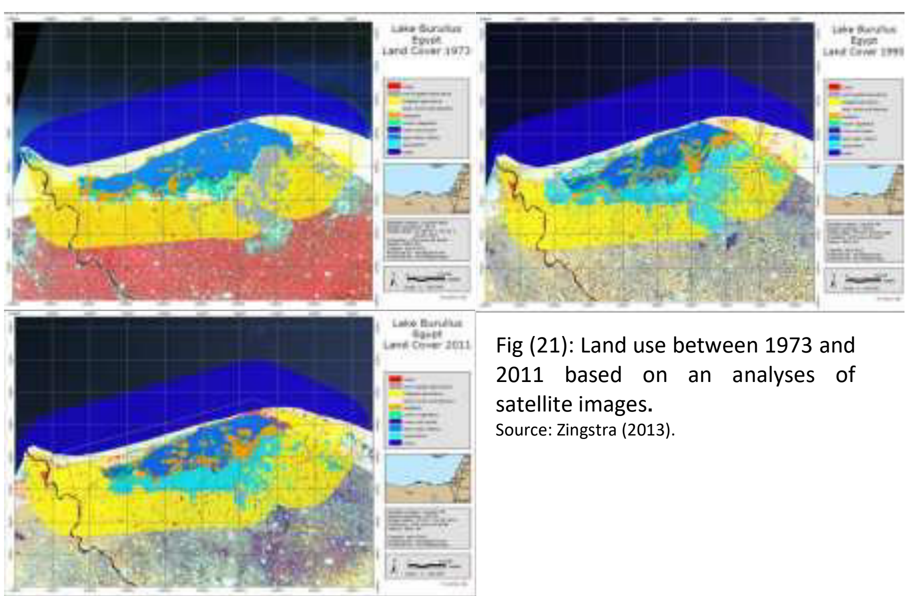


Fig (21): Land use between 1973 and 2011 based on an analyses of satellite images.
Source: Zingstra (2013).

Were the anthropogenic activities that are present a subject to authorization requests, impact studies, environmental monitoring, etc.? **Are these documents freely accessible?** *If yes, and if a coastal/marine structures have been recently built (during the last 5 to 10 years), briefly present the major ones. Could these documents be shared?*
According to Egyptian environmental law 4/1994 that was amended by Law 9/2009, its Executive Regulation and their modifications. The following articles are important: Article 19: "Every natural or legal person, public or private, shall commit to presenting a study of Environmental Impact Assessment of the establishment or the project to the competent administrative body or the licensing authority before starting implementation thereof." Article 74: It is prohibited to take any measures that may affect the natural coast line or alter its configuration either inwards or outwards, without the agreement of EEAA and the competent authority. The executive regulations of this law shall regulate the procedures and conditions to be followed in this connection. In addition to national legislation, large projects funded by donors or international organizations such as World Bank, It is imperative to follow international performance standards. Once an EIA is approved, it will be followed by environmental monitoring program.

3. Hydrodynamic conditions

Do cartographic data on bathymetry exist? *If yes, describe the existing data*
Yes, They are used for national strategic projects; however, they are protected and permissions from the government is needed. The frequency of measurement depends on the use of data: generally, once per year (except in ports and harbours where shoaling may mandate more frequent measurements)

Are there any data and/or studies in place regarding the hydrodynamic conditions (e.g.

characterization of waves, currents, coastal drift, salinity, temperature)? *If yes, describe the existing data and/or studies.* Refer to the Guiding Factsheet for the parameters needed.
Yes, as follows: For salinity: Periodic monitored by different national institutions For temperature: Periodic monitored by different national institutions For currents: Periodic as research requires; moored and small boat Periodic as research requires. The National Institute of Oceanography and Fisheries (NIOF) is implementing a project, funded by the Egyptian Environmental Affairs Agency (EEAA) for more than 20 years on water quality along the coast are general published annually at the EEAA website. However, clarification on certain parameters is usually contacted with the EEAA. The historical measured wave data from 1977 to 2010 were examined to investigate the effects of climate change on wave climate in front of the Nile Delta coast. Also, the hydrodynamic numerical model ImSedTran-2D has been used to describe changes in wave energy from place to place and to check that existing coastal structures will remain effective. Results showed that there was an increasing trend in the mean significant wave height during the period from 1985 to 2010 by a rate ranging from 2.6 to 2.9 cm/year. Increase in wave height coincides with a decrease in wave period ranging from 0.01 to 0.26 sec./year. Wave energy in front of the coastal structures within this area will increase by about 20% within high storms and decrease by about 1 % within the normal conditions in the next 50 years. Nevertheless, most of the Egyptian coastal structures are over designed and will not be affected by the increase in wave energy due to the climate change. Data records of wind, current and sea level were arranged and smoothed to hourly data off Alexandria coast, Egypt. The first data records in (1996) was collected at the Eastern Harbor (EH), and the second data set (2008) collected at the Western Harbor (WH) of Alexandria at the monthly duration. Currents speed data were statistically analyzed and showed a variation from 0 to 43.2 cm/sec at (EH), while in the (WH) varied from 0 to 27.2 cm/sec. Based on the frequency occurrence percentage, the long-shore NE current component was found highly dominated under the influence of the alongshore wind component of the prevailing NW. The rotary tidal current strength was elongated close to the shore and found directed either in the NE-SW or in the ENE-WSW directions in (EH). Currents in (WH) were generated by the dominant NW wind, and partially due to the huge amount of polluted water discharged from El-Max Bay via El-Umoum drain. At both

Harbors, the average tidal current contribution was estimated as 30 % of the total current energy at both sites.
Sea level data were statistically analyzed, and it was found that the range of sea level variation in the (EH) was about (0.53 m), while inside the (WH) was (0.57 m). Harmonic analysis showed a mixed semi-diurnal tidal regime at both sites with significant dominant constituents. Spectral analysis displayed a tidal energy contribution to the sea surface oscillations at both sites (EH) and (WH) of 22% and 13% of the total sea level variability, respectively. While surge energy was estimated as 78% and 87%, respectively at both harbors. In general, the results implied that, tide-generating forces are responsible for generating less than 30% of the total current and total sea level oscillation, while more than 70% of the total energy in both sea level and current data were mainly due to the wind forcing and other non-tidal factors.

Consequence of the sea level rise (SLR) on the Mediterranean coastal areas in Egypt, particularly the Nile River Delta, has become an issue of major concern to Egypt's population and the government. Previous publications disregard the entire Mediterranean coast of Egypt as an integral unit subject to the impacts of the SLR. This study aims to analyzing the risks, ranking the vulnerability and suggesting adaptation measures to mitigate the impact of the SLR along the Mediterranean coast of Egypt. Although the prominent features of Egypt's Mediterranean coastal zone are the low lying coast of the Nile Delta, associated with land subsidence, tectonic activities and erosion; the contiguous coastal sectors are backed by shore-parallel carbonate ridges and Plateau (the western coast) and sand dune belts (Sinai coast). The coastal zone is ranked as high, moderate, and low vulnerable to the SLR. The social and biophysical vulnerabilities demonstrate the asymmetrical impacts of the SLR on the Mediterranean coast of Egypt. Areas at risk in the Alexandria region are Mandara and El Tarh whereas in the Nile Delta region, they are the Manzala Lagoon barrier, east and west of the Rosetta City, Gamil, and the Tineh plain. Risk associated with these impacts may be reduced provided the consideration of immediate and adequate adaptation measures.

Are in situ measurements available for some of these parameters? *If yes, please provide information on: location, frequency and duration of measurements*
Yes, Most of these parameters are measured in situ. The Environmental Information and Monitoring Program (EIMP) aims at establishing a national environmental monitoring program for coastal waters. A reference laboratory is established to assist contracted national monitoring institutions

in the development of quality assurance systems. An important output from the program will be environmental quality data and database systems which will form an integral part of EEAA's Environmental Information Centre. The program, which started in January 1996, and is continued annually until now.

One of the components of the EIMP is the Coastal Water Monitoring component. This component has developed EEAA capacity to obtain and manage information about the pollution of the coastal waters of Egypt, the coast of the Mediterranean Sea, the Red Sea Region (the Gulf of Suez, the Red Sea, and the Gulf of Aqaba). This component involved the development of a database at EEAA on the pollution of the coastal waters.

The purpose of the Coastal Water Monitoring Program is to obtain baseline knowledge of the quality of the Egyptian coastal waters and to establish a continuous survey (Quarterly) of these waters.

The outputs are also used to establish quantitative and causal relations between pollution sources and pollution impacts.

The proposed water sampling Program focuses on measurements of marine water samples in the vicinity of:

- Identified major industrial pollution sources along the Egyptian coastal waters.
- Pollution from sewage discharges from the major coastal cities.
- Pollution from sewage discharges at the major tourist resort areas.
- Outlets from the river Nile and the major lakes.

The goals of the EIMP Coastal Water Monitoring Project are to conduct sampling of marine waters at approximately 45 positions along the Mediterranean coastal waters and 38 in the Red Sea Region and perform analyses of basic, eutrophication, and bacteriological parameters.

4. Planning of new installations in coastal or marine environment

Which Ministry is responsible for authorizing construction in marine environment and for monitoring? Is there a construction of a new or extension of existing coastal/marine structures planned in the near future (5 to 10 years)?

Present the type of constructions and locations if available.

- Egyptian Ministry of Environment
- Ministry of water resources and irrigation (shoreline protection authority)

If yes, are the maps and descriptions of the new structures known and available?
Is an environmental impact assessment planned or available for this new structure? Is monitoring of hydrographic alterations that would potentially impact marine habitats as a consequence planned? Have areas and parameters for monitoring of indicator 15 for the new structures been identified?

Yes,

EIA studies must be approved for any new project from EEAA, in addition to prior approval from high committee for licences according to Egyptian environmental law 4/1994 and its modifications.

EEAA is responsible preparing a database for all projects and their approval status which is available only between national authorities.

Number of touristic projects have been recently implemented in the north coast of Egypt e.g. Paros – Mountain View Ras Al Hikma, Marina West – Marassi North Coast, El Alamein city, **Jefaira North Coast,…etc.**

Recent Beach Protection Projects

1- Protection of Ras al-Bar beaches and tongue area

The Ministry of Irrigation has carried out protection work in Ras al-Bar city to protect beaches and facilities from erosion, as the Beach Protection Authority has carried out the operation to protect the area west of Ras al-Bar.

The Beach Protection Authority has also rehabilitated the sea wall west of Ras al-Bar, strengthened and rehabilitated surf barriers, protected and rebuilt the mouth of Jamsa Bank, and carried out protection work for the Gulf areas, east of Damietta port, west of San Ras al-Bar and east of the tower estate.

2- Beach protection in Alexandria

The Beach Protection Authority has implemented the project to protect the scaffolding area in front of the navy, In the Bay of Abi Qir, to protect the area from flooding, especially in the season of the nucleus, through the work of concrete tiles above the stone tongue, the work of a pavement of metal curtains, the extension of the width of the main scaffold, the restoration of the old scaffold, and the renovation of the current aquarium to the level (-3.00) meters.

3- Protecting the Nile Estuary of Rashid Branch

The Beach Protection Authority carried out the Nile Estuary Tekrik project for Rashid branch in Kafr Al-Sheikh and Al-Lake governorates, about 100 meters wide and about 2 km long.

Drilling and reclining of sand deposited on the eastern side of the Nile, about 2 km from the Bougaz Rashid opening, was also carried out in the south to facilitate navigation.

The operation to protect the low-lying coastal areas west of the mouth of the Rashid branch, in The New Rashid area of Lake Governorate, using geotextel mats, dalumite stones, daqshom and sand bumpers.

4- Protecting the beaches of Kafr Al-Sheikh

In Kafr al-Sheikh province, several protection projects, such as the coastal area protection project north of The Glyon Pond, have been implemented with the construction of 16 stone heads and the low-lying area protection project, from west of Al-Burles to the mouth of the Rashid branch, 29 km long.

5- Protecting the beaches of Daqahliya

The Beach Protection Authority has implemented the project to protect low-lying areas from the western entrance to Jamasa city to the west of the new city of Mansoura, 12 km long, and the area protection project east of the sea heads, which is carried out east of the mouth of The Bank of Kutcher and sand feeding.

6- Protecting the beaches of Matrouh

The Beach Protection Authority in Marsa Matrouh, the first phase of the project to protect and develop the Bay of Marsa Matrouh city, ended the work of tongues to protect the southern region of the Gulf, and the Corniche Marina Matrouh from the bay, and to maintain the appropriate depths of navigation, the nearby shipping corridor, and prevent the reassurance of sediments, with the aim of protecting tourism investments and working on their development.

The second phase of the project is under way and is expected to be completed within 6 months.

7- Protecting Al-Abyad Beach

The Beach Protection Authority has also prepared a study to protect Al-Abyad Beach from the decline of the beach line, by establishing 5 stone protection heads within the sea (T-shaped wave barriers) and working a set of barriers with 20 head barriers east of the current barriers, and implementation is expected to take 3 years.

Fig (22): Recent Beach Protection Projects

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