

**ADAPTATION TO CLIMATE CHANGE IN THE NILE DELTA THROUGH INTEGRATED
COASTAL ZONE MANAGEMENT PROJECT**

INTEGRATED COASTAL ZONE MANAGEMENT IN THE NORTHERN COAST OF EGYPT

VOLUME I
FINAL STUDY REPORT

APRIL 2017



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FOREWORD

Since ancient times the Northern Coast of Egypt has provided strategic importance for the development of the Egyptian society and its relationship with neighboring Mediterranean countries.

The commercial importance of Alexandria from its foundation by Alexandre the Great, the agriculture and industrial development in the Nile Delta area several centuries ago, the construction of the Suez Canal, the II World War, and the recent tourism development are some facts that have shaped the Northern Coast to the present.

Nowadays, this coast faces new challenges as climate change, degradation of natural resources and rapid urbanization. The proper management of these new processes is key to ensure the importance of the Northern coast as engine for sustainable development. It can only be achieved through a holistic understanding of coastal processes and in collaboration with all Egyptian institutions and stakeholders that manage and live in the Northern Coast.

The Government of Egypt and the international agencies, aware of the need of facing new coastal challenges from integrated approaches, have supported ICZM processes in Egypt from the 90's. These efforts have turned into a set of ICZM and climate change adaptation initiatives that constitute the necessary framework to plan the sustainable management of the Northern coast.

The *ICZM Scoping Study in the Northern Coast of Egypt* is the first step towards an integrated management of the Northern Coast. This study provides a baseline understanding of the Northern Coast, its current and future needs and challenges including physical, ecological, socioeconomic, institutional and legal aspects. This study will help Egyptian managers to identify priority areas of action and the definition of alternatives for upcoming stages of ICZM and shoreline management.

The participation of a great variety of coastal stakeholders during consultation activities has provided valuable information for the development of the study, and is itself an indicator of the current will of Egyptian institutions to work together for a better coast.

Finally, the elaboration of the *ICZM Scoping Study* under the umbrella of ACCNDP (Adaptation to Climate Change in the Nile Delta through ICZM Project) has contributed to align the outcomes of the scoping study to the ACCNDP's strategic objective of enhancing Egypt's reliance and reducing vulnerability to climate change.

Santander, 28th February 2017.

Raúl Medina Santamaría.

Project Manager

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The ICZM *Scoping Study in the Northern Coast of Egypt* is the result of eight months of work and the collaboration among several institutions. Now is time to thank everyone who has made its successful development possible.

Firstly, we would like to acknowledge the Government of Egypt, the Global Environmental Facility/Special Climate Change Fund and the United Nations Development Programme that have focused their efforts on enhancing ICZM and climate change adaptation in the Mediterranean coast of Egypt. Thanks are also due to the project executive committee staff Prof. Mohamed Abd-Elmotaleb, Eng. Ahmed Fathy, Prof. Mohamed Soliman and Dr. Mohamed Bayoumi for their valuable guidance throughout the study.

The ACCNDP staff Dr. Mohamed Ahmed Aly and Dr. Amr Abd-Elhamid Abd-Elgawad have actively supported the preparation of this study. Their help was invaluable to review study reports and to achieve a broad stakeholder participation.

Sincere thanks are also due to all stakeholders that have participated in the ICZM Scoping Study, with special mention to those stakeholders that have actively contributed and provided data, as NWRC, CoRI, SPA, EEAA, NIOF, NARSS, GOPP, NCPSLU and TDA; their knowledge and experience have improved the expert's views and perception of the Mediterranean coast. Without their feedback and active contributions, the preparation of this study wouldn't have been possible.

CONTRIBUTING AUTHORS

The ICZM Scoping Study has been developed by enthusiastic staff from IHCantabria (Spain) and Environics (Egypt), including ICZM experts, coastal engineers, coastal risk and climate change experts, urban planners, social and legal experts, biologists and IT specialists.

They combine deep understanding of the Northern Coast with international experience in ICZM projects. With their professionalism and dedication they have inspired this work.

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ACRONYMS

ACCNDP: Adaptation to Climate Change in the Nile Delta through Integrated Coastal Zone Mangement Project.

ALAMIN: Alexandria Lake Mariut Integrated Management.

ASTER: Advanced Spaceborne Thermal Emission and Reflection Radiometer.

BFI: Beach Flooding Indicator.

BTI: Beach Type Indicator.

CoRI: Coastal Research Institute.

CTI: Coastal Type Indicator.

CU: Coastal Units.

EAAA: Egyptian Environmental Affairs Agency.

EMODnet: European Marine Observation and Data Network.

GAFRD: General Authority for Fish Resources Development.

GCM: Global Circulation Model.

GEF: Global Environmental Facility.

GESAMP: Group of Experts on the Scientific Aspects of Marine Environmental Protection.

GIS: Geographical Information System.

GOPP: General Organization for Physical Planning.

HDI: Human Disturbance Indicator.

ICZM: Integrated Coastal Zone Management.

MWRI: Ministry of Irrigation and Water Resources.

NCPSL: National Centre for Planning State Land-use

NCICZM: National Committee of Integrated Coastal Zone Management.

PAP/RAC: Priority Actions Programme Regional Activity Centre.

PEGASO: *Project acronym*: People for Ecosystem-based Governance in Assessing Sustainable development of Ocean and coast.

RCP: Representative Concentration Pathway.

SDI: Spatial Data Infrastructure.

SPA: Shore Protection Authority.

SHW: Stress Heat Wave

SWOT: strengths, weaknesses, opportunities and threats.

UNDP: United Nations Development Programme.

WB: World Bank.

CHAPTER 1: INTRODUCTION



CHAPTER 1. INTRODUCTION

The Northern Coast of Egypt extends for about 1,200 km along the Eastern Mediterranean. This coast is characterized by a wide variety of environmental and socioeconomic conditions, as different exposure to coastal dynamics, conservation status, population density or economic activities. Consequently, the challenges to achieve a sustainable development of the coast are variable along the Northern Coast, including climate change impacts, severe environmental degradation, water pollution, deteriorating social conditions and conflicts of responsibilities and interests between different users.

Integrated Coastal Zone Management (ICZM) aims at achieving a sustainable management of the coastal area through the holistic understanding of coastal threats and opportunities, and through the provision of adequate institutional framework. During last years the Government of Egypt has encouraged a more sustainable development of the coastal area, participating in several ICZM initiatives along the Northern Coast. In the Nile delta, the most significant project towards an integrated management of the coastal area is the Adaptation to Climate Change in the Nile Delta through Integrated Coastal Zone Management Project (ACCNDP). ACCNDP is an initiative of the Coastal Research Institute (CoRI) and funded by the Egyptian Ministry of Irrigation and Water Resources (MWRI) through the Shore Protection Authority (SPA), the Global Environmental Facility (GEF) and United Nations Development Programme (UNDP). This project aims to enhance Egypt's resilience and reduce vulnerability to climate change impacts.

The Integrated Coastal Zone Management in Egypt – a Scoping Study (herein after named *ICZM Scoping Study*), is developed under ACCNDP, and focuses on identifying the major present and future challenges of the coastal area from an integrated approach. These challenges define the scope for subsequent stages of ICZM planning in the Northern Coast.

This study was conducted by the partnership IHCantabria (Spain) – Environics (Egypt) and lasted seven months, between July 2016 and February 2017.

1.1. OBJECTIVES

The overall objective of the *ICZM Scoping Study* is to define the scope of establishing an ICZM Plan along the Northern Coast of Egypt. This study constitutes the first stage of the ICZM policy cycle, where main issues and problems of the Northern Coast are identified including physical, environmental and socioeconomic issues at present and long-term situations. This study is then to compile, analyse, integrate and summarize available information in order to holistically understand major coastal challenges. This study provides common datasets and a shared understanding of the issues and opportunities for coastal zone management. To obtain the expected outputs, the *ICZM Scoping Study* encompasses two tasks:

1. The first task is devoted to **compile, analyse and integrate existing information of the Northern Coast in order to identify the key issues and management priorities**. That is, this task gathers available information, spread among coastal stakeholders, regarding coastal dynamics, environmental sensitive habitats, social, urban and economic trends and the policy and institutional context. This information is analysed and summarized to provide an integrated vision of coastal challenges and synthetic information for coastal management. The results of this task are presented in this final study report and in the ICZM GIS Catalogue, including baseline information for developing ICZM plans in the Northern Coast.
2. The second task is to **involve coastal stakeholders** -governmental authorities, public agencies, private sector, NGOs, society, etc. - into the definition of coastal issues in order to achieve a **shared understanding and ownership of future coastal planning stages**. To this end, this task includes the organization of individual meetings and workshops at different stages of the *ICZM Scoping Study*: inception workshop and meetings to compile stakeholders concerns and data, and disclosure workshop and meetings to validate and agree on Key Issues for coastal management.

1.2. STRUCTURE OF THE DOCUMENT

This document is structured into five chapters and four annexes:

This first chapter introduces the study itself and describes its main objectives.

Chapter two explains the methodology followed to conduct the *ICZM Scoping Study*. First, this chapter presents the conceptual framework, illustrating the main steps of the methodology. Secondly, it describes the procedure to divide the coast stretch into homogeneous coastal management units, and finally, this chapter presents the steps followed to conduct sectoral (physical, ecological, socioeconomic, and legal & institutional) and integrated diagnoses of each coastal unit.

Chapter three analyses the available data and describes the data used for the study, assembled in four groups according to their contribution area: physical, ecological, socioeconomic, and legal & institutional.

Chapter four presents the coastal diagnosis through a set of four factsheets for each coastal unit: one for each of the sectoral diagnoses performed at coastal unit scale (physical, ecological and socioeconomic), and one factsheet for the integrated diagnosis, including SWOT analysis and the Key Issues for each coastal unit. These results are also displayed in the ICZM GeoViewer (<http://iczmegypt.ihcantabria.com/>). Finally, Chapter four presents a legal factsheet at national level; it summarizes the major findings of the legal assessment, presented in Annex IV.

Last but not least, chapter five presents the conclusions of the study and identifies the future stages and recommendations to establish ICZM processes in the Northern Coast.

All references and baseline information used for the development of the *ICZM Scoping Study* are compiled in the last section of this document.

Finally, four annexes provide detailed results of physical, environmental and legal analyses:

- Annex I: Hazard characterization and climate change.
- Annex II: Coastal impacts and indicators.
- Annex III: Ecological assessment of the Northern Coast.
- Annex IV: Legal and institutional assessment.

Additionally, Volume II compiles all supplementary reports of the study: "Inception Report", "Progress Report Summarizing Stakeholder Analysis, Field Work, Consultation Process and Stocktaking Activity", "Initial GIS Design Report" and "Summary of the Consultation Process".

CHAPTER 2: METHODOLOGY



CHAPTER 2. METHODOLOGY

2.1. CONCEPTUAL FRAMEWORK

According to the Protocol on ICZM in the Mediterranean Sea ‘integrated coastal zone management’ means a dynamic process for the sustainable management and use of coastal zones, taking into account at the same time the fragility of coastal ecosystems and landscapes, the diversity of activities and uses, their interactions, the maritime orientation of certain activities and uses and their impact on both the marine and land parts.

In practice, ICZM planning is a cyclical process following a sequence of basic stages. The Priority Actions Programme/Regional Activity Centre (PAP/RAC) of the Mediterranean Action Plan (MAP) identifies the following stages: problem formulation, definition of goals, development and implementation of strategies and finally monitoring. In this line, the policy cycle proposed by GESAMP includes five stages, as shown in figure 2.1.:

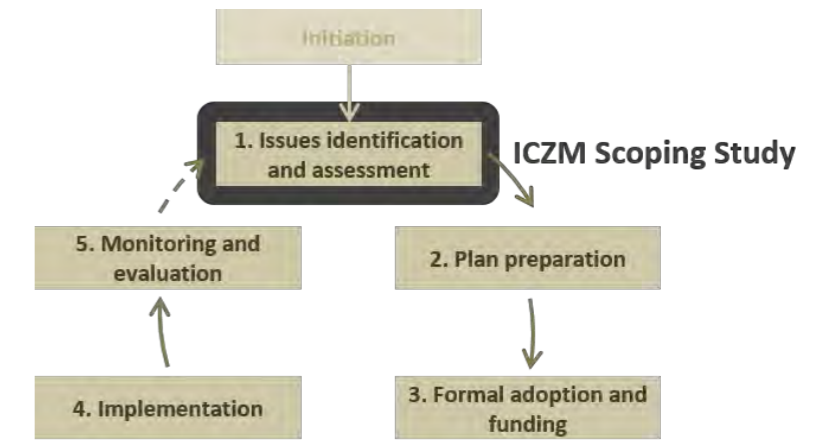


Figure 2.1. ICZM policy cycle (adapted from GESAMP, 1996)

The *ICZM Scoping Study* constitutes the first stage of the ICZM policy cycle in the Northern Coast of Egypt. This first stage is where main issues and problems are identified, including physical, environmental and socioeconomic issues. The steps followed for the development of the *ICZM Scoping Study* are shown in the following figure:

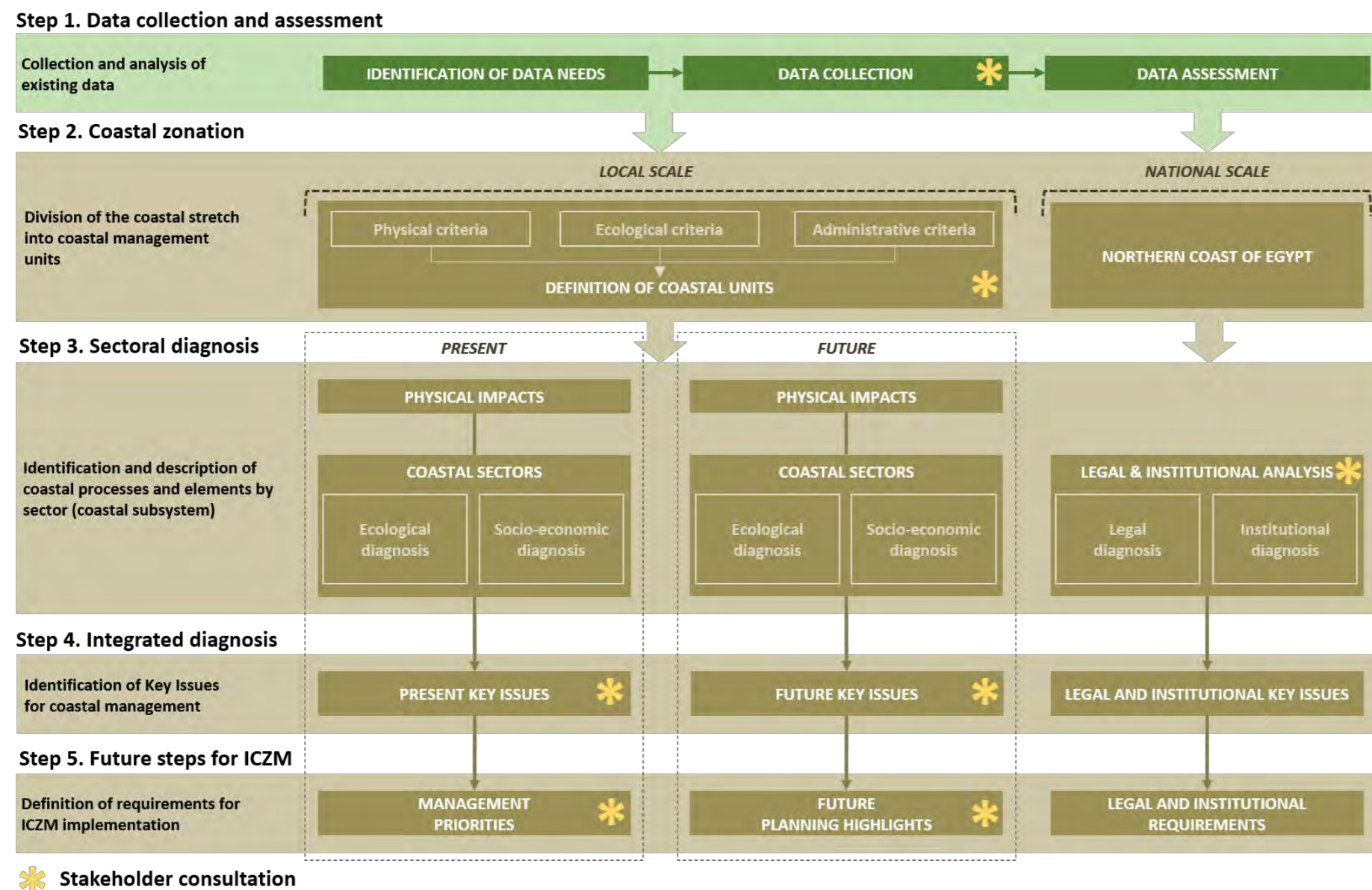


Figure 2.2. Conceptual framework

This methodological approach aims at understanding the functioning of the complex coastal system based on the integration of sectoral diagnoses. Sectoral diagnoses focus on the four coastal sub-systems used to compile the information and to assembly the whole coastal system: 1) physical, 2) ecological, 3) socioeconomic, and 4) legal & institutional subsystem. Stakeholder participation and consultation are central elements of ICZM; dissemination and consultation activities were organized in order to integrate stakeholder knowledge into the different steps of the *ICZM scoping study*.

The first step of this methodological approach is the collection and analysis of available data, followed by the coastal zonation. That is, the division of the Northern Coast (national scale) into homogenous units for coastal management (local scale), called coastal units.

The next step is the development of sectoral diagnoses for each coastal unit. These physical, ecological and socioeconomic diagnoses are performed for different time scales: present and future situation, in order to further identify present and future Key Issues for coastal management. The physical diagnosis focuses on the identification, assessment and classification of physical impacts derived from coastal dynamics and processes, as erosion and flooding. The ecological diagnosis describes the biodiversity status of each coastal unit and identifies the main threats for conservation. The socioeconomic diagnosis describes the main economic activities and the social challenges of each coastal unit. On the other hand, legal & institutional diagnosis are performed at national scale, since most of regulations about coastal management affect the entire coast of Egypt. The institutional assessment also includes a description of stakeholders and institutional arrangements at local level, in order to understand the future stages of ICZM in coastal governorates.

Once the sectoral diagnoses are performed, the next step is to understand the interrelations between the coastal sub-systems through integrated diagnosis. It aims to integrate the major findings of sectoral diagnoses in order to identify present and future Key Issues for coastal management. This is the main output of the *ICZM Scoping Study*.

Finally, Key Issues lead the management priorities and future steps for developing ICZM processes in the Northern Coast. Following sections describe the methodology followed for each step:

2.2. COASTAL ZONATION

In order to deal with the great variety of conditions of the Northern Coast, the coastal strip is divided into **homogeneous coastal units (CU) that require a specific management strategy**. Therefore, this division is to facilitate not only the coastal diagnosis but also future planning and management. The division of the coast has been done according to **physical, environmental and administrative criteria** (hierarchically):

1. Physical criteria. A preliminary physical assessment has been done in order to divide the Northern Coast into main management units. At this step a gross division of the Egyptian coast has been performed in order to identify the lateral boundary of the units, by identifying the main sediment transport barriers, either (1) natural, defined by capes or main changes in coast-line orientations or in coastal type, or (2) artificial, created by major coastal structures, keeping in mind that alongshore length scale of the units had to be designed in an ICZM perspective, and therefore in agreement with the other environmental and administrative criteria.

2. Environmental criteria. The division has been made taking into account the presence of protected areas and water bodies (lakes and lagoons). To the extent possible (in agreement with the physical criteria), the protected areas and the main water bodies have not been split and have been completely included within a proper coastal unit.

3. Administrative criteria. The division has been made based on the governorates and *marakiz* (districts) limits, when these limits agree with the previous criteria.

Finally, the inland and seaward limits of the final Coastal Units consider Article 39 of the Environmental Law 4/1994 amended by Law 9/2009: "Coastal Zone: the area extending from the coasts of Arab Republic of Egypt encompasses the territorial sea, exclusive economic zone and continental shelf, and extending landward to areas of active interactions with the marine environment for that not exceeding 30 km in the desert areas, unless major topographical features interrupt this stretch, while in Nile Delta would extend up and contour (+3m). Each of the coastal governorates shall define their coastal zone according to its physical conditions and environmental resources, not in any case less than "10 km" landward from coast line."

The division of the coastal strip has resulted in fourteen coastal units (following figure): six CU in the North-Western Coast, six CU in the Delta Coast and two CU in the coast of North Sinai. The division of the coastal strip has been **presented, discussed and agreed with the key stakeholders** during the following meetings:

- Kick off meeting: held at the facilities of the National Water Research Centre (NWRC) in Cairo, on 15th August 2016. ACCNDP validated the proposed coastal units.
- Meeting with SPA: the preliminary coastal units were presented and discussed with SPA on 16th August 2016, at the SPA headquarter facilities in Cairo. One of the main objectives of the meeting with SPA was the revision of existing coastal units or schemes defined under previous Master or Shoreline Management Plans. Proposed coastal units were validated.
- Inception Workshop: the preliminary coastal units were shown to the attendees of the Inception Workshop. No comments received about the coastal units, with exception of EEAA Environmental Management Sector.
- Meeting with EEAA Environmental Management Sector: the criteria for the establishment of coastal units was discussed in the first week of September. EEAA Environmental Management sector agreed with proposed criteria for the definition of coastal units.

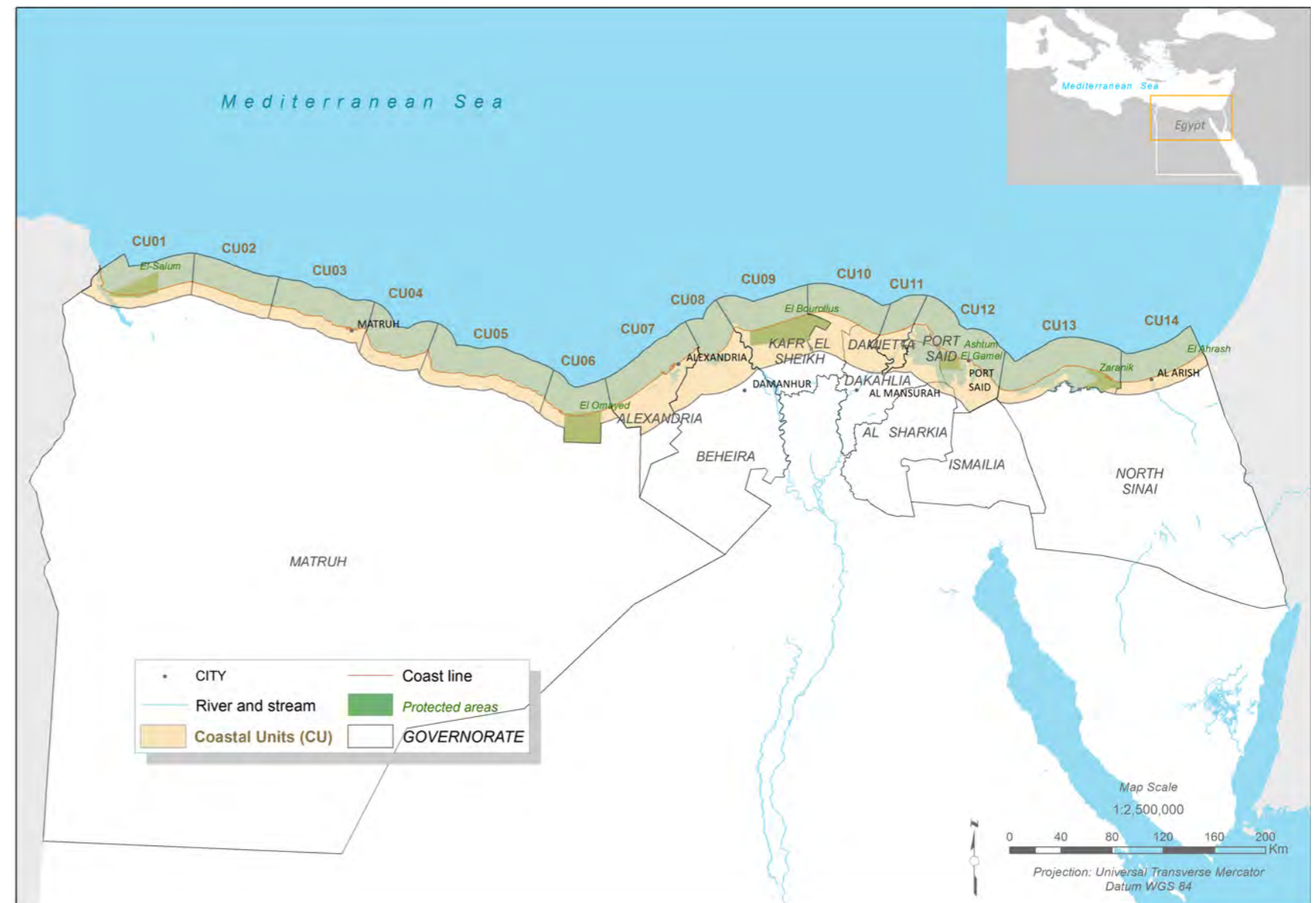


Figure 2.3. Coastal Units.

2.3. SECTORAL DIAGNOSES

2.3.1. Physical diagnosis

The main objective of the physical diagnosis is to perform an assessment of the most relevant climatic and climate-related drivers triggering impacts on key environmental and socioeconomic coastal sectors. In order to inform the decision making process in coastal planning, impacts will be assessed at three different timeframes, namely present, near-term (2030-2040) and long-term (2050-2070) situations, and two Representative Concentration Pathways (RCPs scenarios) will be studied. A preliminary step consisted of selecting and identifying the most relevant impacts that can affect the northern Egyptian coastline. This has been done in close concertation with the key stakeholders and agreed during the Inception Workshop. A brief description of the analysed impacts is given as follows:

Erosion. Coastal erosion is especially high in vulnerable exposed sandy beaches with high potential of shoreline retreat, located in an area of strong sediment transport. Clifly areas with rocky beaches are however less affected at present, but the situation can change in the future if artificial beaches are created.

Flooding. The level (degree) of flooding in a coastal stretch is closely related to the mean sea level observed during stormy conditions and to the topographic characteristics of the area. The highest flooding will be registered in the low lying areas (e.g. Nile Delta areas or sabkhas) when high energetic waves and storm surge coincide leading to extreme values of sea levels.

Saltwater intrusion. Sea level rise and saltwater intrusion are closely linked since the former is expected to further exacerbate the latter, significantly affecting groundwater supplies for the region.

Abiotic stress. Abiotic stress has been characterized based on the rate at which *Posidonia oceanica* meadows can decline due to climate change.

Drought. The historical and future level of drought can be directly estimated based on the precipitation data. Particularly, we focus on the number of consecutive day with low precipitation (dry days) and on the intensity of the precipitation during the rainy days.

Heat waves. Heat wave levels is linked to the air temperature, and, precisely, the degree at which frequency and duration of heats waves impacts on human health can be evaluated.

Port downtime. Port downtime is expressed based on the water agitation inside the port and on the overtopping over the port structures. Large values of agitation and overtopping prevent the port operability.

Siltation. Siltation due to sediment deposition is a recurrent problem in the northern Egyptian coast in harbours and navigation channels, and in drainage channels. The strongest problems occur in area with strong longshore sediment transport.

To accurately quantify the different climatic impacts along the Egyptian Northern Coast and to get a spatial characterization of the impacts within each coastal unit, analysis subunits have been defined with a fixed length of 10 km along the eastern direction. At each subunit corresponds a so-called Coastal Point, where the physical impacts will be computed. This uniform division will allow us to perform an homogenous assessment of the physical impacts and to link the obtained results to the other sectorial diagnoses. Finally, the key issues derived from the integrated diagnosis will be obtained in these coastal points.

The coastal points along the Egyptian Northern Coast are presented in the following figure.

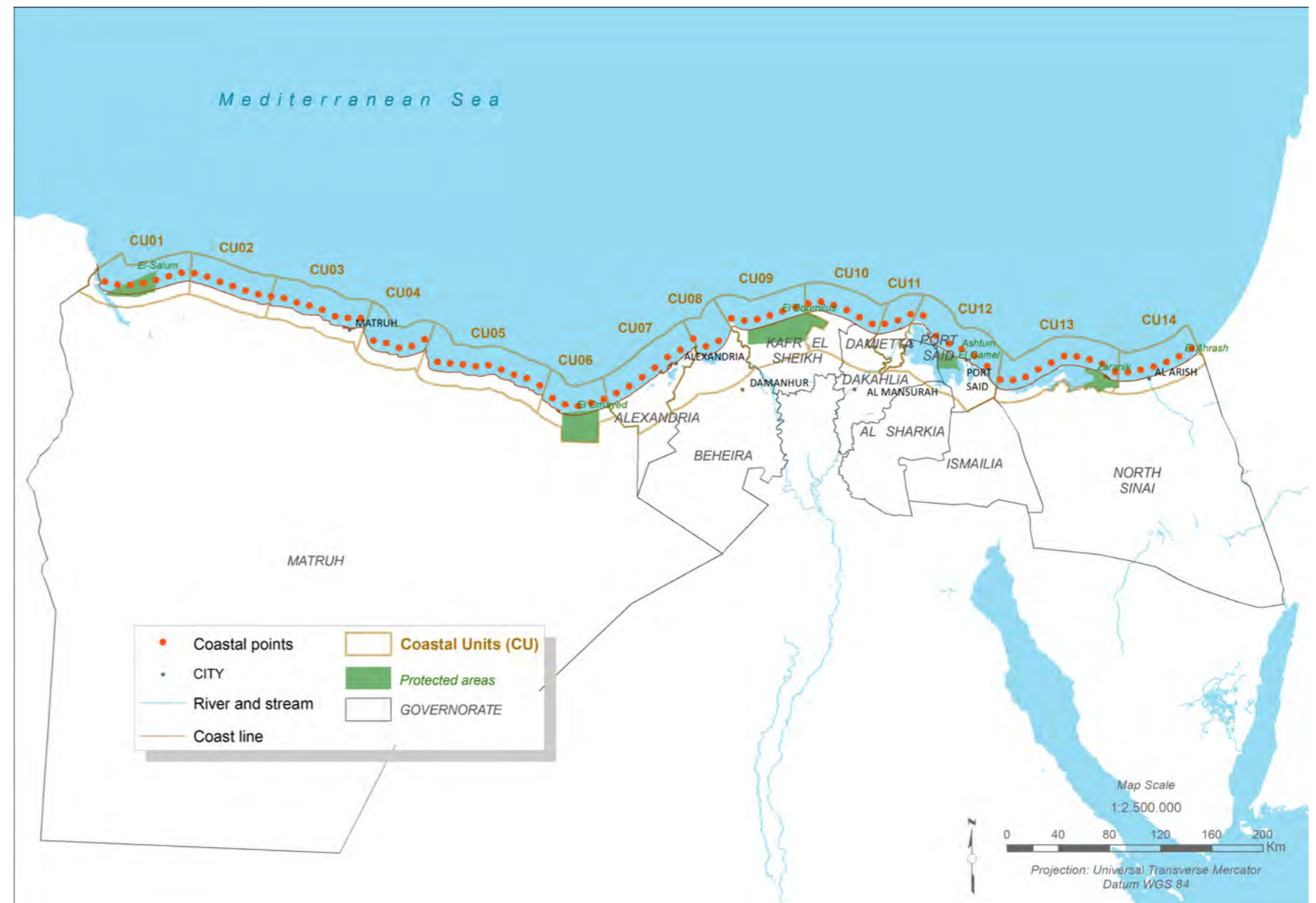


Figure 2.4 Coastal points.

To quantify the selected physical impacts for the present and future situations, the methodology consists of 5 steps and is presented in the following flow chart. The detailed methodology and results of the impact assessment is presented in Annex II: Coastal impacts and indicators.

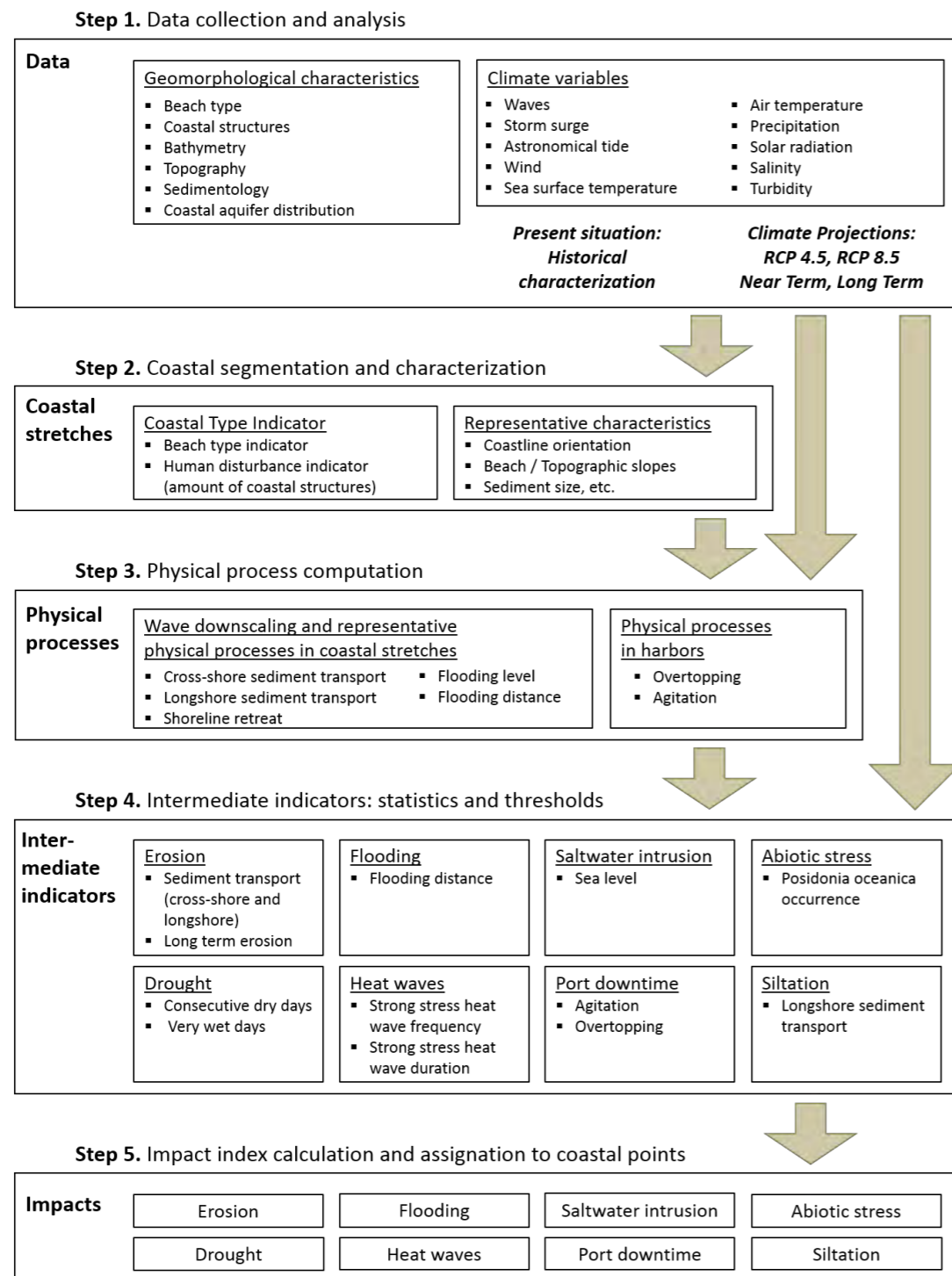


Figure 2.5 Flow chart of the methodology to evaluate the different impacts (physical diagnosis).

Step 1. Data collection and analysis

Two types of data have been used to perform the physical assessment: (1) climate data of the past (historical) climate and of future projections along the Egyptian Northern Coast and (2) physical data of the relevant information relative to the physical characteristics and to the geomorphology of the coast. Information concerning the data used in the study have been described in Section 2 and details concerning the climate data are given in Annex I: Hazard characterization and climate change.

Step 2. Coastal segmentation and characterization

For those specific impacts related to sediment transport, erosion or flooding, which strongly depend on the morphological characteristics of the coastline, on the types of beaches and on the presence of coastal structures, a specific segmentation of the coastline is necessary. To this end, the coastline is divided into irregular coastal stretches with length of the order of 5-15 km. A smaller scale analysis is out of scope of the present study as it would require a local scale study of both marine dynamics and morphological characteristics.

The division is based, essentially, on the geomorphology (e.g. changes in orientation of the coastline), on the type of beaches (rocky, sandy) and on the degree of anthropization (presence, absence of coastal structures). The associated coastal processes (Step 3) and indicators of erosion, flooding and siltation (Step 4) will be evaluated in these segments, then, the final impacts will be assigned to the coastal points (Step 5). Notice that the other impacts have been directly evaluated at the coastal points (then, Step 2 does not proceed).

Furthermore, the analysis of these coastal segments allows us to provide the following information that will be used during the next steps:

- Representative characteristics of the coastal stretches used for the coastal process modelling (Step 3): coastal orientation, beach slope, topographic slope and sediment characteristics (medium grain size).
- An indicator of the type of coastline (the Coastal Type Indicator, CTI), that will be used in Step 4 to compute indicators of flooding and erosion. The CTI depends on the beach type (Beach Type Indicator, BTI) and on the degree of anthropization of the coastline (Human Disturbance Indicator, HDI) that are defined below.

Beach Type Indicator (BTI)

This indicator has been designed specifically for the Egyptian coast based on the indicator of Gornitz et al., 1994 and later studies. Here we focus on the kinds of beaches and on the presence/lack of sandy beaches in the analysed segment. 5 types of beaches have been identified, and ranked from 1 to 5. In the next part of the analysis, when the 1-5 scale is used, the value of (1) will be assigned to the least vulnerable coast to erosion and flooding, where beaches cannot be eroded, and (5) to the most vulnerable coast as, for a given marine climate, erosion will be maximum in these segments.

Beach Type Indicator (BTI)	
BTI	Description
1	No beach. Coastline with high cliffs, medium cliffs, low cliffs, with insignificant patches of sandy beaches, or coastline stretch consisting of major coastal structures, where harbours or seawalls impede the presence of beaches.
2	Isolated beaches. Clifly coastline with patches of pocket sandy beaches.
3	Rocks & beach. Coastline with low cliffs and many patches of sandy beaches, rocks are still dominant.
4	Beach & rocks. Coastline with low cliffs or no cliffs (e.g. sand dunes) and long sandy beaches with the presence of rocks.
5	Beach. Coastline consisting in long sandy beaches with no rocks (e.g. delta, salt marshes, mud flats)

Figure 2.6. Beach type characterization and the Beach Type Indicator (BTI).



Figure 2.7. Beach type characterization. Google Earth images.

Human Disturbance Indicator (HDI)

The degree of anthropization of the coastline is determined from the percentage of the coastal segment length affected by coastal structures. The affection length has been determined by analysing the most recent google earth images, and different criteria have been used depending on the kinds of coastal structures. It depends essentially on the alongshore extent of the structures but also to its cross extent and position. Precisely, the affection length of the sea wall is defined as its alongshore length, but the affection length of a shore perpendicular sea groin is its cross-shore span. In this way, for a detached break water system, we defined the affection length has the alongshore extent of the entire breakwater system plus the cross-shore position of the last and first breakwater. Based on these criteria, we propose a five group classification of the coastline.

The Human Disturbance Indicator represent the degree of anthropized coastline. Value of (1) corresponds to the least vulnerable coastlines that are the stretches of coastline with no coastal structure, value of (5) corresponds to the most vulnerable coastline that are the coastline highly anthropized. Noticed that coastal stretched composed entirely by sea wall will give a maximum vulnerability. This is because, although sea walls protect the coastline from erosion and flooding impacts, they may have adverse effects on the adjacent coastal stretches.

Human Disturbance Indicator (HDI)	
HDI	Description
1	0%. Coastal stretches without coastal structures
2	0-10%. Coastal stretches with coastal structures, the affection length is less than 10% of the coastal stretch length.
3	10-25%. The affection length of the coastal structures is between 10% and 25% of the coastal stretch length.
4	25-50%. The affection length of the coastal structures is between 10% and 25% of the coastal stretch length.
5	>50%. The affection length of the coastal structures is larger than half the coastal stretch length.

Percentage of coastal stretch affected by coastal structures: the Human Disturbance Indicator (HDI).



Figure 2.8. Classification of the coastline anthropization. Google Earth images.

Step 3. Coastal process computation

The physical impact assessment through indicators required the computation of the main coastal processes related to erosion, flooding, channel siltation and harbour hydrodynamics.

Downscaling wave climate

To obtain the local wave climate from intermediate depths (GOW database), the formula of Larson et al., 2009 has been used. It allows us to compute incipient breaking wave properties based on a simplified solution of the wave energy flux conservation equation combined with Snell's law from the hourly sea states of the historical database (36 years) in the different coastal stretches. This is a relatively simplified technique that assumes parallel depth contour from the intermediate depths to the breaking zone, thus, the refraction effects due to the complex bathymetry and the diffraction processes over the headlands and coastal structures are disregarded. This method is valid to give an approximation of the representative mean wave climate in the surf zone along the entire northern Egyptian coast. For a more accurate downscaling, i.e., for local studies, a more sophisticated wave propagation model is needed as well as a high resolution bathymetry.

To downscale the future (projected) wave climates, a similar method has been used, and has been applied to a projected database that includes the changes in significant wave height and mean wave period obtained in the four different scenarios (RCP 4.5 near-term, RCP 4.5 long-term, RCP 8.5 near-term, and RCP 8.5 long-term).

Sediment transport

Both alongshore and cross-shore sediment transport have been computed for the different coastal stretches.

Concerning the alongshore sediment transport, different formulations have been tested (CERC formula, Coastal Engineering Manual, 2002; Kamphuis, 1991; Van Rijn, 2002; Van Rijn, 2014). The Van Rijn (2002) formula has been used as it gave the best agreement with the local studies performed by Coastal Research Institute (2012). It depends essentially on the significant wave height (at breaker line), on the wave incidence angle at the breaker line, on the sediment size and on the beach slope. Hourly time series of longshore sediment transport for the 36-year historical database as well as for the 4 projected scenarios have been obtained in the different coastal stretches. From these data both yearly net alongshore sediment transport (in m³/year, positive values mean eastward and negative values mean westward) and gross (positive) alongshore sediment transport (in m³/year) have been computed.

To compute the cross-shore sediment transport, the formula introduced by Bailard (1982) has been used. It depends on the significant wave height, on the fall velocity of the sediment, on the beach slope, and on other parameters that have been set as constant in this study. Positive values indicate onshore directed transport (obtained during calm conditions) and negative values indicate offshore directed transport (during storms). In this study, we compute the net yearly cross-shore transport in m³/m/year from the cross-shore transport computed from our hourly historical database.

Flooding

The coastal flooding in the different coastal stretches has been obtained by considering the flooding due to the astronomical tide, the meteorological tide (storm surges) and the effect of waves (wave setup). Historical data of astronomical and meteorological tides have been obtained from the GOST database. Wave setup at the shoreline has been computed by using the Dean and Dalrymple (2002) formulation from the downscaled wave climate.

Concerning the historical characterization, the representative flooding level for each coastal stretch has been defined as the 99th percentile of the hourly total flooding time series obtained from the summation of the astronomical/meteorological tidal level and wave setup at the shoreline.

To compute the projected flooding level in the different scenarios (near-term / long-term, RCP 4.5 / RCP 8.5), the astronomical tide has been obtained from the historical characterization, storm surge projections have been performed, and the wave setup projections have been obtained from wave climate projections. Furthermore, the projected sea level rise has been included.

Finally, the representative flooding distance has been obtained by considering a representative topographic slope for each coastal stretch.

Shoreline retreat

The shoreline retreat of sandy beaches associated to sea level rise induced by climate change has been obtained following the concepts of Bruun (1954) and Dean (1977). The water depth along the beach profile will be increased as a result of sea level rise. In this new situation, the beach will adjust to maintain its equilibrium profile relative to the new water level. This is achieved by moving the profile landwards and upwards. This movement should occur at the expense of existing sand in the profile, assuming two-dimensional beach. Therefore, the shoreline retreat will occur in order to cover the shortfall sand generated on the beach. The significant wave height only exceeded 12 hours a year determinates the closure depth of the beach profile (the depth where the profile is still active). A possible increase of the incident significant wave height in the future will generate an increase in the closure depth, and therefore, a general retreat in the beach whenever the beach is oversupplied of sand.

Based on projected values of sea level rise and projected changes in wave heights, a representative shoreline retreat has been obtained in each coastal stretch for the four scenarios studied (near-term / long-term, RCP 4.5 / RCP 8.5).

Overtopping in harbour

The overtopping performance of seawalls has been undertaken by a number of studies. In this work it has been applied the formulation proposed by Owen (1980). It depends essentially on the wave height propagated on the toe of the port seawalls and on the seawall characteristics.

Step 4. Intermediate indicators: statistics and thresholds

Many existing indicators to evaluate coast and beach vulnerability from a physical point of view can be found in the literature. The "Coastal Vulnerability Index" introduced by Gornitz et al., 1994 and applied to the USA Southeast coast is certainly the most widely used and has been adapted to other areas around the world. It includes, with the same grade of importance, some geomorphological characteristics, dynamic variables (e.g. wave height, tidal range), drivers (sea level rise) and impacts (shoreline erosion in m/year). Particularly, the Coastal Vulnerability Index of Gornitz et al., 1994 has been adapted to the entire northern Egyptian coast by Hereher (2014), and improved by El-Hattab in the Nile Delta coastal zone. This indicator gives a general characterization of the coastal variability to sea level rise but it only considers a limited number of the possible impacts related to climate change. Furthermore, it has not been designed to perform a specific impact assessment.

Alexandrakis and Poulos (2014) introduced a new improved indicator to quantify the vulnerability of a Mediterranean sandy coastline to erosion, specifically: the "Beach Vulnerability Index". This indicator is based on a series of indicators of the mechanisms related to the processes that control beach evolution, such as sediment availability, wave climate, beach morphodynamics and sea level change. Some drawbacks have been identified to apply this method to the northern Egyptian coast: (1) it is applicable to sandy beaches only and (2) it is applicable to coastline without coastal protection structures.

Here we define a series of specific indicators that will be applied to characterize the different impacts previously defined with the coastal stakeholders for the present situation. Furthermore, they are designed in order to extrapolate the analysis for the future impact assessment and to compare future and present impacts. The method of calculation of the different indicators is presented as follows.

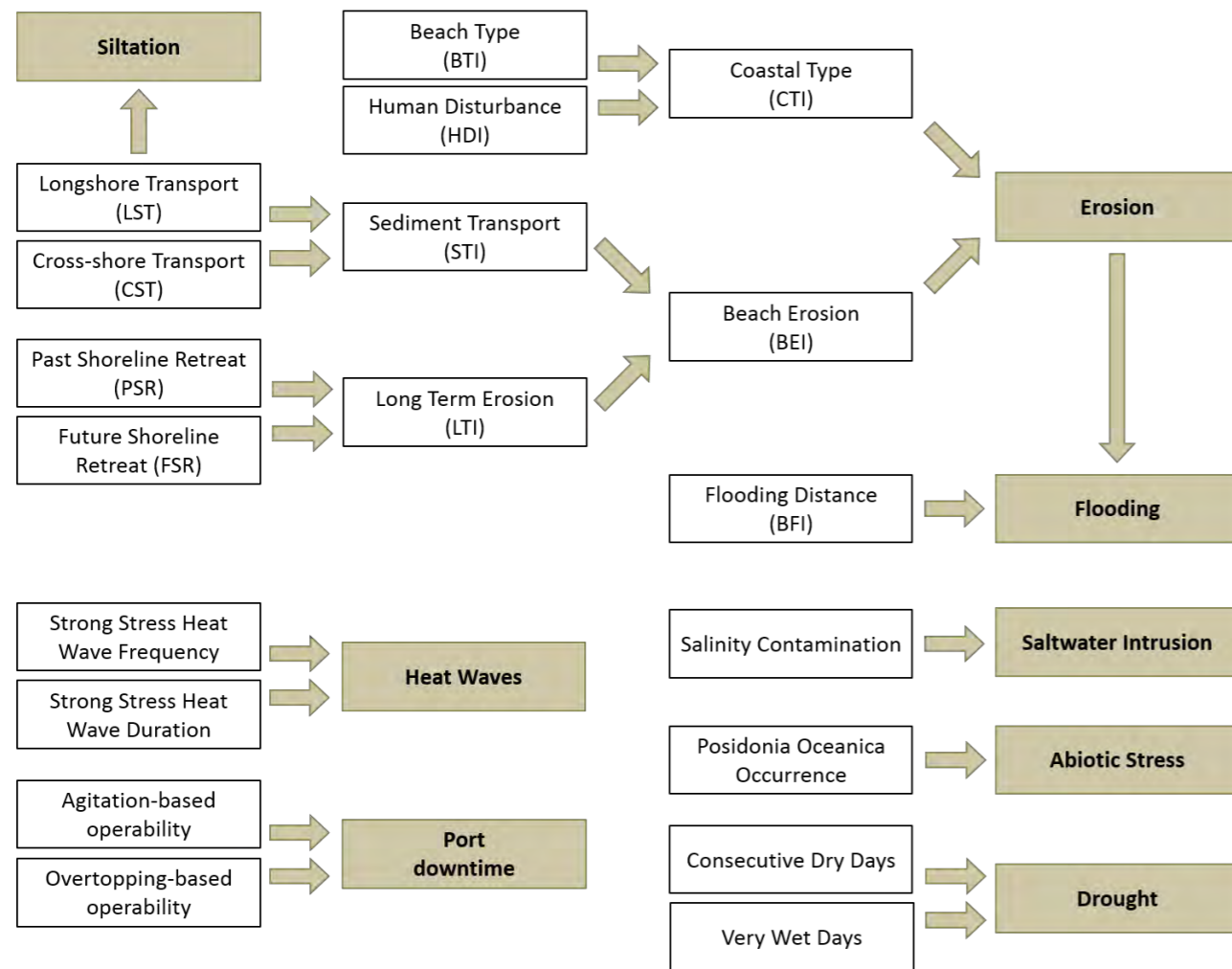


Figure 2.10. Flow chart of the impact calculation method based on a series of indicators.

Impact	Indicator	very low limits	low limits	medium limits	high	very high limits
Erosion / Siltation	Gross longshore sediment transport (10 ³ m ³ /year)	0 150	150 300	300 500	500 750	750 1000
Erosion	Cross-shore sediment transport (10 ³ m ³ /m/year)	0 3.5	3.5 6.5	6.5 15	15 27.5	27.5 36
Erosion	Projected shoreline retreat (m)	0 10	10 20	20 30	30 40	40 50
Flooding	Flooding distance (m)	0 40	40 70	70 100	100 150	> 150
Saltwater intrusion	Sea level rise (cm)		<10	10 20	>20	
Abiotic stress	Posidonia oceanica probability of occurrence		<0.2	0.2 0.4	>0.4	
Drought	Consecutive dry days (day)		<222	222 240	>240	
Drought	Very wet day precipitation (mm)		<1	1 10	>10	
Heat waves	Strong stress heat wave frequency (day)		<15	15 60	>60	
Heat waves	Strong stress heat wave duration (day)		<10	10 50	>50	
Port	Period exceeding agitation limit (hrs)		<200	200 300	>300	
Port	Period exceeding overtopping limit (hrs)		<200	200 300	>300	

Figure 2.11. Thresholds used for indicator computations.

Once the indicators identified and the variable / processes related to the different impacts computed, they have to be grouped into categories corresponding to a level of vulnerability. To do this, the thresholds between two categories are defined. Although the final impact index is classified following 3 levels (low, medium and high), it has been sometimes necessary to use, for intermediate indicators a grouping into 5 categories, corresponding to (1) very low, (2) low, (3) medium, (4) strong and (5) very strong. In general, the thresholds have been defined specifically for the Egyptian coastline, such as the mean values along the Egyptian northern coast (weighted taken into account the coastal stretch length) belongs to the medium level.

Erosion

An indicator to evaluate erosion impacts in the Egyptian coastline has been obtained from the **Coastal Type Indicator (CTI)** defined in step 2 and the **Beach Erosion Indicator (BEI)** which allows us to evaluate erosion of sandy beaches only. The Beach Erosion Indicator is based on the Beach Vulnerability Indicator of Alexandris and Poulos (2014), developed for sandy beaches only. The objective of such indicator definition is to evaluate the potential drivers (sediment transport) and the potential erosion for different transect of the Egyptian coast for the existing sandy beaches, but also for future potential beaches. Here we relate this potential beach erosion to the sediment transport magnitude in each coastal stretch (**Sediment Transport Indicator, STI**), and to the longer term erosion (**Long-term erosion Indicator, LTI**) related to the observed mean shoreline retreat occurred in the past and, for future scenarios, related to shoreline retreat due to sea level rise.

The Sediment Transport Indicator (STI), is based on the following indicators:

Gross longshore sediment transport (LST)

Cross-shore sediment transport (CST)

The Long-term erosion Indicator (LTI), is based on the following indicators:

Past observations of mean shoreline retreat (**Past Shoreline Retreat, PSR**) based on the results of Hereher (2014).

Future erosion due to sea level rise and differences in climate dynamics (futures scenarios only): **Future Shoreline Retreat (FSR)**.

Flooding

An indicator to evaluate coastal flooding has been designed based on the representative flooding distance over the different coastal stretches (through the **Beach Flooding Indicator, BFI**) but also, by considering in some way the possible interaction between the erosion and flooding processes. For instance, a coastal stretch strongly affected by erosion, or that expects a strong shoreline retreat in the future will be more severely concerned by flooding problems.

Saltwater intrusion

Sea level rise and saltwater intrusion are closely linked since the former is expected to further exacerbate the latter, significantly affecting groundwater supplies for the region. According to such close relation between sea level rise and salt water intrusion a saltwater intrusion indicator has been herein developed based on expert judgement to indicate the degree at which salinity contaminates the coastal aquifer (low, medium or high) and how it varies for different horizons. For the definition of the indicator over the historical period 3 factors have been taken into account: 1) information from stakeholders, 2) the coastal aquifer and 3) water bodies along the coastal stretch.

Abiotic stress

Abiotic stress has been characterized based on the rate at which *Posidonia oceanica* meadows can decline due to climate change. The rate at which *Posidonia oceanica* meadows are declining due to climate change and human activities is alarming (Telesca et al., 2015). A *Posidonia oceanica* indicator has been constructed upon its probability of occurrence. For that purpose presence/absence data across the Mediterranean basin has been derived from the COCONET project. The application of the Maxtent model has enabled us to obtain present and future probabilities of occurrence over the 21st century, based on sea surface temperature projections. In addition to the sea surface temperature, the simulation involves a set of variables whose contribution to the model reaches 5% (Coro et al., 2015), including the maximum photosynthetically available radiation, the mean turbidity, the mean significant wave height and the salinity. This work developed by IHCantabria was presented at the Coastal and Estuarine Research Federation (CERF) Congress in 2015 (Puente et al., 2015).

Drought

Two indicators developed by Sillmann et al. (2013a, 2013b) have been herein applied. The first one responds to a consecutive dry days (CDD) indicator that counts the largest number of consecutive days where precipitation is lower than 1 mm (measured in days); the second one is a very wet days (R95p) indicator where, being the daily precipitation amount on a wet day (precipitation > 1 mm), R95p is defined by the authors as the 95th percentile of precipitation wet days in a period (measured in mm). Both indicators have been derived for the historical period 1981-2000 (Sillmann et al., 2013a) and under the RCP4.5 and RCP8.5 scenarios for the period 2081-2100 (Sillmann et al., 2013b). These indicators indicate the level at which droughts threaten the Egyptian coast and how it varies for different horizons.

Heat waves

A strong stress heat wave (SHW) indicator developed by Amengual et al. (2014) has been herein applied. It has been defined as a spell of at least 6 consecutive days with daily maximum physiologically equivalent temperatures exceeding a thermal sensation of 35°C. Frequency and duration of SHW (days) in summer have been developed for the historical period 1990-2009 and under SRES A1B scenario (equivalent to RCP2.6) for the periods 2015-2034 and 2045-2064. These indicators allow us to indicate the degree at which frequency and duration of heat waves impacts on human health (low, medium or high) and how it varies for different horizons.

Port downtime

A port (in)operability indicator (port downtime indicator) has been defined on those ports that are more relevant based on the number of hours per year that 1) agitation exceeds 2.5 m in the manoeuvring zone, and 2) overtopping exceeds 0.1 m³/s/m leading to dangers for pedestrians and possible structural deterioration (Franco et al., 1994). The overtopping performance of seawalls has been undertaken by a number of studies. In this work the formulation proposed by Owen (1980) has been applied. These indicators allow us to evaluate the degree at which the loss of operability that may affect the Egyptian ports (low, medium or high) and how it varies for different time horizons.

Siltation

A channel siltation indicator has been computed in the area where an inlet (or channel drainage) or a port has been identified. It is based on the gross sediment transport computed in the corresponding coastal stretch and in its closest neighbouring stretches. The gross sediment transport values have been grouped following the criteria previously introduced. It is important to notice that this indicator does not take into account the presence of coastal structures built for navigation purpose or to reduce siltation issues. However, it is a good indicator to identify the potential issues and to identify those areas where mitigation measures are the most difficult to apply (that are the coastal stretches where sediment transport is strong).

Step 5. Calculation of impact indices and assignment to coastal points

The last step of the impact characterization consists of determining the final indices in a 1-3 scale (1: low, 2: medium and 3: high), in the different coastal points. These indices will be used to determine the key issues related to our different impacts. They have been determined according to the following method:

Firstly, each coastal point is assigned to one or several coastal stretches (the coastal stretches that intersect the analysis subunit).

Secondly, for each impact, the indicator value at the coastal point is defined as the maximum (the most pessimist) indicator value of all the assigned coastal stretches.

Finally, the 1-5 scale is converted into the 1-3 scale by considering the correspondence presented in the following table.

Index	1	2	3		
Index (1-3 scale)	low		medium	high	
Intermediate indicator	very low	low	medium	high	very high
Intermediate indicator (1-5 scale)	1	2	3	4	5

Figure 2.12. Correspondence between the 1-5 indicator scale and the 1-3 final index scale.

2.3.2. Ecological diagnosis

The diagnosis of the ecological sub-system aims at assessing the most significant ecological characteristics of each coastal unit. The ecological assessment is based on a comprehensive desk study of the Northern Coast of Egypt.

For the ecological diagnosis, the Northern Coast has been geographically divided into four main eco-regions, including two or more coastal units:

- The Western Mediterranean Coastal Desert: is the northern part of the wider Western Desert eco-region. It includes seven coastal units (CU01 to CU07). This coastal belt stretches from Sallum in the west to Alexandria in the east, bounded by the shoreline on the north and the Qattara Depression to the south.
- The Deltaic Mediterranean Coast: located in the middle part of the Mediterranean Coast of Egypt. It includes three coastal units (CU08 to CU10).
- The Eastern Mediterranean Coastal Desert: located in the eastern part of the Mediterranean coast of Egypt, separated from North Sinai by the Suez Canal. It includes two coastal units (CU11 and CU12).
- The Mediterranean coastal Desert of Sinai: including two Coastal Units (CU13 and CU14).

The ecological assessment analyses the status of the main species of concern - including threatened and/or protected species as well as species of ecological and/or economic importance - as well as current impacts and threats on biodiversity. Habitats of each region and main characteristics of each coastal unit have been emphasized; locations of specific habitats and/or records of particular species are provided, whenever available.

Coastal unit status indicators have been selected from a set of guidelines (Government of Catalonia, 2007; OECD, 2003; UNESCO, 2003; UNESCO, 2006) and adapted to the current study. Selection of indicators is also subjected to a set of criteria, as follows:

- Be simple and easy to interpret;
- Based on available supporting data;
- Supporting data should be adequately documented and of known quality;
- Have a numerical value as a basis for comparison;
- Provide a representative picture of ecological conditions and pressures on biodiversity.

Accordingly, the following indicators have been selected:

- Indicators to highlight the status of biodiversity:
 - Extension of natural habitats.
 - Loss of natural habitats.
 - Existence of protected areas.
 - Extension of protected areas.
 - Existence of IBAs.
 - Existence of Ramsar Sites.
 - Number of endemic/threatened species.
 - Number of protected species.
- Indicators to highlight the status of natural water bodies:
- Pollution and contaminants.

- Indicators to highlight the importance of natural resources:
 - Inland fisheries stocks.
 - Species with potential use.

The value of Indicators has been obtained as follows:

- The following indicators are categorized into High, Medium, Low, and Not Applicable and each category has been given a numerical value (where High = 3; Medium = 2; Low = 1 and NA = 0):
 - Extension of natural habitats
 - Extension of protected areas
 - Number of endemic/threatened species
 - Number of protected species
 - Inland fisheries stocks
 - Species with potential use
- The following indicators are categorized into High, Medium and Low and each category has been given a numerical value (where High = 1; Medium = 2 and Low = 3)
 - Loss of Natural Habitats
 - Pollution and contaminants
 - As the absence of natural water bodies does not decrease the value of a CU, in case the “Pollution and contaminants” criterion is NA it is not counted in the assessment.
- The following indicators are categorized into Yes and No and each category has been given a numerical value (where Yes = 3 and No = 0):
 - Existence of protected areas
 - Existence of IBAs
 - Existence of Ramsar Sites

These indicators assess the present situation of the ecological sub-system. The long-term situation is described through indicating the existence of proposed protected areas.

Finally, a simple Ranking Matrix was developed and utilized to categorize the value of each coastal unit, allowing their comparison at national scale.

2.3.3. Socioeconomic diagnosis

The diagnosis of the socioeconomic sub-system is to identify the socioeconomic challenges of each coastal unit, as well as the socio-economic elements that could be affected by physical impacts: i) urban services and population, ii) economic activities, and iii) infrastructures. The steps followed to identify the coastal elements that can be exposed to physical impacts are:

Step 1: Data collection.

Step 2: Define specific indicators of presence of coastal elements:

- Urban services and population:
 - Large cities: presence of urban areas with more than 15,000 inhabitants on the coastal front.
 - Small cities: presence of urban areas with less than 15,000 inhabitants on the coastal front.
- Economic activities
 - Tourism: presence of resorts on the coastal front.
 - Agriculture: presence of agricultural land on the coastal front.
 - Fishing ports: presence of fishing port.
 - Marine transportation: presence of commercial or petroleum port.
 - Industries: presence of industries on the coastal front.
- Infrastructures:
 - Regional roads: presence of regional roads on coastal front.
 - Inlets: presence of inlets.

Step 3: Identify the position of coastal elements using GIS.

Step 4: Give a numerical value to each indicator (0=absence; 1=presence) for each coastal point.

The diagnosis of the future situation of the socioeconomic sub-system is based on the analysis of future development plans. It allows identifying new economic activities planned in the coastal area, and the population growth expected for urban centres. Therefore, the urban assessment provided the necessary information to calculate above-mentioned indicators in the future situation. The methodology to conduct the urban assessment has the following steps:

- Step 1: Data collection: collecting secondary data from governmental authorities; collected data include the regional and strategic plans on different sectors related to urban development mainly the development strategies for northern coastal governorates and strategic development plan for Northern-Western coast and its desert hinterland.
- Step 2: Data Reviewing: sorting and reviewing the available secondary data for each coastal unit in regional and national strategic plans of the north coast and previous tourism and/or urban projects of the coast.
- Step 3: Data Summarizing: summarize the main issues and proposed projects for each coastal unit with take into consideration the current situation of the urban development.

2.3.4. Legal and institutional diagnosis

The legal and institutional diagnosis is based on both desk review and individuals interviews with coastal stakeholders. A desk review has been done through several laws, regulations, frameworks and ministerial decrees. The assessment relies on the prior ICZM legal assessment done under the Mariut Lake and Valley ICZM Plan, draft Strategy for ICZM in Egypt, in addition to relevant laws such as Environmental Law no.4/1994 amended by law no. 9/2009, Drainage and Irrigation Law 12/1984, etc. The steps followed for the desk review are:

- Reviewing the historical sequence of national initiatives and structures launched towards achieving ICZM compared to the legal context;
- Reviewing the concerned and related legislations governing the ICZM endeavour (laws, decrees and strategies) affiliated to different entities at the national level with highlighting key responsibilities;
- Review documents published in the area of interest;
- Analysing available data (regulatory & institutional) as to conclude similarities and differentiations among them;

On the other hand, individuals interviews with local key stakeholders that have substantial differences such as Alexandria, Port Said, Matruh and Kafr el Sheikh or Dakahlia / Beheira, have been carried out to emphasize the variation in the Northern Coast and in order to determine their roles and responsibilities and their internal procedures affecting the proper preparation of achievable ICZM plans. Interviewing key stakeholders playing important roles (with engaging number of representing governorates along the northern coast) is to gain from their experience, present lessons learned, illustrate the practical application of the regulatory framework and determine actual roles.

The last step is the identification of key challenges and gaps hampering the proper implementation of ICZM and provide supporting recommendations.

The study approach basically depends upon the participatory approach through engaging key stakeholders and concerned authorities enrolled in coastal management and in the implementation of the ICZM. In addition, the analytical approach will be integrated among the participatory one where a holistic understanding of the coastal area and its singularities is required to present the results in a realistic and integrated manner. The analytical process is considering the institutional setup among different concerned entities where operational functions for each entity are demonstrated. Moreover, the actual practicing and progressing for joint cooperation is analysed and elaborated.

2.4. INTEGRATED DIAGNOSIS

Previous sections described the methodology followed to conduct sectoral diagnoses of coastal sub-systems. This section describes the steps followed to integrate them and obtain a holistic understanding of coastal challenges.

The integrated diagnosis has two parts: SWOT analysis and identification of key Issues for each coastal unit.

2.4.1. SWOT analysis

SWOT analysis is a strategic planning tool that facilitates the discernment of the most significant interrelations between the different sub-systems of the coastal area. The SWOT analysis identifies specific assets that should be maintained, avoided, promoted or prevented in order to progress towards a sustainable management of the Northern coast of Egypt.



Figure 2.13. SWOT analysis.

2.4.2. Identification of Key Issues.

The identification of Key Issues allows identifying the major problems and opportunities of the coastal area, so Key Issues are the cornerstone for achieving the transition from the diagnosis to the definition of management priorities. The identification of Key Issues encompasses three types of Key Issues:

- Key Issues related to coastal risks, for each coastal unit.
- Key Issues related to land-use and environmental conflicts, for each coastal unit.
- Key Issues related to legal and institutional challenges, at national scale.

Finally, Key Issues were presented and validated in the Final Workshop and through web means.

Key Issues related to coastal risks

These are Key Issues obtained by analysing the negative consequences that physical impacts may have on i) the socioeconomic or ii) ecological sub-systems.

i) Erosion, flooding, siltation and port downtime may cause negative consequences on socioeconomic sub-system: urban services and population, economic activities and infrastructures. The identification of Key Issues derived from these interrelations were obtained according to the following matrix. The indices and indicators used were calculated in the sectoral diagnoses.

MATRIX FOR IDENTIFICATION OF KEY ISSUES		SOCIOECONOMIC SYSTEM											
		Urban development and population				Economic activities				Infrastructures			
		Large cities		Small cities		Tourism	Agriculture	Fishing ports	Marine transportation	Industries	Regional roads	Inlets	
PHYSICAL IMPACT INDICES	Erosion index	3	Urban areas >15,000 inhab. On the first 500 m from coastline	Urban areas <15,000 inhab. On the first 500 m from coastline	Urban areas >15,000 inhab. On the first 500 m from coastline and floodplains in the Delta	Urban areas <15,000 inhab. On the first 500 m from coastline and floodplains in the Delta	Presence of resorts on the first 500 m from coastline and floodplains in Delta	Presence of agricultural land on the first 500, from coastline and floodplains in Delta	Presence of fishing port	Presence of commercial and petroleum port	Presence of industries on the first 500 m from coastline	Presence of regional roads on the first 500 m from coastline and floodplains in Delta	Presence of inlet
		2											
		1											
	Flooding index	3											
		2											
		1											
	Siltation index	3											
		2											
		1											
	Port downtime index	3											
		2											

Figure 2.14. Matrix for the identification of Key Issues related to coastal risks.

Key Issues correspond to yellow and red cells, which indicate the interaction between high or medium level of physical impact affecting a certain coastal element or activity. In summary, the Key Issues identified through the interaction matrix include:

- Negative consequences that erosion may cause on economic activities or infrastructures:
 - Urban areas with high or medium level of erosion.
 - Resorts built on areas with high or medium level of erosion.
 - Industrial areas with high or medium level of erosion.
 - Roads in areas with high or medium level of erosion.
 - High level of erosion affecting other areas: additionally, areas with high level of erosion even they don't contain key coastal elements or sectors, are identified as Key Issues.
- Negative consequences that flooding may have on economic activities or infrastructures:
 - Urban areas with high or medium level of flooding.
 - Resorts built on areas with high or medium level of flooding.
 - Agricultural areas with high or medium level of flooding.
 - Industrial areas with high or medium level of flooding.
 - Roads in areas with high or medium level of flooding.
 - High level of flooding affecting other areas.
- Negative consequences that siltation may cause on economic activities or infrastructures:
 - Inlets with high or medium level of channel siltation.
 - Ports with high or medium level of channel siltation.
- Negative consequences that port downtime may cause on port activity.
 - Ports with high or medium level of overtopping.

ii) **Salt water intrusion and abiotic changes impacts may cause negative consequences on ecological sub-system, specifically on groundwater and marine habitats respectively.** These Key Issues are defined as follows:

- Salt-water intrusion.
 - Areas with high or medium level of salt-water intrusion.
- Loss of marine habitats.
 - Areas with high probability of *Posidonia oceanica* occurrence.

Key Issues related to land-use and environmental conflicts

These are Key Issues related to the conflicts on land-use policies that create competitive demands for the use of the coast, causing negative impacts on other uses or on the coastal environment. These are concerns derived from the impacts of economic developments on the i) socioeconomic sub-system, and ii) on the ecological sub-system These Key Issues includes: developments on coastal ecosystems:

- Negative impacts of future developments on coastal ecosystems.
 - Urban or tourism areas on coastal ecosystems or protected areas.
 - Polluted water bodies due to industrial, agricultural or aquaculture activities.
 - Areas potentially affected by extraction of black sands.
- Land-use conflicts.
 - Future urban, tourism or industrial development on agricultural areas.
 - Additionally, diagnosis factsheets describe include social and economic challenges (i.e.: preservation of culture and traditions, lack of investment and economic activities, human security, etc.)

Key Issues related to legal and institutional challenges

At national level, the legal assessment finalizes with the identification of legal and institutional challenges, considered Key Issues for the future ICZM stages in Egypt. Legal assessment is presented in Annex IV.

Validation of Key Issues

Major results of the study were presented in the Final Workshop, held on 5th January 2017 in Cairo. The aim of this workshop was the presentation and validation of Key Issues. This document presents the final results, once included stakeholder's comments.



Figure 2.15. Final Workshop.

CHAPTER 3: DATA ASSESSMENT



CHAPTER 3. DATA ASSESSMENT

Analysis of existing data and technical reports are the basis for any valuable study and their quality and availability will condition its results. The elaboration of the *ICZM Scoping Study* required setting the baseline conditions of the Northern Coast and identifying its managerial Key Issues. For that, available information about the coastal system has been compiled and new data about marine climate and coastal dynamics has been created in order to understand the long-term effects of climate change in the coast.

This chapter describes in its first section the data collection process and the data compilation into new data catalogues; section two summarizes data used to conduct the study; finally, section three presents the challenges risen during data collection process and assess the suitability of available data for future stages of ICZM in the Northern Coast of Egypt.

3.1. DATA COLLECTION AND DATA CATALOGUES

3.1.1. Data collection

The collection and compilation of available data has followed three steps:

- Identification of data needs.
- Compilation of information.
- Classification and quality control.

Identification of data needs

A data needs list has been prepared, including all necessary data to conduct the *ICZM Scoping Study* (ecological, physical, socioeconomic and legal/institutional assessments) and future stages of ICZM in Egypt. This list includes more than one hundred items (see Deliverable 1 “*Inception report*”) classified into the following categories:

- Coastal management plans.
- Future development plans.
- Satellite images.
- Administrative boundaries and toponomy.
- Coastal morphology.
- Hydrology.
- Ecology.
- Land use and infrastructures.
- Social and cultural characteristics.
- Wave climate.
- Others.

Compilation of information—stakeholder participation

To promote stakeholder collaboration in data compilation, the Inception Workshop was organized on 17th August 2016 in Cairo.



Figure 3.1. Inception workshop.

This workshop aimed at presenting the study to stakeholders and agree on cooperation for data collection. Afterwards, data was collected through the following means:

- Individual interviews with stakeholders: SPA, CoRI, EEAA, GOPP, NCPSL, TDA and coastal governorates.
- Data search in public sources, including websites and coastal projects, as CoCoNET, BirdLife or NASA websites.

Collected data mainly corresponds to coastal management plans, urban development plans, administrative boundaries as governorates and *marakiz*, rivers and waterways, spared land-use information, and economic and population data. Due to the lack of available data regarding wave climate and coastal processes, met-ocean data were generated from IHCantabria databases (<http://www.ihdata.ihcantabria.com/>).

Classification and quality control

After compilation, all information and data are reviewed, analysed and classified into four categories: (1) environmental, (2) physical impacts, (3) coastal management and (4) socioeconomic, and one additional category for raster data.

In order to obtain a homogenous quality of the georeferenced data, a data validation is carried out, including: (i) review of spatial reference system, (ii) verify topology, and (iii) standardize name of fields in different layers.

3.1.2. Data catalogues

All compiled documents and data have been integrated into two catalogues, one for documents “ICZM DOC Catalogue” and one for georeferenced data “ICZM GIS Catalogue”. Both of them are accompanied by excel files that easily help to locate and understand the information of the catalogues.

ICZM DOC Catalogue

This catalogue contains reports and scientific papers about the Northern Coast, in .pdf, .doc, .ppt format. The catalogue is structured into four folders (environmental, physical impacts, socioeconomic and coastal management). The topics that have larger quantity of documents on the catalogue are related to urban planning and ICZM plans followed by climate change.

ICZM GIS Catalogue

The “ICZM GIS Catalogue” contains vector and raster files, structured in the four categories previously mentioned according to the following figure:

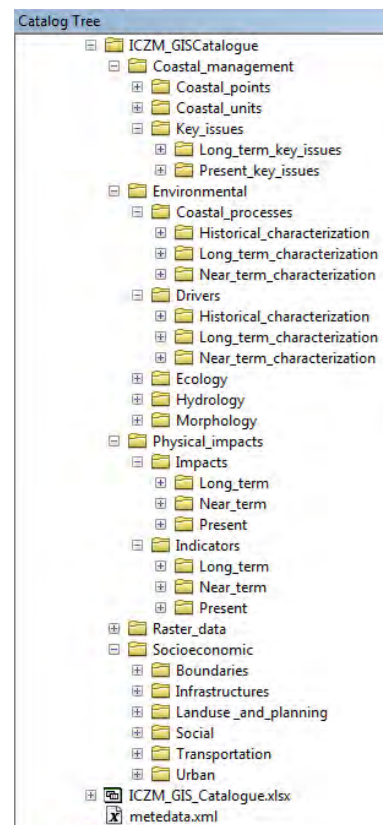


Figure 3.2. ICZM GIS Catalogue tree.

The four categories are briefly explained in the following paragraphs:

Environmental

This folder includes data that describes the natural conditions of the Northern Coast, including ecology, hydrology and coastal morphology, as well as marine and hydro-meteorological drivers and coastal processes.

The ecological and hydrological information has been collected from Egyptian authorities and existing projects in the Mediterranean; whereas the description of the coastal morphology, marine and hydro-meteorological drivers and derived coastal processes have been generated during the study. Drivers (i.e. wave height, sea surface temperature) and coastal processes (i.e. sediment transport and flooding level) are presented for three timeframes: present situation (based on historical characterization), near-term (period 2030 -2040) and long-term (period 2050-2070).

Physical impacts

This folder includes the results of the physical diagnosis carried out within the *ICZM Scoping Study*; that is, this category presents the indicators constructed to assess physical impacts throughout the Northern Coast for the present situation, near-term (period 2030 -2040) and long-term (period 2050-2070). Physical impacts calculated are: coastal erosion, coastal flooding, channel siltation, port downtime, heat waves, drought, saltwater intrusion and marine abiotic stress

Socioeconomic

It includes information regarding the main social and economic features of the Northern Coast, as population and economic activities along the coast. This section compiles information collected from different Egyptian authorities regarding the land-use, administrative limits, urban centres and transportation infrastructures.

Coastal management

This folder presents the major results of the ICZM Scoping Study to inform decision making process in coastal planning. It includes coastal units (see section 3.2) and the results of Key Issues related to coastal risks classified as important and very important. Key Issues have been estimated for the present and long-term (2050-2070) situations.

Most of this information is displayed in the ICZM GeoViewer, a web portal developed under the *ICZM Scoping Study* in order to present and the major results of the study to stakeholders and visualise them. The ICZM GeoViewer is accessible through: <http://iczmegyptmaps.ihcantabria.com/>.

3.2. DATA USED FOR THE ICZM SCOPING STUDY

3.2.1. Physical data and climate change

Two types of data have been used to perform the physical assessment: (1) climate data of the past (historical) climate and of future projections along the Egyptian Northern Coast and (2) physical data of the relevant information relative to the physical characteristics and to the geomorphology of the coast.

Climate data

Given the importance of climate data in the physical assessment and the potential vulnerability of the Egyptian Northern Coast to the climate change, a specific study of the most relevant climate related drivers of impacts have been performed. The details of the study is presented in Annex 1: Hazard characterization and climate change.

The selection of the climate related drivers analyzed in the present study has been made based on the different impacts identified in concertation with the stakeholders. They include waves, sea level, sea surface temperature, air temperature and precipitation.

In order to inform the decision making process in coastal planning, the climatic drivers have been assessed at three different timeframes that will be used to quantify the identified coastal impacts. The different timeframes are:

- Present situation (based on historical characterization of climatic drivers).
- Near-term situation: 2030-2040.
- Long-term situation: 2050-2070.

The future (near-term and long-term) characterization of the climate drivers is derived from the global circulation models (GCMs). GCMs are numerical models that represent physical processes in the atmosphere, ocean, cryosphere and land surface and are the most advanced tools currently available for simulating the response of the global climate system to increasing greenhouse gas concentrations (IPCC, 2013). Herein climate driver projections derived from GCMs are presented for the near- and long-term, and under two Representative Concentration Pathways (RCP) scenarios based on Greenhouse gas (GHG) emissions: RCP4.5, corresponding to a pathway with moderate GHG emissions; and RCP8.5, that accounts for the pathway with the highest GHG emissions.

Geomorphological data and coastal structures

The second type of data concerns the geomorphological and physical characteristics of the Northern Coast. They include the natural geomorphological characteristics of the coast such that the sea bottom level (bathymetry), the land relief (topography) and the natural beach characteristics (beach type, sedimentology) but also the information on the artificial elements such that coastal structures or artificial beaches. These data are used to model the main physical coastal processes along the Northern coast and to give an indication of the vulnerability of the coastline to the different impacts.

Bathymetric data are used to downscale the wave climate from deep water to the surf zone and to compute coastal processes such that sediment transport and flooding levels. The dataset used for the bathymetry is the European Marine Observation and Data Network (EMODnet) 2013 database for European waters (Schaap and Moussat, 2013; Schmitt and Weatherall, 2014; <http://www.emodnet-bathymetry.eu>) with a spatial resolution of 0.125 deg (about 900 m resolution). Although the existence of higher resolution bathymetries have been identified in some specific areas as in Nile Delta, (as stated by SPA, and described in CoRI 2012), the scope of this project imposes the use of a homogenous bathymetry along the entire Northern Coast. These local high resolution bathymetries are however needed for local studies that need a finer description of the coastal processes.

Concerning the topographic data, we used the 30 m resolution Digital Elevation Model (DEM) of the Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) Global Digital Elevation Model Version 2 (GDEM V2) released on October 17, 2011 (Tachikawa et al., 2011; <https://asterweb.jpl.nasa.gov/gdem.asp>).

As indicator of coastline vulnerability to physical impacts, the type and location of natural/artificial beaches and of coastal structures are necessary. Although numerous scientific studies describe such information (see Coastal Research Institute, 2012), the lack of digitalized databases covering the entire Northern Coast has made necessary, for the purpose of the study, a specific analysis of the beach type and coastal structures based on the existing scientific studies and Google Earth images.

3.2.2. Ecological data

The ecological data used to conduct the ecological assessment rely on previous detailed specialist studies and field surveys of the area carried out by Environics. External technical reports and literature covering the Northern Coast, as well as satellite images have been also utilized.

The CITES (Convention on International Trade of Endangered Species of Fauna and Flora, Washington D.C., 1973) appendices and the Red List issued by the International Union for the Conservation of Nature (IUCN) were used to indicate the international status of species. The local status was based on Boulos (1999; 2000; 2002; 2005; 2009) and Shaltout and Khalil (2005; 2006) for flora, Baha El Din (2006) for amphibians and reptiles, Tharwat (1997) for avifauna and Basuony et al. (2010) for mammals. The status of species is determined according to the IUCN Red List categories (EX: Extinct; EW: Extinct in the Wild; CR: Critically Endangered; EN: Endangered; VU: Vulnerable; NT: Near Threatened; LC: Least Concern; DD: Data Deficient; NE: Not Evaluated).

IBA and RAMSAR information have been used to update national protected areas shapes file and to create another one for international protected areas.

3.2.3. Socioeconomic data

The socioeconomic data used for the development of the socioeconomic assessment is based on desk study. The description of the socioeconomic characteristics of each Coastal Unit relies on the data provided by the national census of year 2006. The assessment of urban development and long-term situation relies on the analysis of future development plans promoted by the General Organization for Physical Planning (GOPP) and available development plans of coastal governorates.

3.2.4. Legal and institutional data

The legal and institutional data used to develop the legal assessment is based on both desk review and individuals interviews.

A desk review has been done through several laws, regulations, frameworks and ministerial decrees. The assessment relies on the prior ICZM legal assessment done for the Mariut Lake and Valle ICZM Plan, the draft Strategy for ICZM in Egypt, in addition to relevant laws such as Environmental Law 4/1994 amended by Law 9/2009, Drainage and Irrigation Law 12/1984, etc.

Individuals interviews with local key stakeholders that have substantial differences such as Matruh, Alexandria, Beheira, Kafr el Shiekh, Dakahlia or Port Said have been carried out to emphasize the variation in the Northern Coast and in order to determine their roles and responsibilities and their internal procedures affecting the proper preparation of achievable ICZM plan.

3.3. SUITABILITY OF AVAILABLE DATA FOR FUTURE STAGES OF ICZM

Coastal management and planning should be based on scientific knowledge in order to ensure the applicability and effectiveness. Accurate and homogeneous data are required to properly understand the coastal processes and their evolution in the long-term. However, the collection of reliable and homogeneous data along the Northern Coast is one of the most challenging task when developing coastal initiatives. This section is divided into two parts: the first summarizes the main challenges and needs related to data collection; and second proposes major recommendations to fill existing gaps.

3.3.1. Challenges and needs

About data availability

Future high-resolution analysis will require accurate and homogenous data along the coast, especially georeferenced data to conduct vulnerability analysis. These data are not currently available. The following constraints have been identified regarding data availability:

- In general, institutions ignore which information is available in other agencies.
- Institutions seem to be reluctant to share their data, which hampers the correct development of studies and projects.
- References found in reports and documents are difficult to find. This constraint is more significant regarding spatial information.
- Lack of spatial information entails a simplified characterization based on Google Earth images and on scientific contributions.

About data update and timeliness

Egyptian institutions make great efforts to update data related to the coastal environment through periodical campaigns and monitoring programs. However, updated information is not available and time to access to data is very limited. In this regard, the following constraints have been identified regarding update and timeliness of data:

- Many studies about coastal environment (physical or ecological) do not consider the environmental changes caused by the rapid action of human activities.
- The temporal scope of met-ocean instrumental data is very short to properly characterize the wave climate.
- Geoportal and web sites of coastal management projects in the Mediterranean have no maintenance; most of data generated under these projects are no longer available.

About data accuracy

- Many spatial data have no attributes, only geometry and it is usually presented as a point features, which does not represent the studied variable. Therefore, there is a need to standardize and improve description fields of georeferenced information along the coast.
- Spatial data provided has not metadata available.

About data completeness (geographic scope)

There is a concentration of studies, technical and scientific reports and data in the Nile Delta coast, which represent a disadvantage to develop studies in the North-Western and North Sinai coasts, where environmental, physical, land use and coastal infrastructures data are limited.

Data Needs


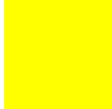

A more detailed description of existing data gaps and needs is included in the following table:

CATEGORY	SUB-	DATA	CU01	CU02	CU03	CU04	CU05	CU06	CU07	CU08	CU09	CU10	CU11	CU12	CU13	CU14	COMMENTS		
Coastal Management	ICZM	ICZM plans	(1)	(1)	(1)				(1) (2) (3) (4)								Level 1 data: ICZM National Strategy (source: EEAA), ICZM in the Northern Coast of Egypt, a Scoping Study (source: IHCantabria) Limited level 2 data: (1) Guidelines for the ICZM plan for the coastal area between Marsa Matruh and El Sallum, Egypt (source: EEAA- IHCantabria, see Doc Catalogue). (2) Alexandria Lake Maryut Integrated Management (ALAMIN) (3) Pegaso Project Level 2 data: (4) Mariut Lake and Valley ICZM Plan (source: IHCantabria) Data need: ICZM plans implementation		
	Strategic development	Strategic development plans	(2)	(2)	(2) (5)	(2)	(2)	(2)	(1) (3) (4)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	Limited level 2 data: (see Doc Catalogue) (1) Strategic plans for Governorates (2008, 2010, 2015) (2) Strategic development Plan for Northern-Western Coast and Its Desert Hinterland 2032 (3) Strategic Urban Plan for Alexandria City 2032 (SUP) (4) The industrial development in Alexandria report (5) The integrated planning of the Marsa Matrouh city 1997 Data need: Update and implement strategic development/urban plans		
Environmental	Morphology	Satellite Images / Aerial photos															Aerial photos: No data Limited level 2 data: Different satellite images of the Northern Coast used in scientific studies, some of them collected in the GIS-catalogue (Landsat (2000), Landsat 7 (2003), Spot IV). Data need: Need of open catalogue with all existing images.		
		Bathymetry	(4)	(4)	(4)	(4)	(4)	(4)	(2)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(3)	Level 1 data: Low resolution (900m) bathymetry available for the Northern Coast (source: USGS, see GIS-Catalogue). Limited level 2 data: Beach profile surveys (source: CoRI, data not available): (1) Yearly beach profile surveys each 0.5-5km from 1980. (2) Alexandria monitoring programme (1998-2000 and 2000-2002). (3) El Arish monitoring program (1996-1998). (4) West coast beach profiles (2000). Data need: Need of higher resolution bathymetry / collect existing profiles for local studies.	
		Topography									(1)	(1)	(1)	(1)	(1)			Level 1 data: Medium resolution (30m) topography available for the Northern Coast (source: ASTER, see GIS-Catalogue). Limited level 2 data: (1) High resolution topography for Rosetta-Burullus and Damietta areas (source: CoRI, data not available) Data need: Need of high resolution topographies (or collect existing topography) for local flooding studies.	
		Shoreline position	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(2)	(1)	(1)	(1)	(1)	(1)	(4)	(3)	Level 1 data: Shoreline position of the Northern Coast for year 2003 (Source: EEAA, IHCantabria, see GIS-Catalogue). Limited level 2 data: Time series of shoreline position (source: CoRI, data not available): (1) Yearly shoreline positions at Nile Delta coastline. (2) Alexandria monitoring programme (1998-2000 and 2000-2002). (3) El Arish monitoring program (1996-1998). (4) Detected shorelines (source: NWRC, Damietta university, data not available). Data need: Need of shoreline evolution data for local studies.	
		Coastal type / beach characterization																Level 1 data: Coastal type characterization of the Northern Coast (source: IHCantabria, see GIS-Catalogue). Beach location for the Northern Coast (source: NOSCP, EEAA). Data need: Need detailed information (width, length, slopes, sedimentology) of all beaches and coastline type for more detailed diagnosis for future stages of ICZM.	
		Coastal structure characterization																Level 1 data: Proportion of coastal structures within coastal stretches for the Northern Coast (source: IHCantabria, see GIS-Catalogue). Data need: Need of coastal structure layers for the Northern Coast.	
		Sediment size distribution									(2)	(1)	(1)	(1)	(1)	(1)	(1)	(3)	Level 1 data: Main sediment size distribution of some beaches (from available literature). Limited level 2 data: Sedimentology data of the nearshore zone (main source: CoRI, data not available): (1) Detailed sediment size distribution in the Nile Delta coastal zone. (2) Alexandria monitoring programme (1998-2000 and 2000-2002). (3) El Arish monitoring program (1996-1998). Data need: Detailed information needed for local studies.
		Sediment mass balance									(2)	(1)	(1)	(1)	(1)	(1)	(1)	(3)	Level 1 data: Low resolution shoreline change study for the Northern Coast (source: NWRC, Damietta university). Limited level 2 data: Detailed sediment mass balance studies (source: CoRI, data not available): (1) Detailed sediment mass balance study in the Nile Delta coastline. (2) Alexandria monitoring programme (1998-2000 and 2000-2002). (3) El Arish monitoring program (1996-1998). Data need: High resolution shoreline evolution data and homogenous sediment mass balance data for the entire Northern Coast needed for more detailed analysis.
		Coastal dunes																	Level 0 data: digitized layer of coastal dune not available, sand dune system can be detected from satellite images approximatively only. Limited level 2 data: Specific study of Burullus and Baltim sand dune system (source: CoRI, data not available). Data need: Coastal dune layer for the Northern Coast.
Geological characterization																	Level 1 data: Geology/Soil layers at national scale (source: BIOMAP, see GIS-Catalogue) Data need: Level 2 data would require accurate geologic/soil spatial information all along the coast.		

CATEGORY	SUBSYSTEM	DATA	CU01	CU02	CU03	CU04	CU05	CU06	CU07	CU08	CU09	CU10	CU11	CU12	CU13	CU14	COMMENTS	
Environmental	Hydrology	Rivers / wadis / drains							(1)	(1)	(1)	(1)	(1)	(1)			Level 1 data: location of wadis/rivers (source: ACCNDP, Open Street Map, see GIS-Catalogue) (1) Nile River layer (source: CAPMAS, see GIS-Catalogue) Data need: Level 2 data would require water flux information	
		Wetlands / sabkhas																Level 0 data: digitized layer of wetlands/sabkhas not available, approximative location of wetlands/sabkhas obtained from satellite imagery Data need: Spatial layers of wetlands/sabkhas have to be built
		Lakes / lagoons																Level 1 data: location of lakes/lagoon (source: ACCNDP, CAPMAS, IHCantabria see GIS-Catalogue) Data need: Level 2 data would require accurate bathymetries
		Aquifers																Level 1 data: location of aquifers (source: BIOMAP, IHCantabria, see GIS-Catalogue) Data need: Level 2 data would require water table information
	Ecology	Protected areas																Level 1 data: Natural areas with high environmental value identified, they include (source NCPSP, WDPA, IHCantabria, see GIS-Catalogue): International protected areas (IBA, RAMSAR or UNESCO-MAB Biosphere Reserve) National protected areas Proposed protected areas Data need: update; make coincident boundaries between different protected areas and with boundary lakes
		Turtle nesting sites	(1)		(1)											(1)		Level 1 data: (1) only CU1, CU3 and CU13 has observations of turtle nesting according to developed projects and stakeholder consultation (see GIS-Catalogue). Level 0 data: digitized layers of this topics not available Data needs: Level 2 data would require update accurate georeferenced information all along the coast.
		Seagrass distribution																Level 1 data: Seagrass distribution (source: Coconet project, see GIS-Catalogue). Data need: Level 2 data require update accurate georeferenced information all along the coast.
		Black sands																Level 1 data: Black sands distribution (source: NCSPL, see GIS-Catalogue). Data need: Level 2 data require update accurate georeferenced information all along the coast.
		Ecosystems / habitats																Level 0 data: Description of main ecosystem / habitats available (see Scoping Study). Digitized layers not available. Data need: Spatial layers have to be built for all along the coast.
		Flora and fauna																Level 0 data: Description of main species available (see Scoping Study). Digitized layers not available. Data need: Spatial layers have to be built for all along the coast, species of concern have to be identified (and mapped) for future stages of ICZM.
		Water quality								(1)	(1)	(1)	(1)	(1)	(1)	(1)		No data. (1) Level 0 data. Only some information on water quality available (see Scoping Study). Data need: Information on water quality required for future stages of ICZM.
		Natural resources																Level 0 data: Description of natural resources available (see Scoping Study). Digitized layers not available. Data need: Spatial layers have to be built for all along the coast, species of concern have to be identified (and mapped) for future stages of ICZM.
	Climate drivers	Waves							(1)	(2)	(3)	(4)						Level 1 data: Wave reanalysis database (source: IHCantabria, see GIS-Catalogue). Limited level 2 data: Buoy data (source: CoRI, data not available): (1) El Hamra (1998-1999), (2) El Dikheila harbor (1992-1995), (3) Abu Qir headland (some data 1971-1977), Abu Qir bay (1985-1990, 2003-2005), (4) Damietta harbor (1997-1999, 2001-2004, 2009-2010), West Ras El-Bar (1985-1990), East Ras El-Bar (some data 1972-1977) Data need: Continous long-term data from wave gauge, downscaling at specific sites
		Sea level								(1)		(2)				(3)		Level 1 data: Sea level reanalysis database (Source: IHCantabria, see GIS-Catalogue). Limited level 2 data: Tidal gauges (source: CoRI, data not available): (1) Alexandria (1980-2000), (2) El Burullus (1972-2001), (3) Port Said (1979-2000) Data need: Continous long-term data from tidal gauges, more gauges needed in Nile Delta coast because of strong variability in subsidence results
		Wind																Level 1 data: Wind reanalysis database (Source: IHCantabria, see GIS-Catalogue). Limited level 2 data: Weather stations (Source: CoRI, data not available). Data need: Collect available instrument data.
		Sea surface temperature																Level 1 data: Sea surface temperature data (Source: IHCantabria, see GIS-Catalogue). Limited level 2 data: Weather stations (Source: CoRI, data not available). Data need: Collect available instrument data.
		Air temperature																Level 1 data: Air temperature data (Source: IHCantabria, see GIS-Catalogue). Limited level 2 data: Weather stations (Source: CoRI, data not available). Data need: Collect available instrument data.
		Precipitation																Level 1 data: Precipitation data (Source: IHCantabria, see GIS-Catalogue). Limited level 2 data: Weather stations (Source: CoRI, data not available). Data need: Collect available instrument data.
Coastal processes	Sediment transport																Level 1 data: Sediment transport computations for the Norhern Coast (Source: IHCantabria, see GIS-Catalogue) Limited level 2 data: local sediment transport studies in some specific sites and in Nile Delta coastline (Source: CorI, data not available) Data need: Local sediment transport studies will be needed for future stage of ICZM (pilot sites)	
	Flooding area								(1)	(1)	(1)	(1)	(1)	(1)			Level 1 data: Flooding level / distance computations for the Norhern Coast (Source: IHCantabria, see GIS-Catalogue). Limited level 2 data: (1) Potential flooding areas for the Nile Delta (Source: CoRI, data not available). Data need: Local flooding studies will be needed for future stage of ICZM (pilot sites)	

CATEGORY	SUBSYSTEM	DATA	CU01	CU02	CU03	CU04	CU05	CU06	CU07	CU08	CU09	CU10	CU11	CU12	CU13	CU14	COMMENTS
Physical impact	Coastal erosion	Coastal erosion assessment															Level 1 data: Erosion impact assessment at Northern Coast scale, indicator based assessment (source: IHCantabria, see GIS-Catalogue). Data need: Local scale studies needed for future stage of ICZM (pilot sites) / probabilistic erosion assessment recommended
	Coastal flooding	Coastal flooding assessment															Level 1 data: Flooding impact assessment at Northern Coast scale, indicator based assessment (source: IHCantabria, see GIS-Catalogue). Data need: Local scale studies needed for future stage of ICZM (pilot sites) / probabilistic flooding assessment recommended
	Channel siltation	Channel siltation assessment															Level 1 data: Channel siltation impact assessment at Northern Coast scale, indicator based assessment (source: IHCantabria, see GIS-Catalogue). Data need: Local scale studies needed for future stage of ICZM (pilot sites)
	Drought	Drought assessment															Level 1 data: Drought impact assessment at Northern Coast scale, indicator based assessment (source: Sillmann et al., 2013a, 2013b; see GIS-Catalogue). Data need: Local scale studies needed for future stage of ICZM (pilot sites).
	Heat waves	Heat waves assessment															Level 1 data: Heat wave impact assessment at Northern Coast scale, indicator based assessment (source: Amengual et al., 2014; see GIS-Catalogue). Data need: Local scale studies needed for future stage of ICZM (pilot sites).
	Saltwater intrusion	Saltwater intrusion assessment															Level 1 data: Saltwater intrusion assessment at Northern Coast scale, SLR-indicator based assessment (source: IHCantabria; see GIS-Catalogue). Data need: Specific data on aquifer location/ local scale studies needed for future stage of ICZM (pilot sites).
	Port downtime	Port downtime assessment			(1)		(1)		(1)	(1)				(1)			Level 1 data: (1) Operability impact assessment of ports at Northern Coast scale, indicator based assessment (source: IHCantabria; see GIS-Catalogue). Data need: Freebord data / local scale studies needed for future stage of ICZM (pilot sites).
	Abiotic stress	Abiotic stress assessment															Level 1 data: Presence/absence of <i>Posidonia oceanica</i> assessment at Northern Coast scale (source: IHCantabria; see GIS-Catalogue). Data need: Local scale studies needed for future stage of ICZM (pilot sites) / consideration of alien species recommended e.g. <i>Halophila stipulacea</i>
Socioeconomic	Boundaries	Administrative and political boundaries															Level 1 data: Political and administrative limits of the Northern Coast have been obtained (source: CAPMAS, ACCNDP, BIOMAP, EEAA, IHCantabria, see GIS-Catalogue) Data need: A review of spatial layers is needed in order to make coincident the boundaries that country, governorates and markaz share.
	Infrastructures	Energy stations															Level 1 data: Proposed power plants or under construction distribution (source: NCSPL, see GIS-Catalogue) Data need: Level 2 data would require update accurate georeferenced information all along the coast.
		Sanitation systems															Level 1 data: Sanitation systems distribution (see GIS-Catalogue) Data need: Level 2 data would require update accurate georeferenced information all along the coast.
	Land use	Resorts															Level 1 data: Urbanized areas destined to turistic use like villages and hotels (source: IH Cantabria from data of OSM and photointerpretation of satellite images, see GIS-Catalogue) Data need: Level 2 data would require update accurate georeferenced information all along the coast.
		Agriculture															Level 1 data: Lands under agricultural use from NARSS database 2003 for the NW Mediterranean coast of Egypt and from ACCNDP for agriculture of Nile Delta (source: ACCNDP and EEAA/IH Cantabria, see GIS-Catalogue). Data need: Level 2 data would require update accurate georeferenced information all along the coast.
		Industry															Level 1 data: Areas with industrial use (source: IHCantabria, see GIS-Catalogue). Data need: Level 2 data would require update accurate georeferenced information all along the coast.
		Ports															Level 1 data: Main ports of the study area (source: IHCantabria, see GIS-Catalogue). Data need: Level 2 data would require update accurate georeferenced information all along the coast.
		Aquaculture															Level 1 data: Aquaculture distribution (source: NCPSTL, see GIS-Catalogue). Data need: Level 2 data would require update accurate georeferenced information all along the coast.
		Historical sites															Level 1 data: Historical sites distribution (source: NCPSTL, see GIS-Catalogue). Data need: Level 2 data would require update accurate georeferenced information all along the coast.
	Social	Bedouin settlement	(1)													Level 0 data: Spatial layer of Bedouin settlements distribution not available. Level 1 data: (1) Bedouin settlements distribution (source: EEAA/IHCantabria, see GIS-Catalogue). Data need: Level 2 data would require create accurate georeferenced information when it doesn't exist and update existent.	
	Transportation	Airports															Level 1 data: Airports by governorate, district and type (source: IHCantabria, see GIS-Catalogue). (1) Airports of Alexandria y Port Said, Ministry of civil aviation (source: NCPSTL) Data need: Level 2 data would require update spatial layers, making them polygonal layers.
		Railway															Level 1 data: Infrastructures associated to railway transportation (source: OSM, see GIS-Catalogue). Data need: Level 2 data would require update spatial layers
		Roads															Level 1 data: Roads by type (footway, primary, secondary,...) in the study area (source: OSM, see GIS-Catalogue). Data need: Level 2 data would require update spatial layers
Urban	Urban areas	(1)	(1)	(1)	(1)	(1)	(1)								Level 1 data: Cities, towns and villages with population attributes based on CAPMAS census 2006 (source: IHCantabria from FAO land cover database for Egypt and CAPMAS census 2006). (1) Settlements in Matrouh Governorate (source: NCPSTL, see GIS-Catalogue) Data need: Level 2 data would require polygonal spatial layers with population attributes of the main cities, towns and villages all along the coast.		

Legend

	Level 2 data. High resolution data / intensive monitoring program. Data accurate enough for future stages of ICZM and do not need improvement.
	Level 1 data. Low/medium resolution data, useful for a scoping study and large scale study (Northern Coast scale). Data might require improvement for future stages of ICZM. Limited level 2 data. Level 2 data exists only for a part of a unit / Level 2 data exists but not available. Data have to be collected and might require improvement for future stages of ICZM.
	No data. Level 0 data. Data not enough accurate to perform any stage of ICZM / Spatial layers not available. Data require improvement for future stages of ICZM.

3.3.2. Recommendations to fill existing gaps

These challenges and needs should be overcome in the following years to ensure the success of ICZM process in the Northern Coast, because information is knowledge, and knowledge is power.

The development of future ICZM plans requires **accessible and updated databases** and the establishment of collaboration mechanisms among coastal stakeholders to move towards a **data sharing strategy**. These databases should contain data from monitoring systems as well as future predictions of climate change impacts obtained through statistics and modelling techniques.

Towards a spatial data infrastructure

Technological advances in the field of geographic information technologies and communications provide a priori a favourable context. Indeed, it appears that ICZM is enhanced by the implementation of methods and technological tools appropriate to the acquisition, storage, analysis, representation and communication of different kinds of data coming from various sources. In particular, geographic information systems (GIS) can put georeferenced data acquired by different geomatics methods into a coherent framework, suitable for analysis and mapping of the data. (Gourmelon et al, 2012.)

In this way, the implementation of the ICZM GeoViewer represents a significant effort in the right direction and constitute a major step forward in the improvement of the state of information and data related to coastal areas in Egypt.

According to Ali (2015), the development of Standardizing Spatial Data Infrastructures data (SDI) in Egypt is a key resource in the development of the Nation.

An advance stage of the state of the art is performed by European INSPIRE Directive and could be taken as reference to guide the next steps. The INSPIRE Directive aims to create a European Union spatial data infrastructure for the purposes of EU environmental policies and policies or activities which may have an impact on the environment. This European Spatial Data Infrastructure will enable the sharing of environmental spatial information among public sector organisations, facilitate public access to spatial information across Europe and assist in policy-making across boundaries (<http://inspire.ec.europa.eu/>).

CHAPTER 4: COASTAL DIAGNOSIS



CHAPTER 4. COASTAL DIAGNOSIS

This chapter presents the results of the sectoral and integrated diagnoses. The diagnosis of each coastal unit is presented in a set of four factsheets:

- Ecological diagnosis factsheet: summarizes the ecological diagnosis of each coastal unit. Additional information regarding the ecological diagnosis is presented in Annex III.
- Socioeconomic diagnosis factsheet: compiles the results of socioeconomic and urban assessments.
- Physical diagnosis factsheet: provides summarized information about physical impacts. Annex I presents detailed information about characterization of coastal hazards, for every timeframe and RCP scenario analysed; and Annex II includes all results obtained from analysing physical impacts on the Northern Coast.
- Integrated diagnosis factsheet: presents the SWOT analysis and Key Issues of each coastal unit.

Finally, this chapter presents a summary of the legal and institutional assessment, fully included in Annex IV.

The following paragraphs explain the structure and contents of each factsheet in order to facilitate their reading and understanding.

ECOLOGICAL DIAGNOSIS

Text box 1: General description of the coastal unit. A brief description of the coastal unit: location, coastal length, main towns, Governorate, Markaz.

Text box 2: Ecological system. The ecological system is described, pointing out different natural features that can be found in the coastal unit:

- Habitats
- Flora
- Fauna
- Other interesting features: Protected areas, lakes, rivers...

Text box 3: Diagnosis of present situation. An analysis of the present situation is presented.

- Current impacts and threats are listed
- Different aspects of the biodiversity, natural resources and natural water bodies are assessed with a rate scale of low, medium or high.

Text box 4: Diagnosis of long term situation. It says whether there is any proposed protected area or not.

Figure 1: Land use. A detailed map of the coastal unit with the most relevant information is shown.

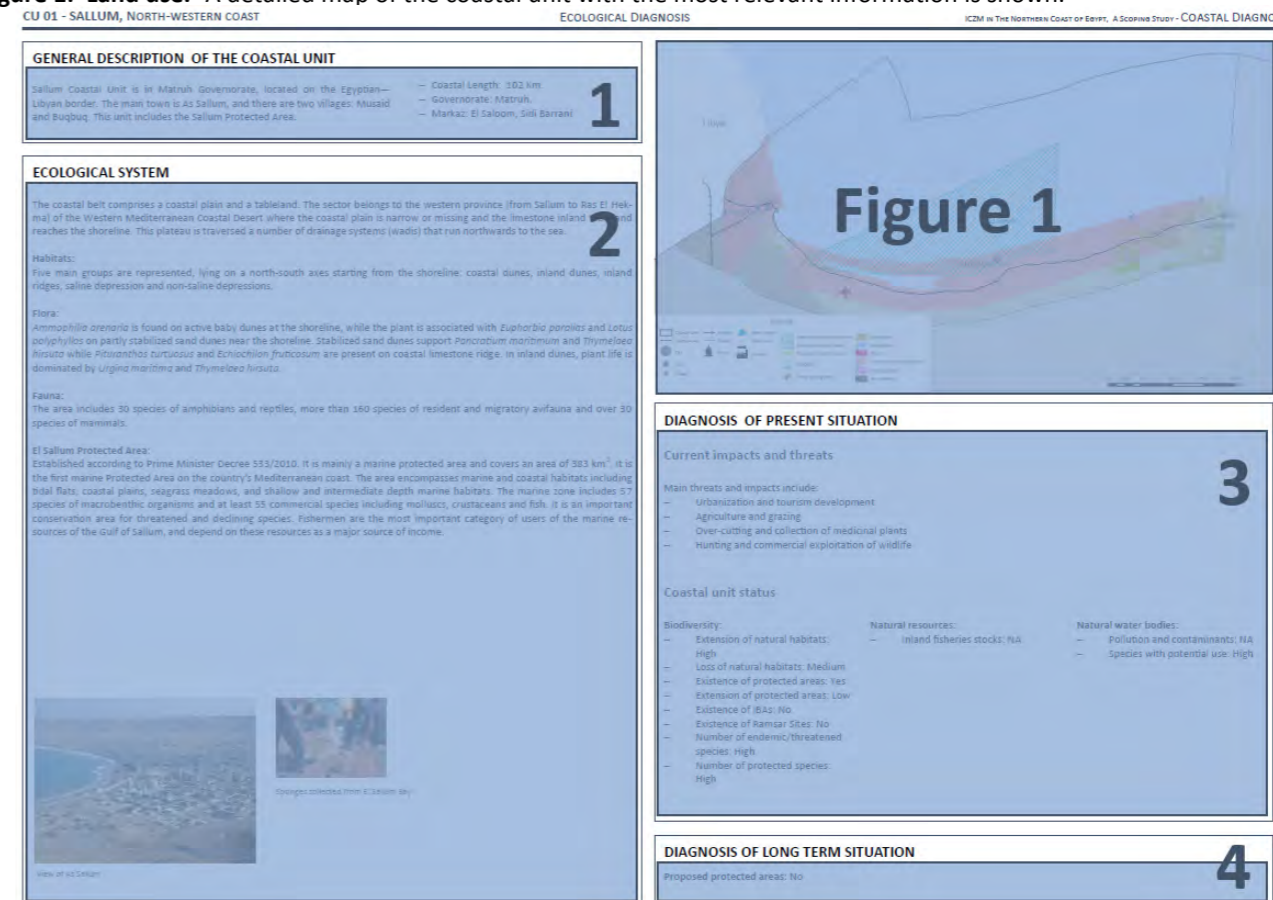


Figure 4.1. Ecological diagnosis factsheet presentation.

SOCIOECONOMIC DIAGNOSIS

Text box 1: Socioeconomic diagnosis. The socioeconomic system is described by giving information about the economic activities, cultural and heritage sites and social group and ethnicities.

Text box 2: Diagnosis of present situation. Details about the present socioeconomic situation are listed (e.g. educational facilities, unemployment rate, tourism development...).

Text box 3: Diagnosis of long term situation. Diagnosis of the situation that is expected in the long term is described (e.g. new urban communities, industrial and tourism development...)

Text box 4: Plans and projects, existing studies. A summary of the most recent studies related to coast, water, environment, urban growth... are listed.

Text box 5: Plans and projects, long term development. A list of the long term development plans is presented. A table with the local stakeholders, its group (authority, civil society organization or private sector) and the website is presented.

Text box 6: Local stakeholders. A brief description of the coastal unit: location, coastal length, main towns, Governorate, Markaz.

PHYSICAL DIAGNOSIS

Text box 1: Physical system. A general description of the coast together with information about the coastal structures and beaches is presented in this box.

Text box 2: Diagnosis of present situation. The present situation of the coast is described by analysing different impacts (e.g. erosion, flooding, abiotic stress...) and evaluating it with a rate scale of low, medium or high.

Text box 3: Diagnosis of long-term situation. The same impacts as in box 2 are analysed and rated for the long term. The IPCC RCP8.5 scenario is considered.

Figure 1: Coastal processes. In this figure, sea level rise values obtained for the RCP8.5 scenarios for the following time frames are displayed (colour circles, in m): 2016-2035, 2046-2065 and 2081-2100. The mean value of the significant wave height only exceeded 12 hours per year (Hs12, in m) is indicated by the colour triangles. Finally, colourmaps of the gross sediment transport (in m3/year) and of the flooding distance corresponding to the 99th percentile of the total sea level (in m) are mapped.

Figure 2: Coastal impacts. The impacts that are described in box 2 and 3 are mapped along the coast with the rate scale in colour (being green, yellow and red, low, high and medium, flooding respectively) and their diagnosis for the long term indicated by an arrow if the impact is expected to increase or a dash if it is anticipated to be constant.

Figure 3: Geomorphology. A characterization of the coast is shown with information about the type of beaches (rocks or sandy beach) and the amount of coastal structures that can be found along the coast of the coastal unit.

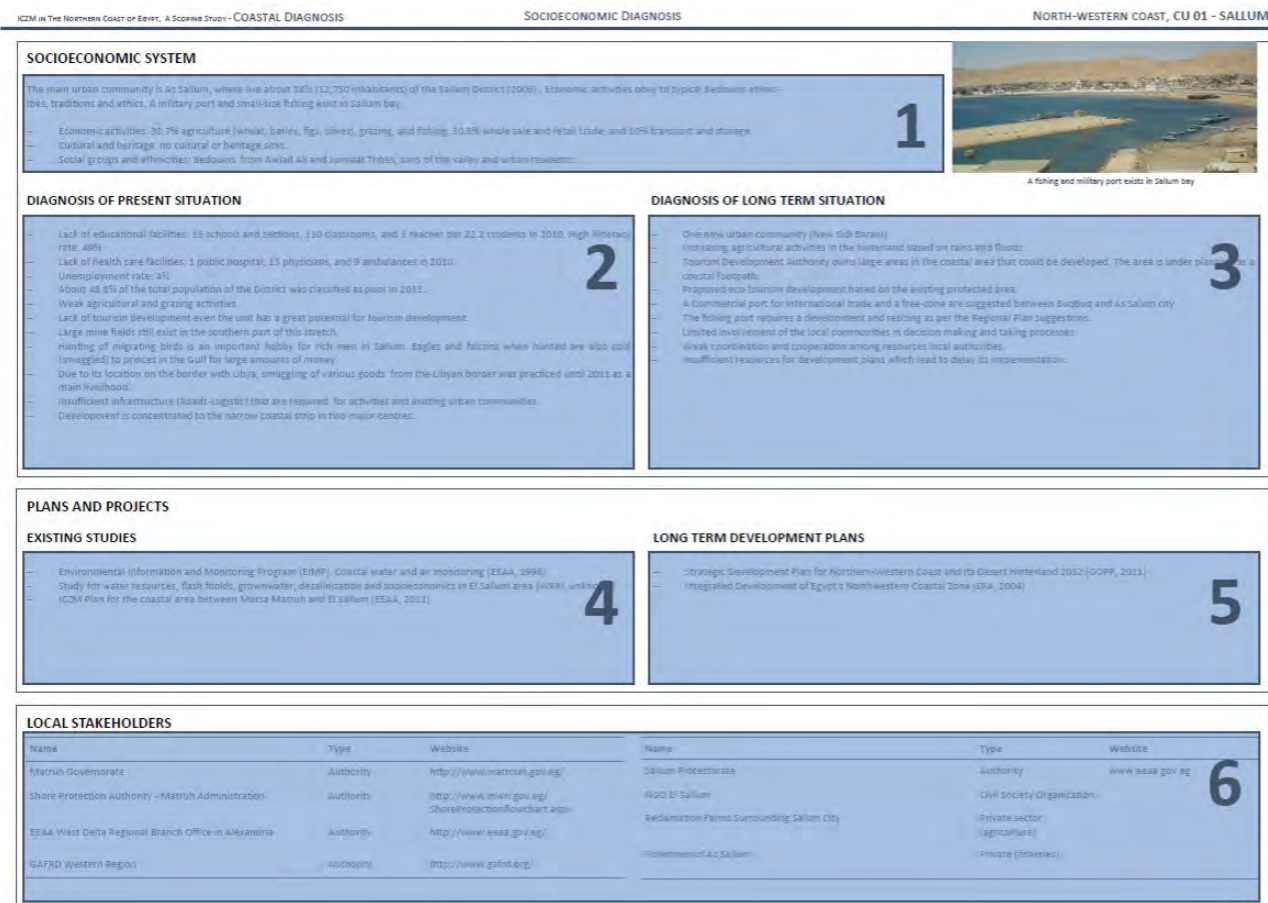


Figure 4.2. Socioeconomic diagnosis factsheet presentation.

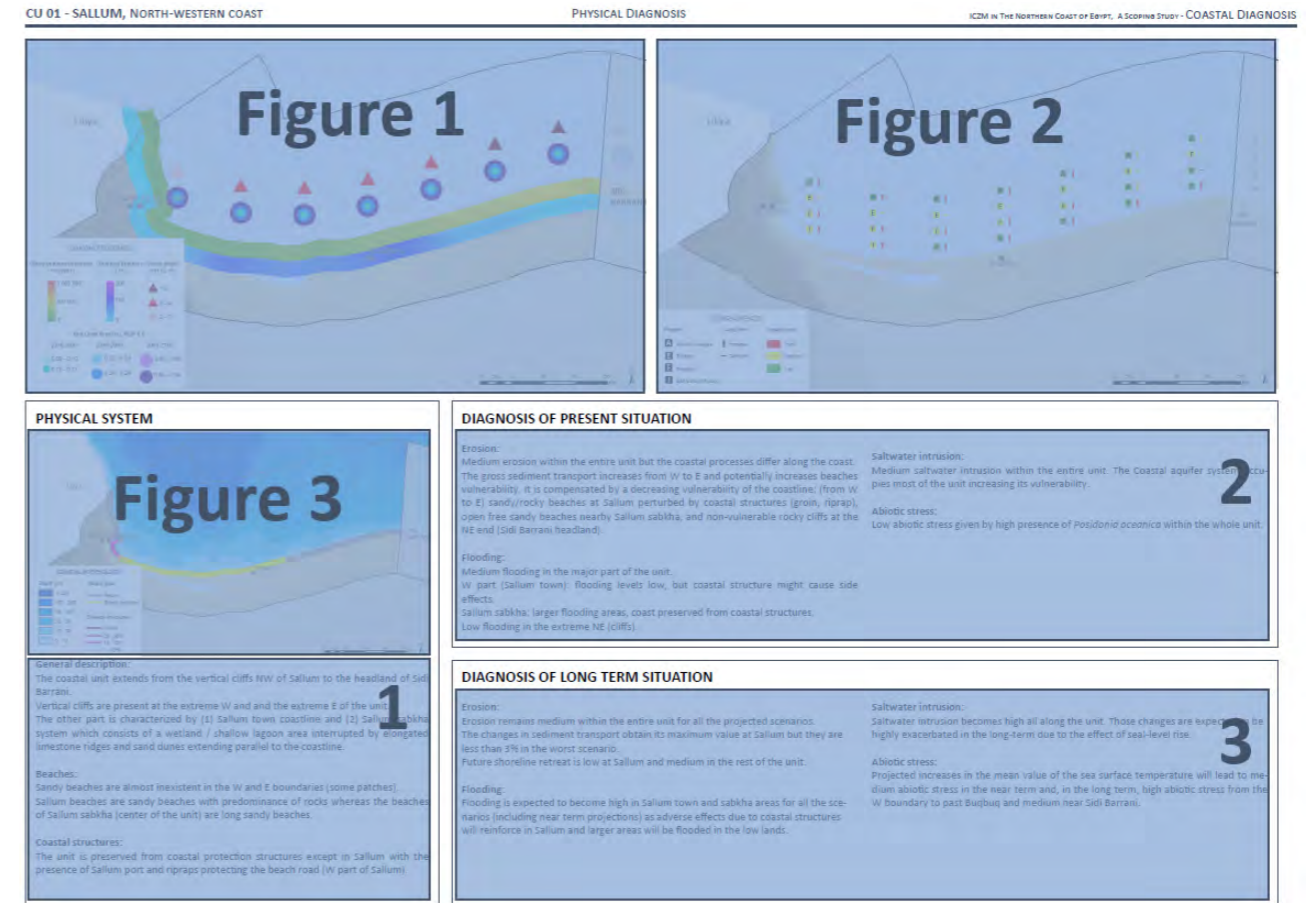


Figure 4.3. Physical diagnosis factsheet presentation

INTEGRATED DIAGNOSIS

Text box 1: Present Key issues. A summary of the present key issues obtained by combining together the different diagnosis (ecological, socioeconomic and physical) are listed.

Text box 3: Long Term Key issues. A summary of the future key issues obtained by combining together the different diagnosis (ecological, socioeconomic and physical) are listed.

Text box 3: SWOT analysis. The results of the SWOT analysis are shown in box 1. A number of strength, weaknesses, opportunities and threats are listed.

Figure 1: Key Issues. The key issues mentioned in box 3 and 4 are mapped along the coast of the coastal unit. Each coastal unit is classified as: red, very important; yellow, important and grey, no key issues. The long term is symbolized by an arrow (increase) or dash (constant), depending whether the key issue will increase or not.

Figure 2: Images. Photos or images of the most important key issues are displayed.

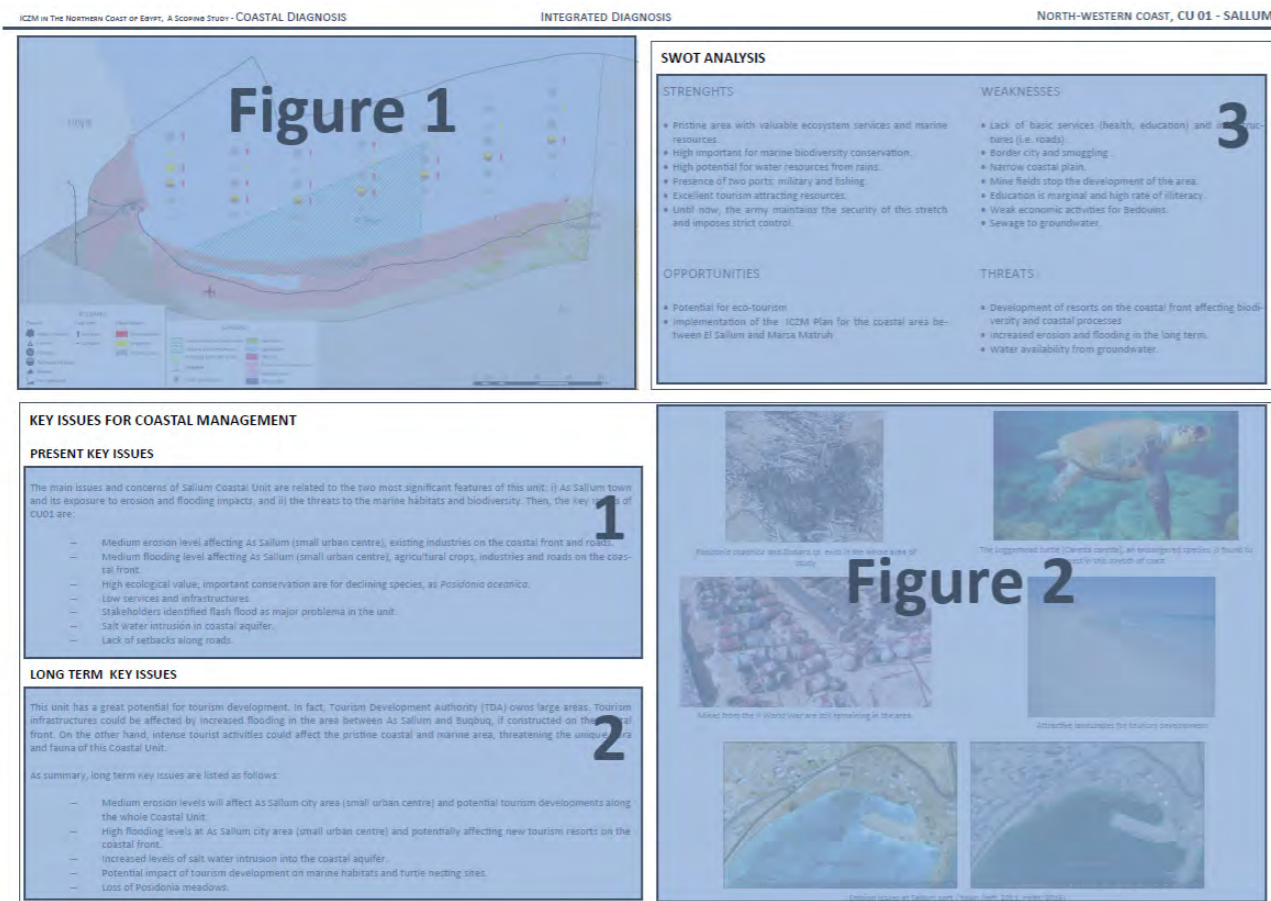
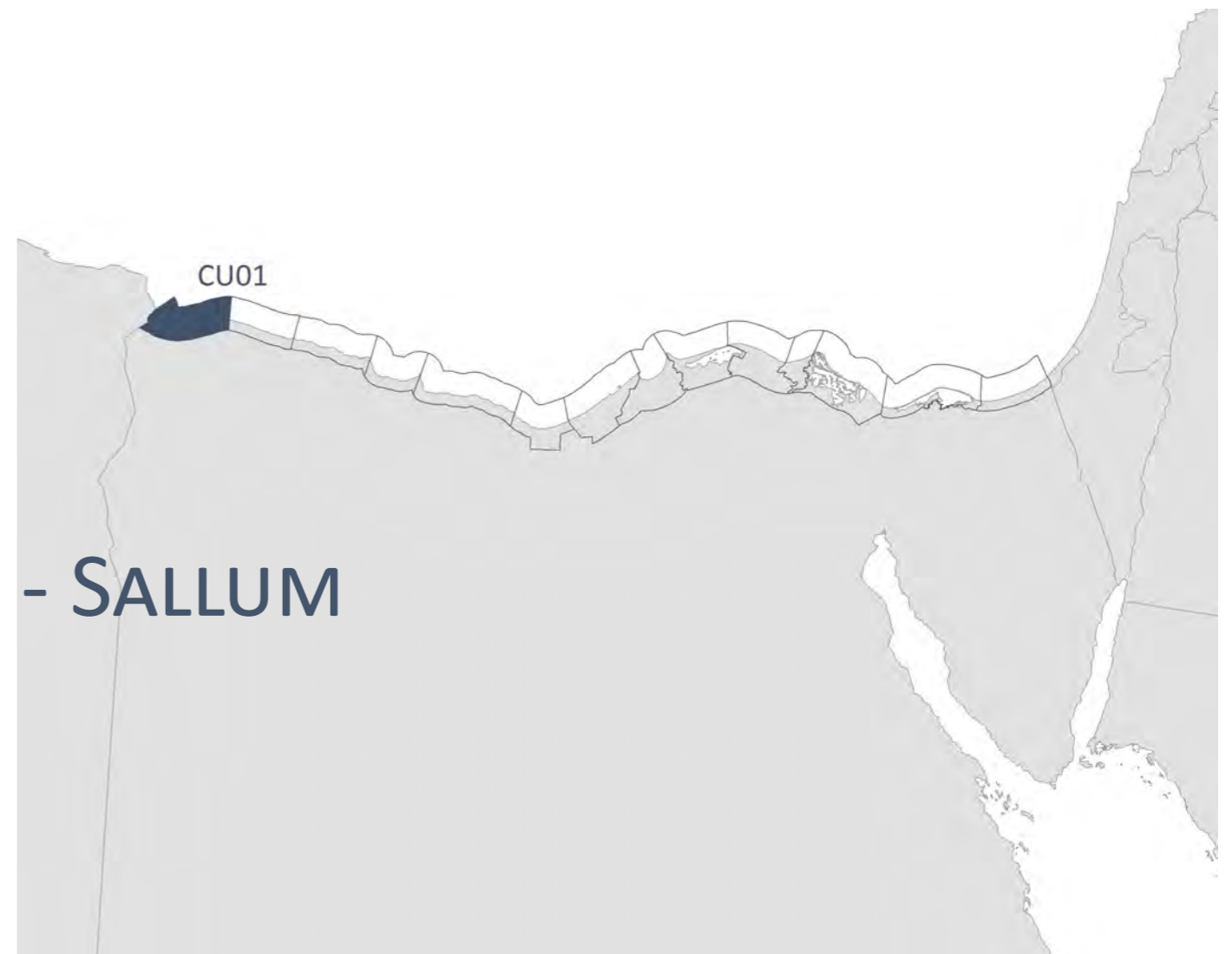


Figure 4.4. Integrated diagnosis factsheet presentation

COASTAL UNIT 01 - SALLUM



GENERAL DESCRIPTION OF THE COASTAL UNIT

Sallum Coastal Unit is in Matruh Governorate, located on the Egyptian—Libyan border. The main town is As Sallum, and there are two villages: Musaid and Buqbuq. This unit includes the Sallum Protected Area.

- Coastal Length: 102 Km.
- Governorate: Matruh.
- Markaz: El Sallum, Sidi Barrani.

ECOLOGICAL SYSTEM

The coastal belt comprises a coastal plain and a tableland. The sector belongs to the western province (from Sallum to Ras El Hekma) of the Western Mediterranean Coastal Desert where the coastal plain is narrow or missing and the limestone inland tableland reaches the shoreline. This plateau is traversed a number of drainage systems (wadis) that run northwards to the sea.

Habitats:

Five main groups are represented, lying on a north-south axes starting from the shoreline: coastal dunes, inland dunes, inland ridges, saline depression and non-saline depressions.

Flora:

Ammophila arenaria is found on active baby dunes at the shoreline, while the plant is associated with *Euphorbia paralias* and *Lotus polyphyllus* on partly stabilized sand dunes near the shoreline. Stabilized sand dunes support *Pancreatium maritimum* and *Thymelaea hirsuta* while *Pituranthos turtuosus* and *Echiochilon fruticosum* are present on coastal limestone ridge. In inland dunes, plant life is dominated by *Urgina maritima* and *Thymelaea hirsuta*.

Fauna:

The area includes 30 species of amphibians and reptiles, more than 160 species of resident and migratory avifauna and over 30 species of mammals.

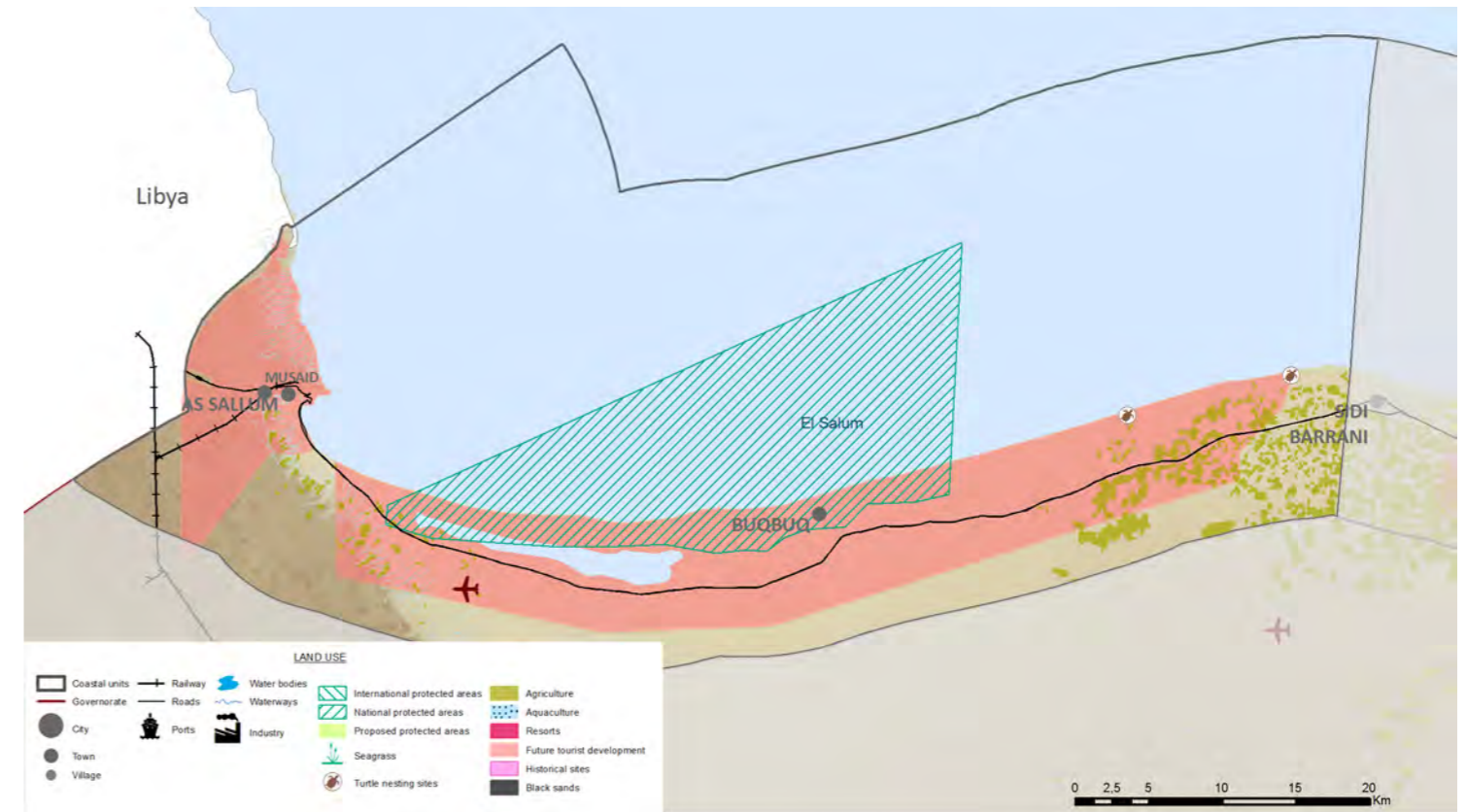
El Sallum Protected Area:

Established according to Prime Minister Decree 533/2010. It is mainly a marine protected area and covers an area of 383 km². It is the first marine Protected Area on the country's Mediterranean coast. The area encompasses marine and coastal habitats including tidal flats, coastal plains, seagrass meadows, and shallow and intermediate depth marine habitats. The marine zone includes 57 species of macrobenthic organisms and at least 55 commercial species including molluscs, crustaceans and fish. It is an important conservation area for threatened and declining species. Fishermen are the most important category of users of the marine resources of the Gulf of Sallum, and depend on these resources as a major source of income.



Sponges collected from El Sallum Bay

View of As Sallum



DIAGNOSIS OF PRESENT SITUATION

Current impacts and threats

Main threats and impacts include:

- Urbanization and tourism development.
- Agriculture and grazing.
- Over-cutting and collection of medicinal plants.
- Hunting and commercial exploitation of wildlife. According to stakeholder inputs, most of the local community works on hunting migratory birds.
- Impacts on marine biodiversity and fishing with destructive materials/equipment.

Coastal unit status

Biodiversity:

- Extension of natural habitats: High.
- Loss of natural habitats: Medium.
- Existence of protected areas: Yes.
- Extension of protected areas: Low.
- Existence of IBAs: No.
- Existence of Ramsar Sites: No.
- Number of endemic/threatened species: High.
- Number of protected species: High.

Natural resources:

- Inland fisheries stocks: NA.
- Species with potential use: High.

Natural water bodies:

- Pollution and contaminants: NA

DIAGNOSIS OF LONG TERM SITUATION

Proposed protected areas: No

SOCIOECONOMIC SYSTEM

The main urban community is As Sallum, where live about 88% (12,750 inhabitants) of the Sallum District (2006). Economic activities obey to typical Bedouins ethnicities, traditions and ethics. A military port and small-size fishing dock exist in Sallum bay.

- Economic activities: 38.7% agriculture (wheat, barley, figs, olives), grazing, and fishing, 30.5% whole sale and retail trade, and 10% transport and storage.
- Cultural and heritage: no cultural or heritage sites.
- Social groups and ethnicities: Bedouins from Awlad Ali and Jumiaat Tribes, sons of the valley and urban residents.



A fishing and military port exists in Sallum bay

DIAGNOSIS OF PRESENT SITUATION

- Lack of educational facilities: 15 schools and sections, 110 classrooms, and 1 teacher per 22.2 students in 2010. High illiteracy rate: 49%.
- Lack of health care facilities: 1 public hospital, 13 physicians, and 9 ambulances in 2010.
- Unemployment rate: 4%.
- About 48.8% of the total population of the District was classified as poor in 2013. CU01 and CU02 are the most poor communities of this area.
- Weak agricultural and grazing activities.
- Lack of tourism development even the unit has a great potential for tourism development.
- Large mine fields still exist in the southern part of this stretch.
- Hunting of migrating birds is an important hobby for rich men in Sallum. Eagles and falcons when hunted are also sold (smuggled) to princes in the Gulf for large amounts of money.
- Due to its location on the border with Libya, smuggling of various goods from the Libyan border was practiced until 2011 as a main livelihood.
- Insufficient infrastructure (Roads-Logistic) that are required for activities and existing urban communities.
- Development is concentrated to the narrow coastal strip in two major centres.

DIAGNOSIS OF LONG TERM SITUATION

- One new urban community (New Sidi Barani).
- Increasing agricultural activities in the hinterland based on rains and floods.
- Tourism Development Authority owns large areas in the coastal area that could be developed. Planned coastal footpath.
- Proposed eco-tourism development based on the existing protected area.
- Stakeholders do not find this area as interesting for tourism investment due to military dangers.
- A commercial port for international trade and a free-zone are suggested between BuqBuq and As Sallum city.
- The fishing port requires a development and resizing as per the Regional Plan suggestions. According to stakeholders participation, two or three more docks are necessary to get commercial exploitation of fisheries.
- Limited involvement of the local communities in decision making and taking processes.
- Weak coordination and cooperation among resources local authorities.
- Insufficient resources for development plans which lead to delay its implementation.

PLANS AND PROJECTS

EXISTING STUDIES

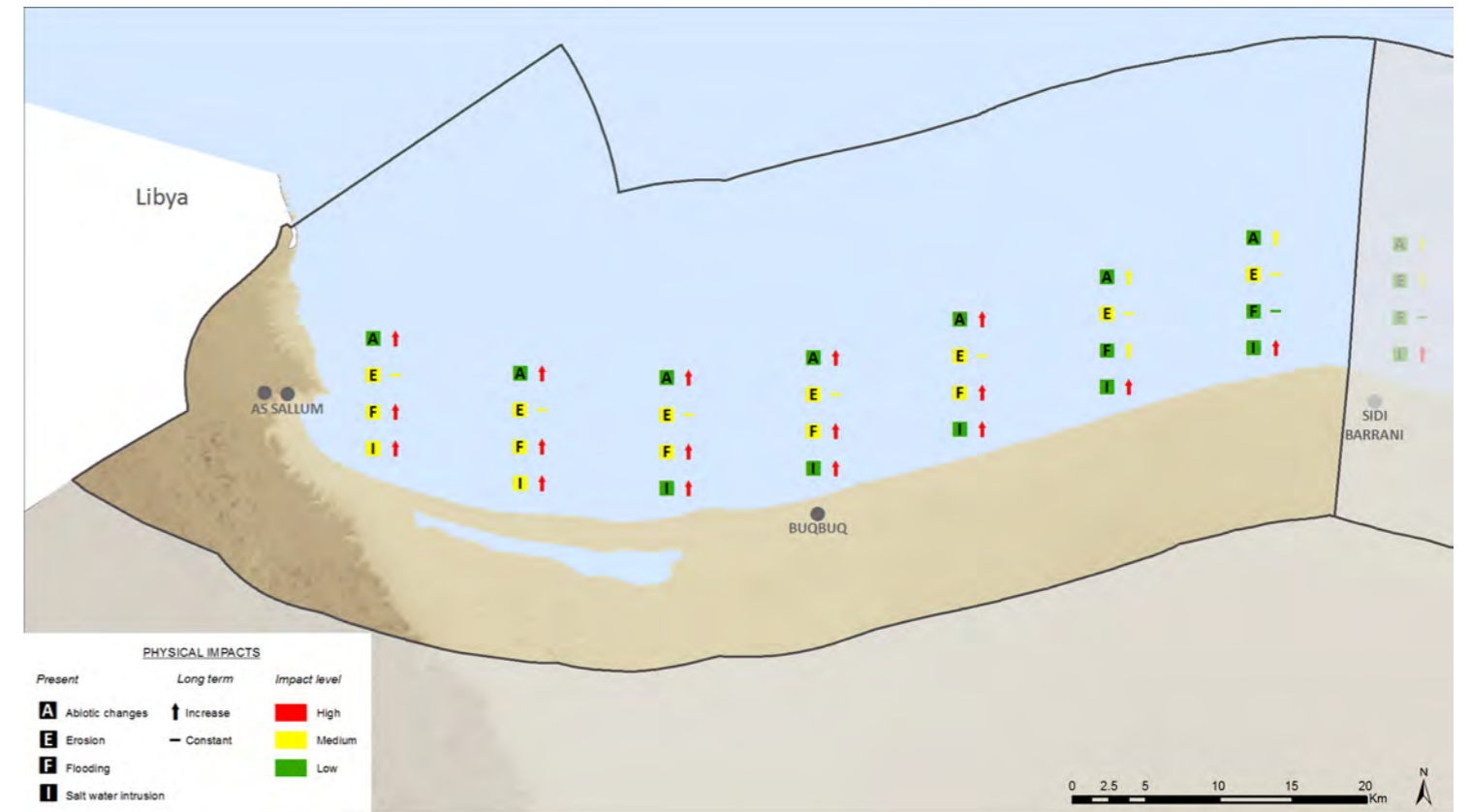
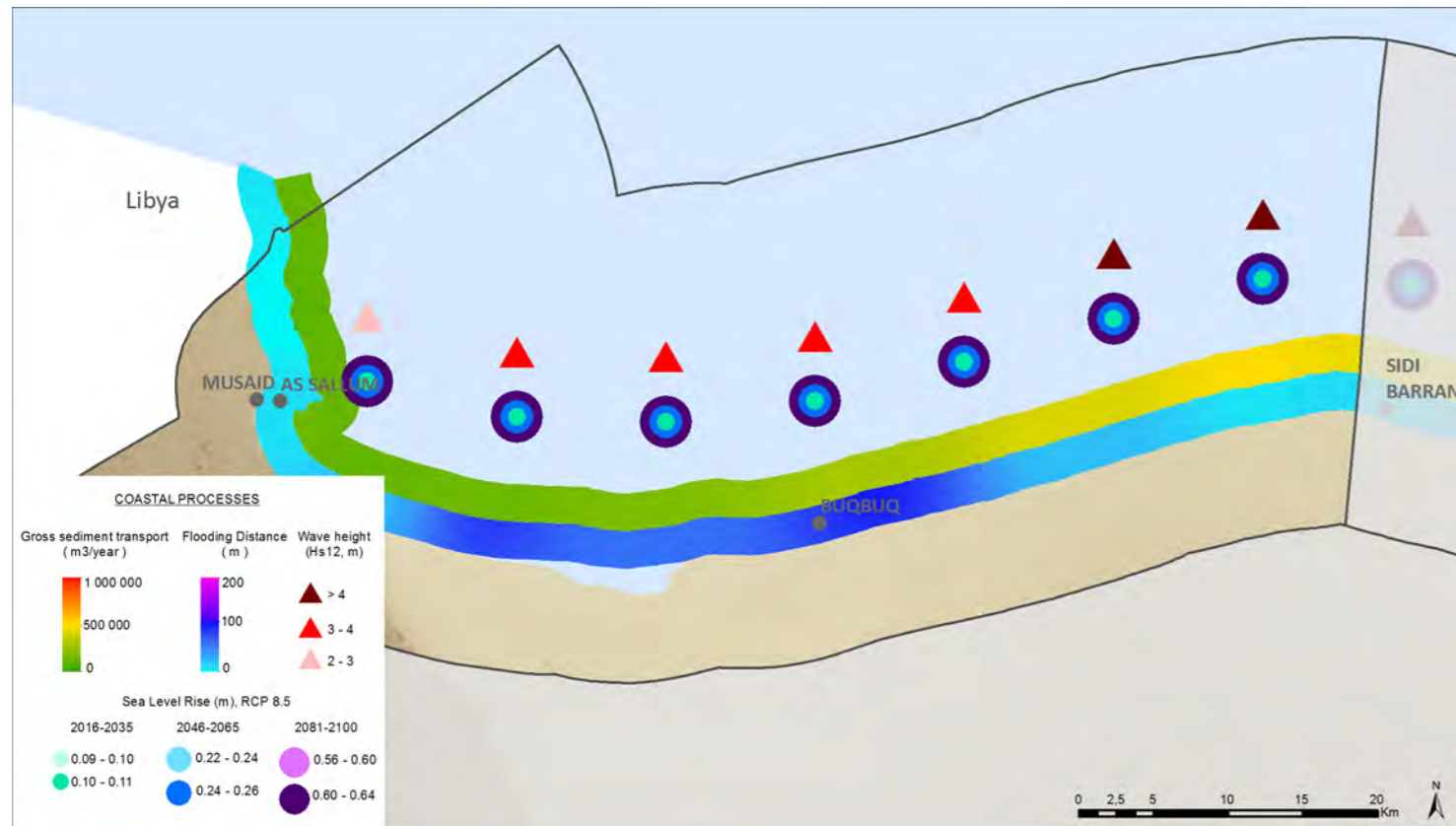
- Socioeconomic studies (unknown, 2014); not available.
- ICZM Plan for the coastal area between Marsa Matruh and El Sallum (EEAA, 2011).
- Environmental Information and Monitoring Program. Coastal water and air monitoring (EEAA, 1996).
- Study for water resources, flash floods, groundwater, desalination and socioeconomics in El Sallum area (WRRRI, unknown).

LONG TERM DEVELOPMENT PLANS

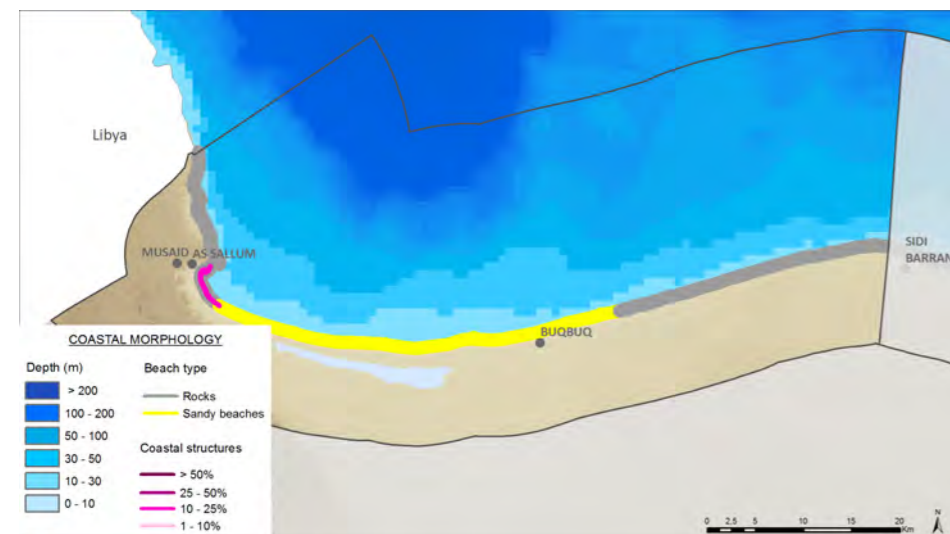
- Strategic Development Plan for Northern-Western Coast and Its Desert Hinterland 2032 (GOPP, 2011).
- Integrated Development of Egypt's Northwestern Coastal Zone (SPA, 2004).
- Fish farming project (unknown).

LOCAL STAKEHOLDERS

Name	Type	Website	Name	Type	Website
Matruh Governorate	Authority	http://www.matrouh.gov.eg/	Sallum Protectorate	Authority	www.eeaa.gov.eg
Shore Protection Authority - Matruh Administration	Authority	http://www.mwri.gov.eg/ShoreProtectionflowchart.aspx	NGO El Sallum	Civil Society Organization	
EEAA West Delta Regional Branch Office in Alexandria	Authority	http://www.eeaa.gov.eg/	Reclamation Farms Surrounding Salum City	Private sector (agriculture)	
GAFRD Western Region	Authority	http://www.gafrd.org/	Fishermen of As Sallum	Private (fisheries)	



PHYSICAL SYSTEM



General description:

The coastal unit extends from the vertical cliffs NW of Sallum to the headland of Sidi Barrani.

Vertical cliffs are present at the extreme W and the extreme E of the unit. The other part is characterized by (1) Sallum town coastline and (2) Sallum sabkha system which consists of a wetland / shallow lagoon area interrupted by elongated limestone ridges and sand dunes extending parallel to the coastline.

Beaches:

Sandy beaches are almost inexistent in the W and E boundaries (some patches). Sallum beaches are sandy beaches with predominance of rocks whereas the beaches of Sallum sabkha (center of the unit) are long sandy beaches.

Coastal structures:

The unit is preserved from coastal protection structures except in Sallum with the presence of Sallum port and ripraps protecting the beach road (W part of Sallum).

DIAGNOSIS OF PRESENT SITUATION

Erosion:

Medium erosion within the entire unit but the coastal processes differ along the coast. The gross sediment transport increases from W to E and potentially increases beaches vulnerability. It is compensated by a decreasing vulnerability of the coastline: (from W to E) sandy/rocky beaches at Sallum perturbed by coastal structures (groin, riprap), open free sandy beaches nearby Sallum sabkha, and non-vulnerable rocky cliffs at the NE end (Sidi Barrani headland).

Flooding:

Medium flooding in the major part of the unit.
 W part (Sallum town): flooding levels low, but coastal structure might cause side effects.
 Sallum sabkha: larger flooding areas, coast preserved from coastal structures.
 Low flooding in the extreme NE (cliffs).

Saltwater intrusion:

Medium saltwater intrusion within the entire unit. The Coastal aquifer system occupies most of the unit increasing its vulnerability.

Abiotic stress:

Low abiotic stress given by high presence of *Posidonia oceanica* within the whole unit.

DIAGNOSIS OF LONG TERM SITUATION

Erosion:

Erosion remains medium within the entire unit for all the projected scenarios. The changes in sediment transport obtain its maximum value at Sallum but they are less than 3% in the worst scenario. Future shoreline retreat is low at Sallum and medium in the rest of the unit.

Flooding:

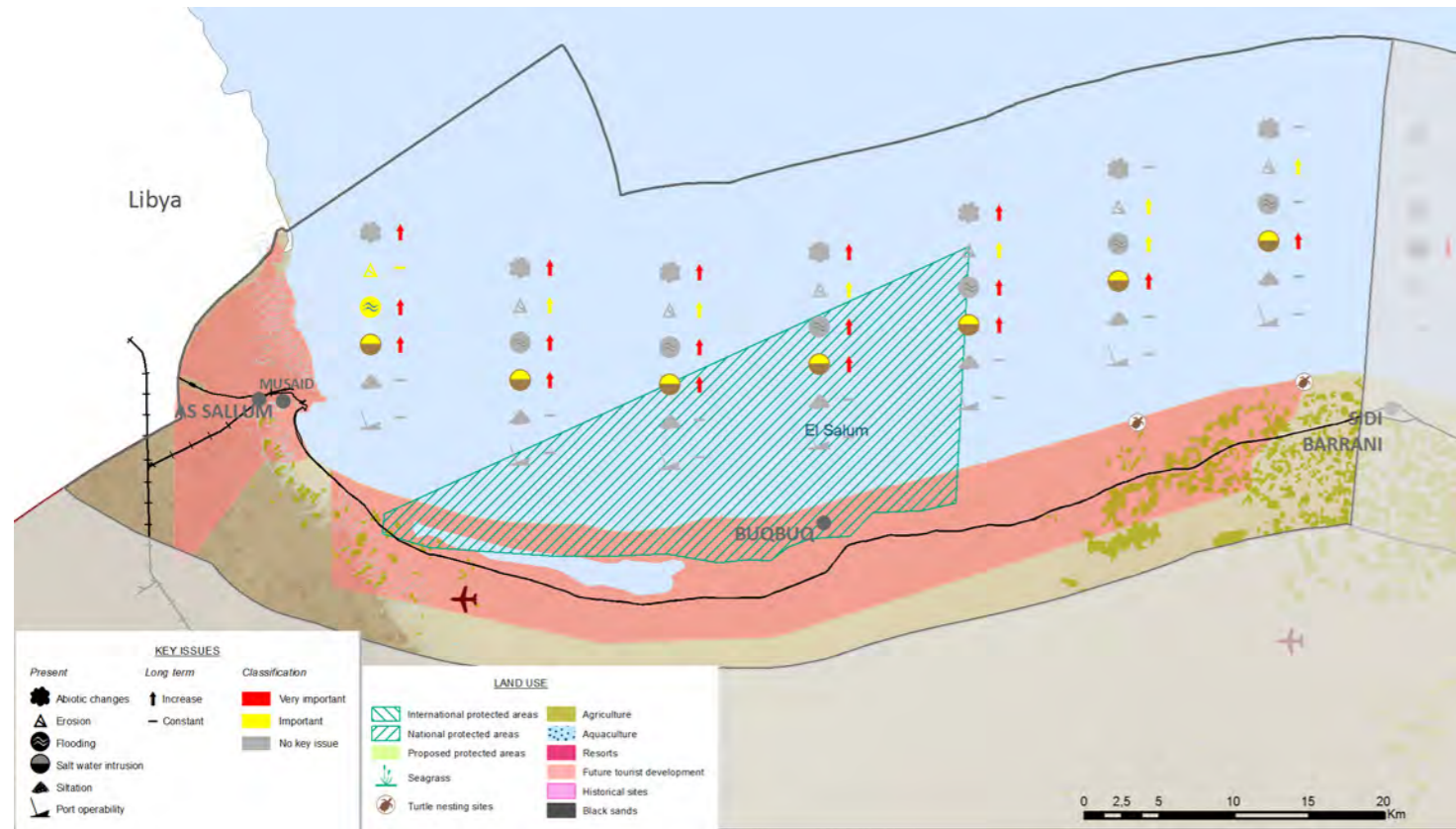
Flooding is expected to become high in Sallum town and sabkha areas for all the scenarios (including near term projections) as adverse effects due to coastal structures will reinforce in Sallum and larger areas will be flooded in the low lands.

Saltwater intrusion:

Saltwater intrusion becomes high all along the unit. Those changes are expected to be highly exacerbated in the long-term due to the effect of sea-level rise.

Abiotic stress:

Projected increases in the mean value of the sea surface temperature will lead to medium abiotic stress in the near term and, in the long term, high abiotic stress from the W boundary to past Buqbuq and medium near Sidi Barrani.



SWOT ANALYSIS

STRENGTHS

- Pristine area with valuable ecosystem services and marine resources.
- Important protected area for marine biodiversity conservation.
- High potential for water resources from rains.
- Presence of a military port with fishing dock.
- Excellent tourism attracting resources.
- Until now, the army maintains the security of this stretch and imposes strict control.

OPPORTUNITIES

- Potential for eco-tourism.
- Implementation of the ICZM Plan for the coastal area between El Sallum and Marsa Matruh.
- Use of soft engineering techniques to deal with erosion problems, avoiding hard structures that affect transportation rates.

WEAKNESSES

- Lack of basic services (health, education) and infrastructures (i.e. roads, tourism).
- No commercial importance.
- Border city and smuggling.
- Narrow coastal plain.
- Mine fields stop the development of the area.
- Education is marginal and high rate of illiteracy.
- Weak economic activities for Bedouins.
- Sewage to groundwater.
- Flash floods affects the coastal road and limits movement in the area.
- Never implemented plans for environmental management.

THREATS

- Development of resorts on the coastal front affecting biodiversity and coastal processes.
- Increased erosion and flooding in the long term.
- Water availability from groundwater.
- Removing sand from beaches and use it as construction materials (The activity was stopped through the aid of the protectorate administration and the city council)

KEY ISSUES FOR COASTAL MANAGEMENT

PRESENT KEY ISSUES

The main issues and concerns of Sallum Coastal Unit are related to the most significant features of this unit: i) As Sallum town and its exposure to erosion and flooding impacts, and ii) the threats to the marine habitats and biodiversity. Then, the Key Issues of CU01 are:

- Medium erosion level affecting As Sallum (small urban centre), existing industries on the coastal front and roads.
- Medium flooding level affecting As Sallum (small urban centre), agricultural crops, industries and roads on the coastal front.
- High ecological value; important conservation area for declining species, as *Posidonia oceanica*.
- Low services and infrastructures.
- Stakeholders identified flash flood as major problem in the unit.
- Salt water intrusion in coastal aquifer.
- Lack of setbacks along roads.
- Poor involvement of executive bodies are in making and implementing coastal management plan for the region.

LONG TERM KEY ISSUES

This unit has a great potential for tourism development. In fact, Tourism Development Authority (TDA) owns large areas. Tourism infrastructures could be affected by increased flooding in the area between As Sallum and Buqbuq, if constructed on the coastal front. On the other hand, intense tourist activities could affect the pristine coastal and marine area, threatening the unique flora and fauna of this Coastal Unit.

As summary, long term Key Issues are listed as follows:

- Medium erosion level will affect As Sallum city area (small urban centre) and potential tourism developments along the whole Coastal Unit.
- High flooding level along As Sallum city area (small urban centre) new tourism resorts on the coastal front.
- Increased level of saltwater intrusion.
- Potential impact of tourism infrastructures and activities on marine habitats and turtle nesting sites.
- Loss of seagrasses meadows.



Posidonia oceanica and *Zostera* sp. exist in the whole area of study



The Loggerhead turtle (*Caretta caretta*), an endangered species, is found to nest in this stretch of coast



Mines from the II World War are still remaining in the area

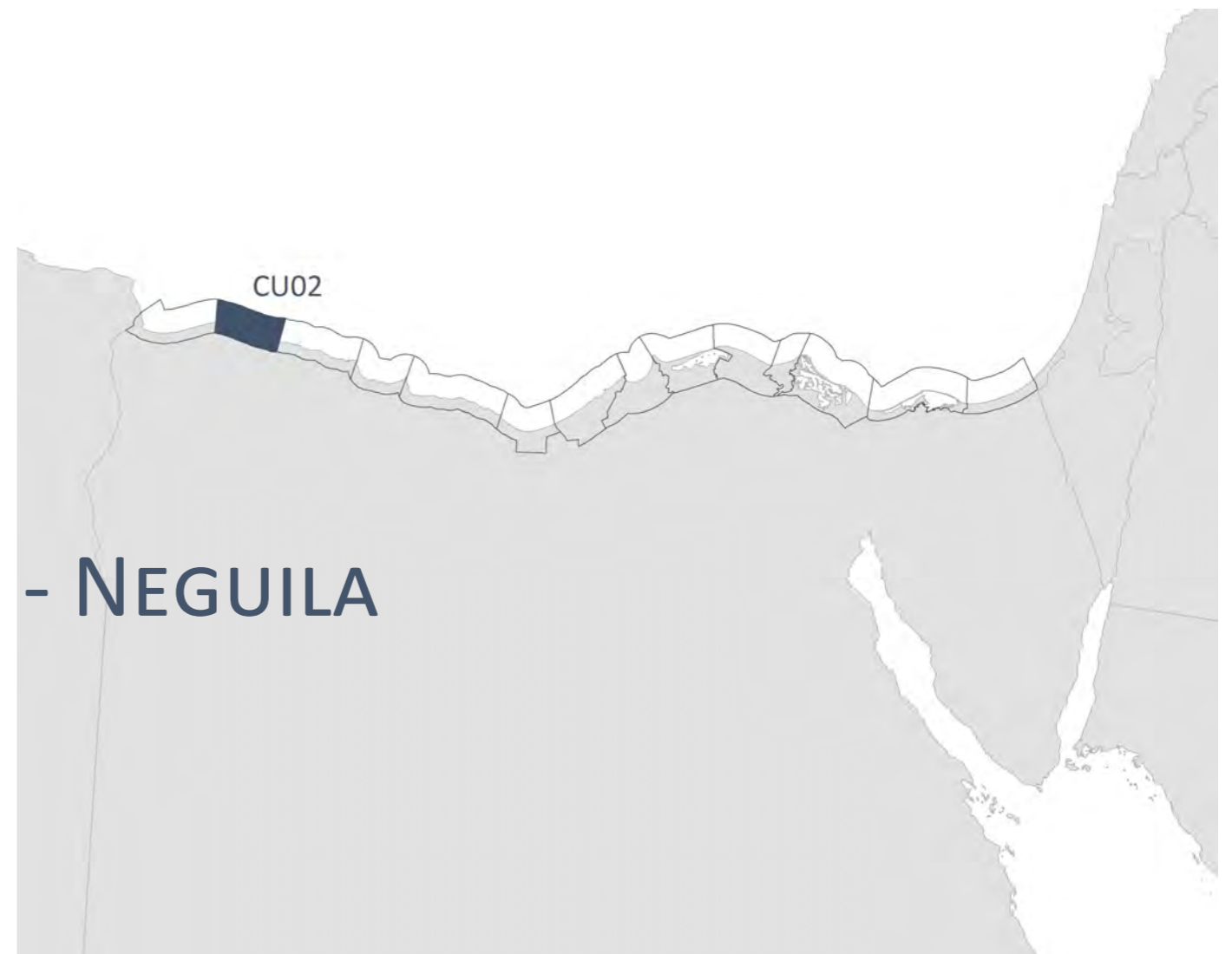


Attractive landscapes for tourism development



Erosion issues at Sallum port /town (left: 2011, right: 2016)

COASTAL UNIT 02 - NEGUILA



GENERAL DESCRIPTION OF THE COASTAL UNIT

Neguila Coastal Unit is located in Matruh Governorate, on the East of El Sallum. The major community is the town of Sidi Barrani.

- Coastal Length: 76 Km.
- Governorate: Matruh.
- Markaz: Sidi Barrani, Matruh.

ECOLOGICAL SYSTEM

The coastal belt comprises a coastal plain and a tableland. The sector belongs to the western province (from Sallum to Ras El Hekma) of the Western Mediterranean Coastal Desert where the coastal plain is narrow or missing and the limestone inland tableland reaches the shoreline. This plateau is traversed a number of drainage systems (wadis) that run northwards to the sea.

Habitats:
Five main groups are represented, lying on a north-south axes starting from the shoreline: coastal dunes, inland dunes, inland ridges, saline depression and non-saline depressions.

Flora:
Ammophila arenaria is found on active baby dunes at the shoreline, while the plant is associated with *Euphorbia paralias* and *Lotus polyphyllus* on partly stabilized sand dunes near the shoreline. Stabilized sand dunes support *Pancretium maritimum* and *Thymelaea hirsuta* while *Pituranthos turtuosus* and *Echiochilon fruticosum* are present on coastal limestone ridge. In inland dunes, plant life is dominated by *Urgina maritima* and *Thymelaea hirsuta*.

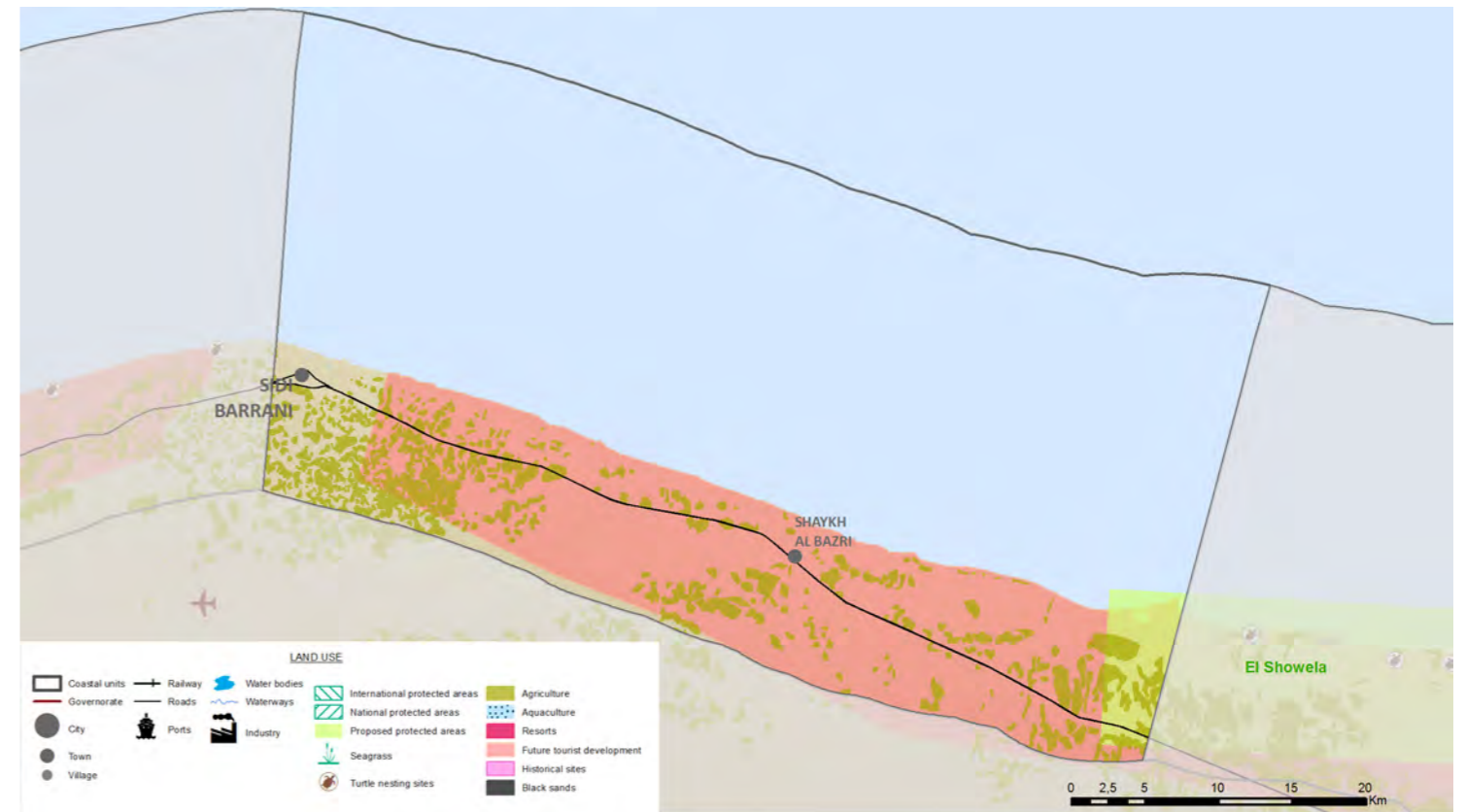
Fauna:
The Western Mediterranean Coastal Desert possesses one of the richest herpetofauna in Egypt. A total of 32 species of reptiles and two species of amphibians have been recorded from this area. At least 38 species of birds are known to breed in the Mediterranean Coastal Desert. Thirty-eight species of mammals have been recorded from this eco-region.



Flora near Sidi Barrani



Blind mouse (*Spalax ehrenbergi*) can be found in the area



DIAGNOSIS OF PRESENT SITUATION

Current impacts and threats

The main threats to the sector are related to the potential development of summer resorts. Main impacts include:

- Urbanization and tourism development.
- Agriculture and grazing.
- Over-cutting and collection of medicinal plants.
- Hunting and commercial exploitation of wildlife.
- Impacts on marine biodiversity.

Coastal unit status

Biodiversity:

- Extension of natural habitats: High.
- Loss of natural habitats: Low.
- Existence of protected areas: No.
- Extension of protected areas: NA.
- Existence of IBAs: No.
- Existence of Ramsar Sites: No.
- Number of endemic/threatened species: Medium.
- Number of protected species: Medium.

Natural Resources:

- Inland fisheries stocks: NA.
- Species with potential use: High .

Natural Water Bodies:

- Pollution and contaminants: NA.

DIAGNOSIS OF LONG TERM SITUATION

Proposed protected areas:
El Showela proposed protected area in the wester part of CU02.

SOCIOECONOMIC SYSTEM

The population on CU02 is mainly urban. Sidi Barrani district hosted 33,456 inhabitants in 2006, of which 62.9% lived in urban areas, as Sidi Barrani City and other villages. This unit obeys to the typical Bedouins ethnicities, traditions and ethics.

- Economic activities: 75.7% agriculture (wheat, barley, fig, olives), grazing, and fishing, and 6.8% wholesale and retail trade.
- Cultural and heritage: A Greco-Roman archeological hill.
- Social groups and ethnicities: Bedouins from Awlad Ali and Jumiaat Tribes, sons of the valley, urban residents.

DIAGNOSIS OF PRESENT SITUATION

- Lack of educational facilities: 92 schools and sections, 261 classrooms, and 1 teacher per 36.2 students in 2010. High illiteracy rate: 50%.
- Lack of health care facilities: 1 public hospital, 16 physicians, and 11 ambulances in 2010.
- Unemployment rate: 3%.
- About 48.8% of the total population of the Sidi Barrani District was classified as poor in 2013.
- Weak agricultural and grazing activities.
- Low production of fish due to absence of fishing ports and associated services.
- Lack of tourism development, even there is a great tourism potential.
- Large mine fields still exist in the southern part of this stretch, which hampers proposed development.
- Hunting of migrating birds is an important hobby for rich men in Sidi Barani. Eagles and falcons when hunted are also sold (smuggled) to princes in the Gulf for large amounts of money.
- Due to its location on the border with Libya, smuggling of various goods from the Libyan border was practiced until 2011 as a main livelihood.
- Limited involvement of the local communities in decision making and taking processes.
- Weak coordination and cooperation among resources local authorities.

DIAGNOSIS OF LONG TERM SITUATION

- Utilization of rain and flashflood waters for agricultural reclamation.
- Legalization of all that pertains to the reclaimed and agricultural lands.
- Livestock projects, mainly sheep herding.
- Reliance on water wells that has become increasingly salty over time that will be unsuitable for use in the future.
- Constructing a factory producing medical and herbal extracts from plants.
- There are proposed tourism development areas.
- Proposed industrial area located in the south of the city of Sidi Barani.
- Development of the transportation network, through the main axis connecting all coastal units (International Coastal Highway).
- Insufficient resources for development plans which lead to delay its implementation.

PLANS AND PROJECTS

EXISTING STUDIES

- ICZM Plan for the coastal area between Marsa Matruh and El Sallum (EEAA, 2011).
- Environmental Information and Monitoring Program (EIMP). Coastal water and air monitoring (EEAA, 1996).
- Study for water resources, flash floods, groundwater, desalination and socioeconomics in El Sallum area (WRRI, unknown).

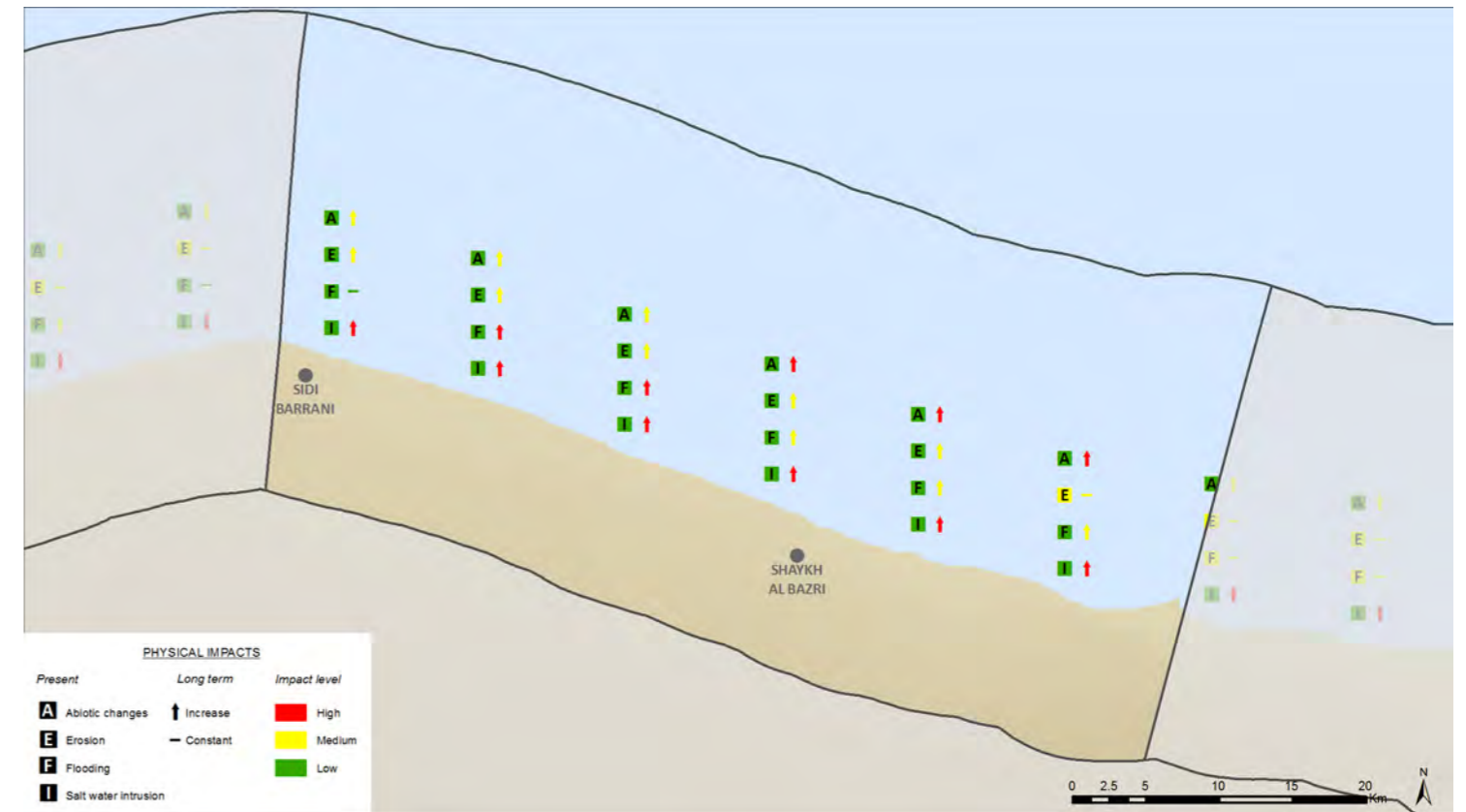
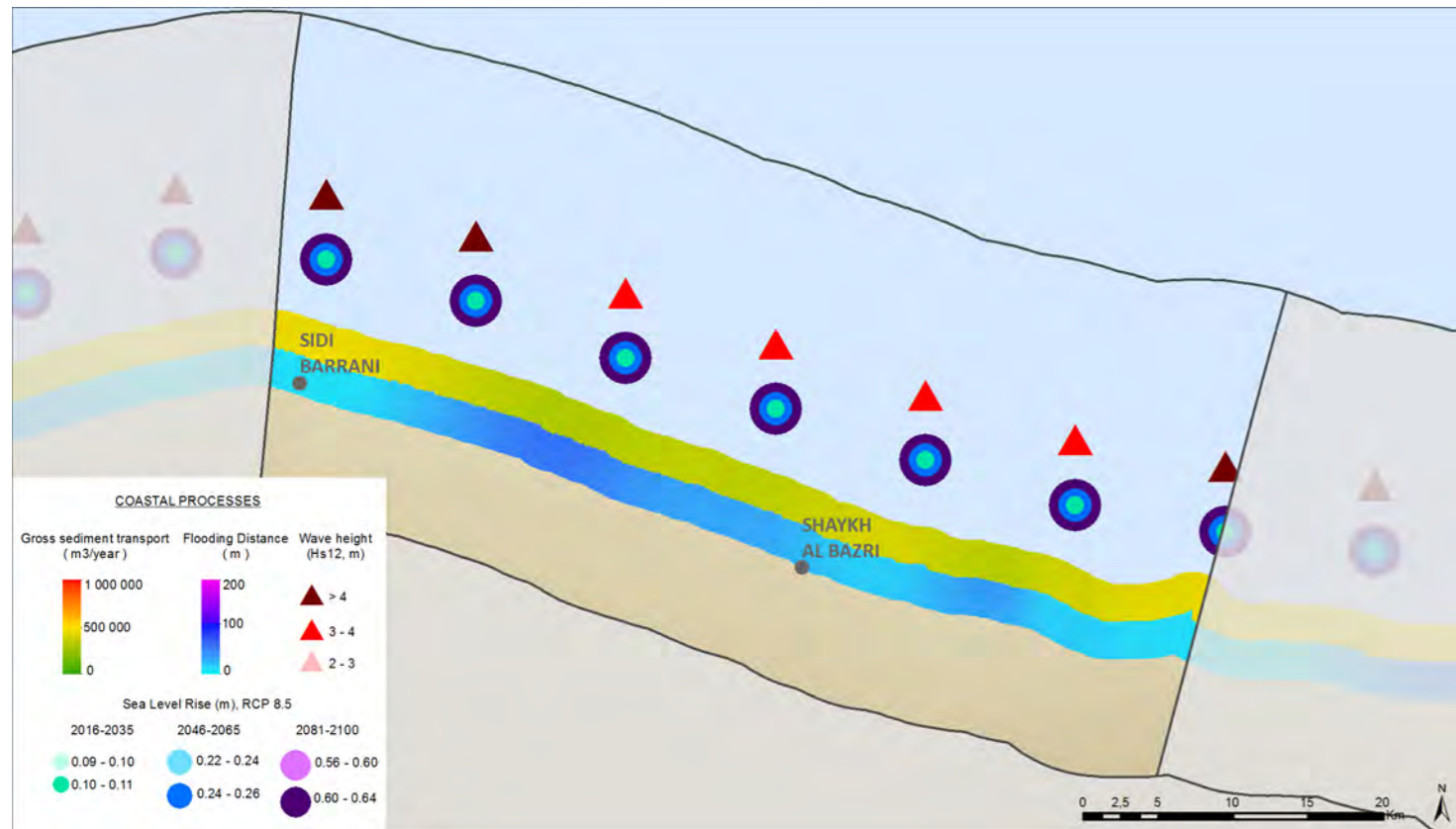
LONG TERM DEVELOPMENT PLANS

- Strategic Development Plan for Northern-Western Coast and Its Desert Hinterland 2032 (GOPP, 2011).
- Integrated Development of Egypt's Northwestern Coastal Zone (SPA, 2004).

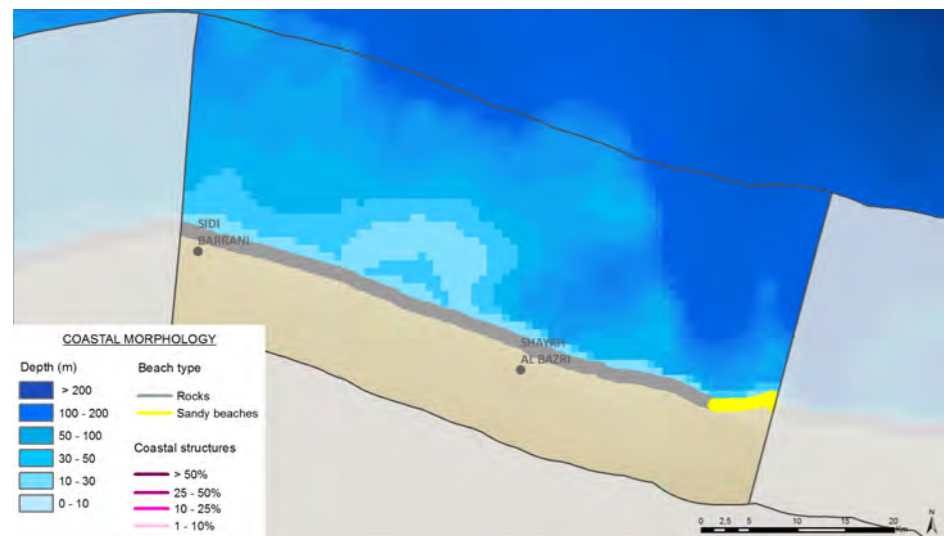


LOCAL STAKEHOLDERS

Name	Type	Website
Matruh Governorate	Authority	http://www.matrouh.gov.eg/
Shore Protection Authority - Matruh Administration	Authority	http://www.mwri.gov.eg/ShoreProtectionflowchart.aspx
EEAA West Delta Regional Branch Office in Alexandria	Authority	http://www.eeaa.gov.eg/
GAFRD Western Region	Authority	http://www.gafrd.org/
Reclamation Farms Surrounding Sidi Barrani	Private sector (agriculture)	



PHYSICAL SYSTEM



General description:

The coastal unit extends from the Sidi Barrani protrusion up to the sharp Maaten El Negela headland. The dominant coastline features are the calcareous rocky formations forming small cliffs along the major part of the unit. Many wadies are present along the entire coastline. Presence of a sabkha at Maaten El Negela.

Beaches:

Sandy beaches are almost inexistent in the W part (Sidi Barrani) where small patches are observed. On the E part, beaches are mainly rocky except at the E end which exhibits the long open beach of Maaten El Negela formed as the headland block the E directed net sediment transport.

Coastal structures:

The unit is preserved from coastal protection structures.

DIAGNOSIS OF PRESENT SITUATION

Erosion:

Low erosion in the major part of the unit: medium potential gross sediment transport, but the absence of beaches gives a low vulnerability. Medium erosion in the extreme E (Maaten El Negela) due to the presence of long sandy beaches and medium sediment transport.

Flooding:

Low flooding in the major part of the unit (low flooding distance due to the cliffs). Medium flooding in Maaten El Negela and the sabkha can be flooded.

Saltwater intrusion:

Low degree of saltwater intrusion within the entire unit.

Abiotic stress:

Modeling results show low abiotic stress all along the coastal unit, allowing the development of different species of seagrasses such as *Posidonia oceanica*.

DIAGNOSIS OF LONG TERM SITUATION

Erosion:

No significant changes are expected at near term with a dominant low erosion along the unit (except medium erosion at Maaten El Negela). Medium erosion expected at long term due to a medium shoreline retreat associated to sea level rise and a medium sediment transport in the area. However the erosion impact is expected to become small in the areas protected by cliffs.

Flooding:

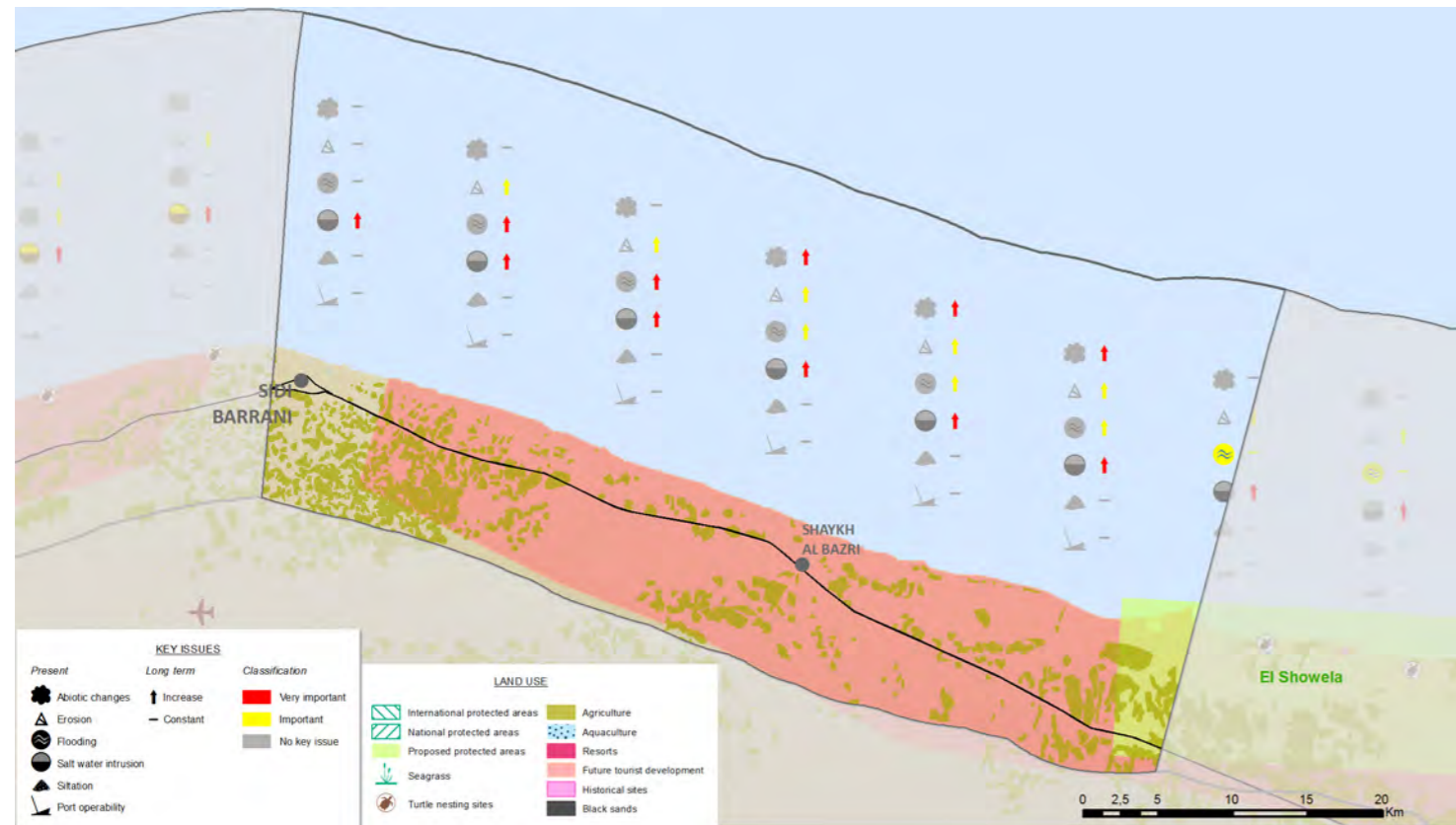
No significant changes are expected at near term (low flooding apart at Maaten El Negela). However, long term projections indicate a high to medium flooding in the lowest areas, including wadi outlets.

Saltwater intrusion:

Due to the effect of sea-level rise, the degree of saltwater intrusion will become medium in the coming decades and high in the long term.

Abiotic stress:

The increases in the mean value of the sea surface temperature found in future projections will lead to medium degree of abiotic stress in the near term and, in the long term, medium degree from Sidi Barrani to Sheikh and already high degree within the rest of the unit.



SWOT ANALYSIS

STRENGTHS

- Pristine area with valuable ecosystem services.
- Potential for fisheries and marine resources exploitation.
- Tourism attracting resources.
- Potential for agricultural activities.
- Richest herpetofauna in Egypt.

WEAKNESSES

- Lack of basic services and infrastructures (roads, port for fisheries).
- Mine fields stop the development of the area.
- Education is marginal and high rate of illiteracy.
- Weak economic activities for Bedouins.

OPPORTUNITIES

- Potential for eco-tourism.
- Implementation of the ICZM Plan for the coastal area between El Sallum and Marsa Matruh.

THREATS

- Salt water intrusion and lack of fresh water.
- Potential impacts to biodiversity and landscape due to tourism development
- Increased erosion and flooding in the long term.
- Loss of seagrasses meadows due to abiotic changes as increase of sea surface temperature.

KEY ISSUES FOR COASTAL MANAGEMENT

PRESENT KEY ISSUES

The main problems of Neguila are related to the social conditions. Therefore, present Key Issues are:

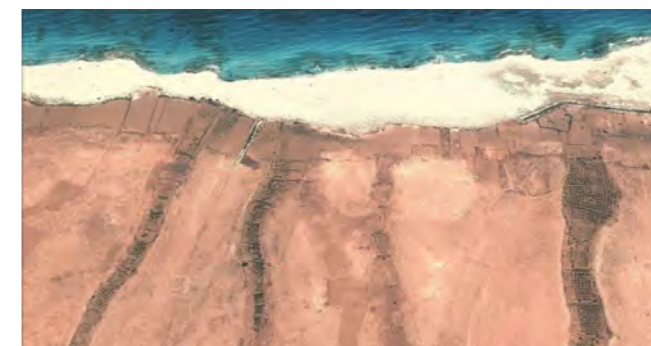
- Low services and infrastructures, especially for water supply and sanitation.
- Presence of mine fields.
- Stakeholders identified flash flood as major problem in the unit.
- Stakeholders concerns focus on unsustainable groundwater extraction and lack of environmental studies.
- Lack of setbacks along roads.

LONG TERM KEY ISSUES

This unit has a great potential for tourism development and the Tourism development Authority (TDA) owns large areas. Tourism infrastructures could be affected by increased erosion and flooding between Sidi Barrani and Maaten El Negela, if constructed on the coastal front.

The Key Issues for the long term are:

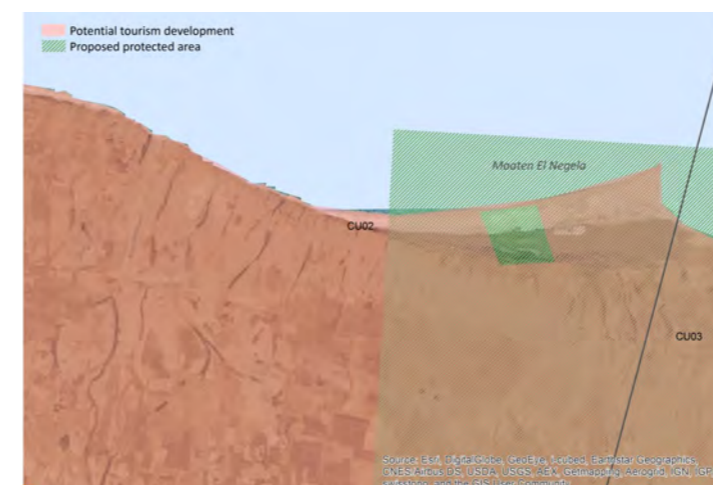
- Medium erosion level potentially interact with tourism facilities.
- High flooding level could affect tourism resorts near Sidi Barrani if built on the coastal front.
- Flooding could affect crops on wadis.
- Increased levels of salt water intrusion into the coastal aquifer.
- Loss of seagrasses meadows.



Agricultural practices on the wadis draining to the Mediterranean



Sheepherding

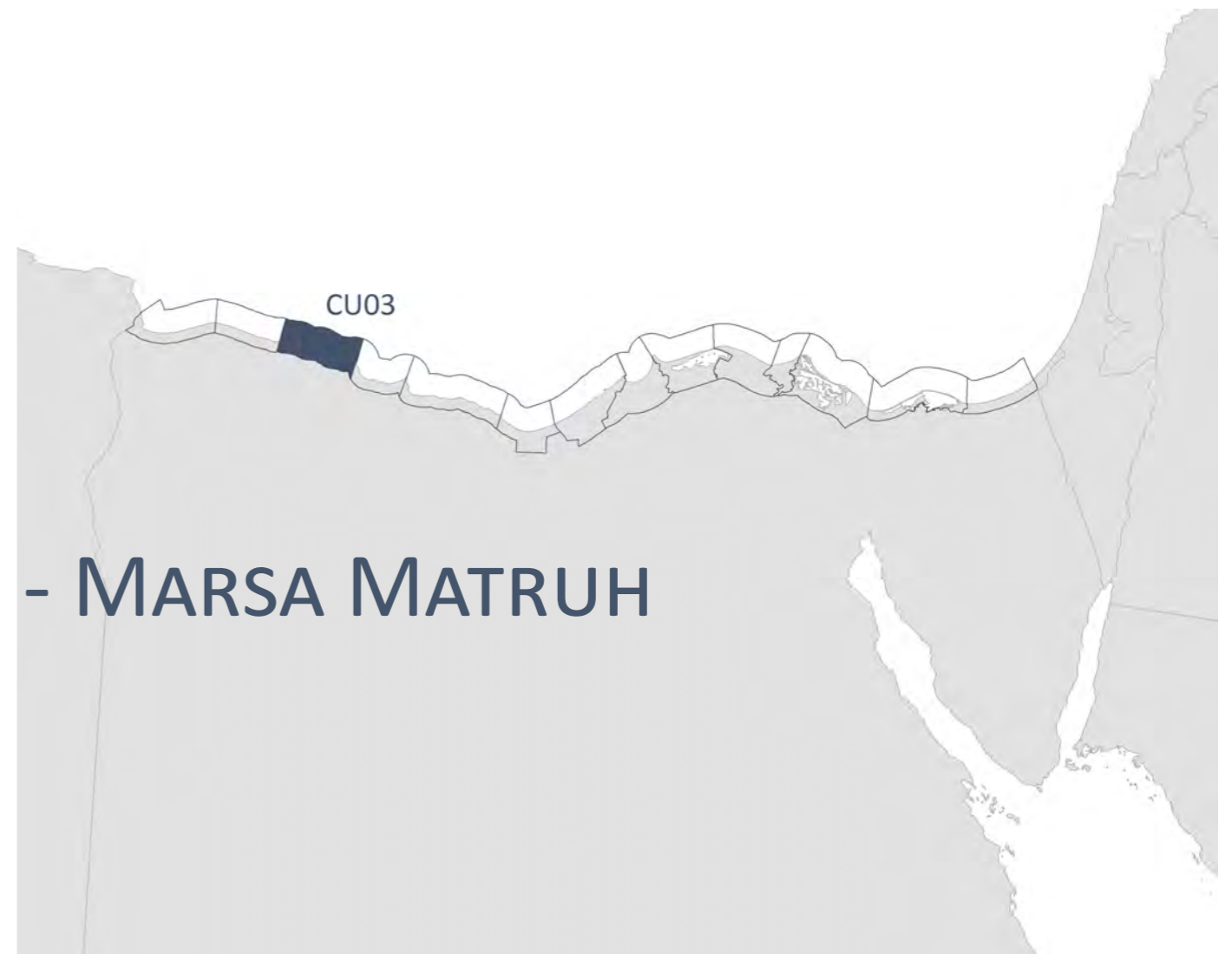


Overlap between TDA Lands and El Showela proposed protected area



The long beach attached to Maaten El Negela. A mobile fragile barred beach system (up: 2004, down: 2016)

COASTAL UNIT 03 - MARSA MATRUH



GENERAL DESCRIPTION OF THE COASTAL UNIT

CU 03 is in Matruh Governorate and it includes its capital: Marsa Matruh. This unit is characterized by natural areas on the west, and Marsa Matruh and resorts on the eastern area.

- Coastal Length: 108 Km.
- Governorate: Matruh.
- Markaz: Matruh.

ECOLOGICAL SYSTEM

The coastal belt comprises a coastal plain and a tableland. The sector belongs to the western province (from Sallum to Ras El Hekma) of the Western Mediterranean Coastal Desert where the coastal plain is narrow or missing and the limestone inland tableland reaches the shoreline. This plateau is traversed a number of drainage systems (wadis) that run northwards to the sea.

Habitats:

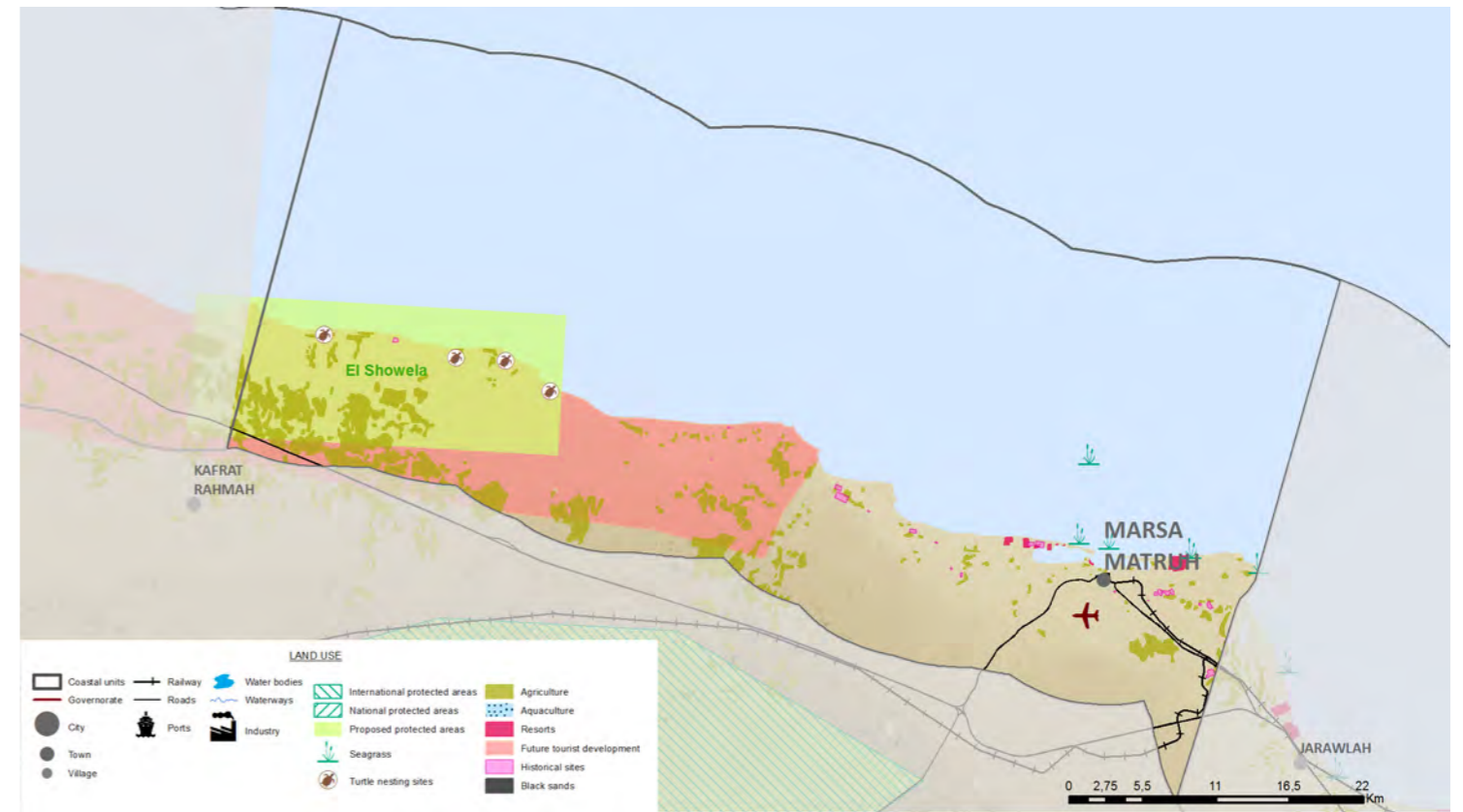
Five main groups are represented, lying on a north-south axes starting from the shoreline: coastal dunes, inland dunes, inland ridges, saline depression and non-saline depressions.

Flora:

Ammophila arenaria is found on active baby dunes at the shoreline, while the plant is associated with *Euphorbia paralias* and *Lotus polyphyllus* on partly stabilized sand dunes near the shoreline. Stabilized sand dunes support *Pancretium maritimum* and *Thymelaea hirsuta* while *Pituranthos turtuosus* and *Echiochilon fruticosum* are present on coastal limestone ridge. In inland dunes, plant life is dominated by *Urgina maritima* and *Thymelaea hirsuta*.

Fauna:

The Western Mediterranean Coastal Desert possesses one of the richest herpetofauna in Egypt. A total of 32 species of reptiles and two species of amphibians have been recorded from this area. At least 38 species of birds are known to breed in the Mediterranean Coastal Desert. Thirty-eight species of mammals have been recorded from this eco-region.



DIAGNOSIS OF PRESENT SITUATION

Current impacts and threats

The main impacts to the sector are related to the development of summer resorts leaving fragments of natural habitats:

- Urbanization and tourism development.
- Agriculture and grazing.
- Over-cutting and collection of medicinal plants.
- Hunting and commercial exploitation of wildlife.
- Impacts on marine biodiversity.

Coastal unit status

Biodiversity:

- Extension of natural habitats: Medium.
- Loss of natural habitats: Medium.
- Existence of protected areas: No.
- Extension of protected areas: NA.
- Existence of IBAs: No.
- Existence of Ramsar Sites: No.
- Number of endemic/threatened species: Medium.
- Number of protected species: Medium.

Natural resources:

- Inland fisheries stocks: NA.
- Species with potential use: High.

Natural water bodies:

- Pollution and contaminants: NA.

DIAGNOSIS OF LONG TERM SITUATION

Proposed protected areas: El Showela proposed protected area in the Eastern part of CU03, existing turtle nesting sites and suitability habitat for seagrasses as *Posidonia oceanica*.



The dune system of Ras Umm el Rakham offers delight landscape and habitat for coastal dune communities.



Vegetated beach, western part of CU03



Agiba beach

SOCIOECONOMIC SYSTEM

Matruh District that had a total urban population of 120,539 in 2006. The 90% of this population live in Marsa Matruh, the largest urban community in the coastal region of the Western Desert. Marsa Matruh assembles urban services and has an important role as tourist destination during summer months. The unit has been a leisure destination for Egyptians during the summer.

- Economic activities: 20.2% agriculture, grazing, and fishing, 16.4% whole sale and retail trade, and 13.8% in public administration and defence. Important touristic area.
- Cultural and heritage: Ramses II Temple, Cleopatra bath, Agiba site, Abou Lahw, Samla. Alam El Room, and Hosheema.
- Social groups and ethnicities: Bedouins from Awlad Ali and Jumiaat Tribes, sons of the valley, urban residents. In addition to workers in tourism and oil & gas companies.



Market in Marsa Matruh. Trade of agricultural products.

DIAGNOSIS OF PRESENT SITUATION

- Existence of educational facilities: 229 schools and sections, 1523 classrooms, and 1 teacher per 17.5 students in 2010 (in urban & rural areas) but high illiteracy rate: 29%.
- Lack of health care facilities: 2 public hospitals, 4 specialized hospitals, 2 private hospitals, 198 physicians, and 47 ambulances in 2010 (in urban & rural areas).
- Unemployment rate: 8% .
- About 25.1% of the total population of the District was classified as poor in 2013. Stakeholders do not consider this unit poor.
- Development is concentrated to the narrow coastal strip.
- Weak agricultural and grazing activities.
- Low production of fish due to absence of fishing ports and associated services.
- Low production of economic activities, according to stakeholder perception.
- The seaport of Eastern Marsa Matruh is a small dock that does not have equipment for shipping and unloading and is served by irregular shipping routes. Matruh airport is used in the summer.
- The city has an integrated sewerage system.
- Landmines are spread across the southern part of this stretch, which hampers proposed development.

DIAGNOSIS OF LONG TERM SITUATION

- Utilization of rain and flashflood waters for agricultural reclamation.
- Legalization of all that pertains to the reclaimed and agricultural lands.
- There are proposed tourism development areas.
- Construct the proposed seaport in the area of El Negila.
- Improve efficiency of the Matruh airport and transforming it to a permanent airport.
- Development of the transportation network, through the main axis connecting all coastal units (International Coastal Highway).
- Construct a solid waste recycling facility.
- Limited involvement of the local communities in decision making and taking processes.
- Weak coordination and cooperation among resources local authorities.
- Insufficient resources for development plans which lead to delay its implementation.

PLANS AND PROJECTS

EXISTING STUDIES

- ICZM Plan for the coastal area between Marsa Matruh and El Sallum (EEAA, 2011).
- Develop of the Kiliopatra lake, Marsa Matrouh, Egypt (CoRI, 2009).
- Shoreline Management Plan - Cell NW4 -2007 (SPA, 2007).
- The integrated planning of the Marsa Matruh city (TDA, 1997).
- Environmental Information and Monitoring Program (EIMP). Coastal water and air monitoring (EEAA, 1996).

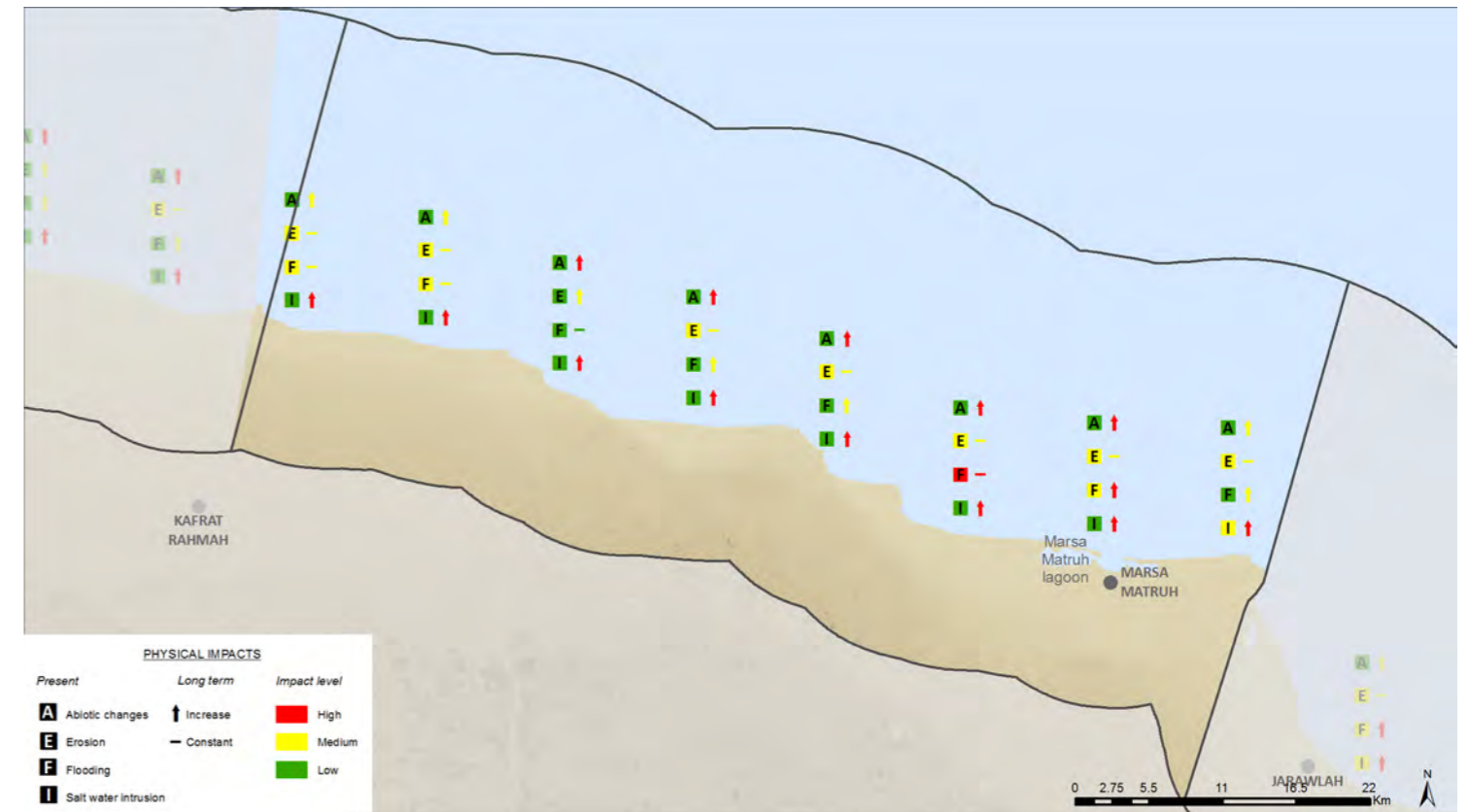
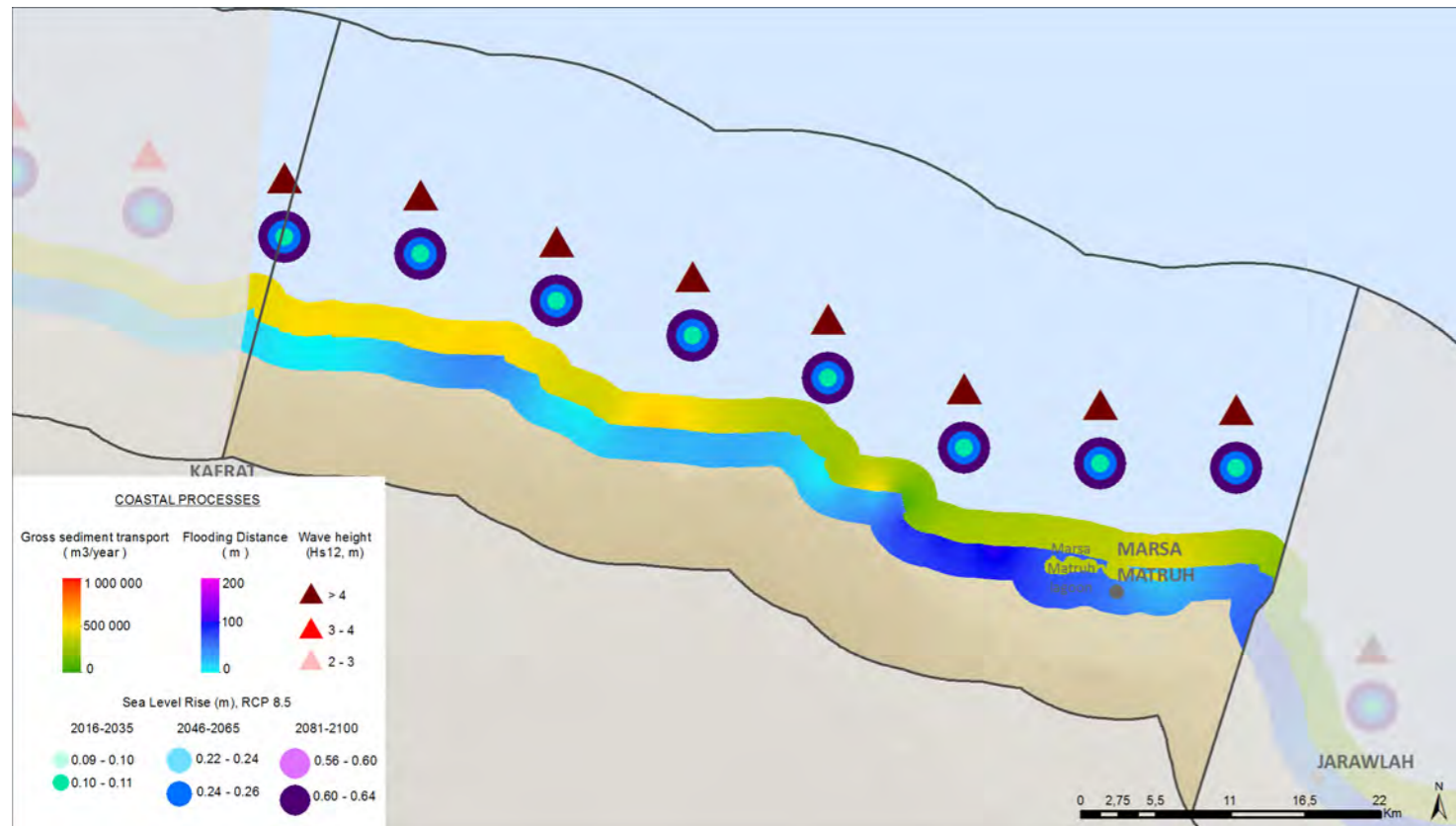
LONG TERM DEVELOPMENT PLANS

- Strategic Development Plan for Northern-Western Coast and Its Desert Hinterland 2032 (GOPP, 2011).
- Integrated Development of Egypt's Northwestern Coastal Zone (SPA, 2004).
- Stakeholders identified a plan to construct a new fishing port near Marsa Matruh.

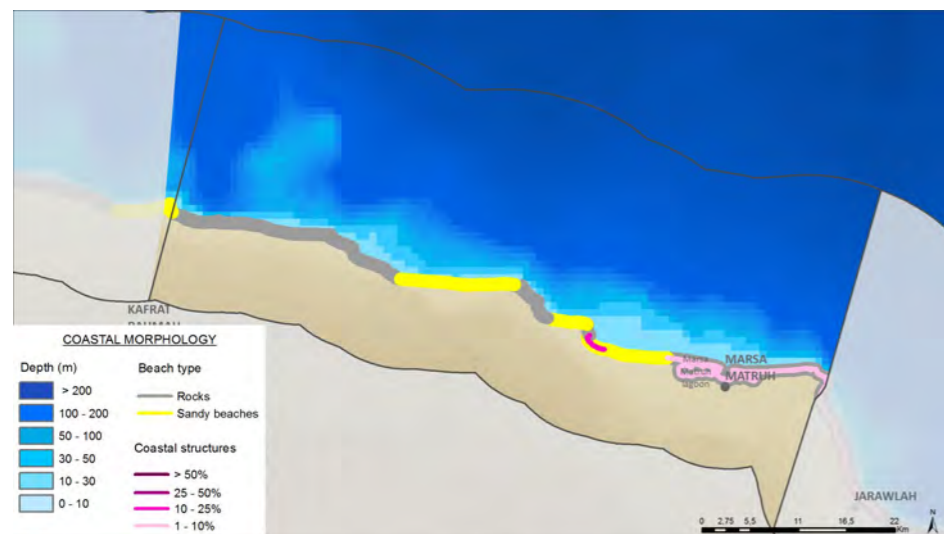
LOCAL STAKEHOLDERS

Name	Type	Website
Matruh Governorate	Authority	http://www.matrouh.gov.eg/
Shore Protection Authority - Matruh Administration	Authority	http://www.mwri.gov.eg/ShoreProtectionflowchart.aspx
EEAA West Delta Regional Branch Office in Alexandria	Authority	http://www.eeaa.gov.eg/
GAFRD Western Region	Authority	http://www.gafrd.org/

Name	Type	Website
NGO Marsa Matrouh	Civil Society Organization	
Industrial Zone Matruh (lack of GIS information)	Private sector (Industrial)	
Andalucia Resort	Private sector (Resorts)	
Porto Matruh Resort	Private sector (Resorts)	
Hotel Carols Beau Rivage Matrouh	Private sector (Resorts)	http://www.carolsbeaurivage.com/



PHYSICAL SYSTEM



General description:

The coastal unit extends from the sharp Maaten El Negela headland up to Marsa Matruh (Ras Alam El Rum headland). The W part is formed by rocky cliffs interrupted by numerous wadies. Several headlands retain sand forming sandy beaches westward. The E part is the Marsa Matruh coastal stretch starting from (1) Agiba beach and the sand dunes of Ras Umm El Rakhm (2) Obayet bay and (3) Marsa Matruh lagoon system bounded northward by a thin barrier (minimum width of 100 m) and draining to the sea in the center lagoon by a 1 km long inlet interrupted by rocky outcrops.

Beaches:

Sandy beaches are almost inexistent in the W and E boundaries. Some patches of sandy pocket beaches appear between high cliffs in wadi inlet (Agiba pocket beaches). Long sandy beaches are present westward of major headlands (Agiba long beach, Obayet bay beach). Along the Marsa Matruh lagoon barrier, beaches are mainly rocky.

Coastal structures:

Coastal protection structures are located in Obayet bay (Obayet beach resort groins and multiple sea groins eastward) and in Marsa Matruh inlet (main inlet and lagoon connections).

DIAGNOSIS OF PRESENT SITUATION

Erosion:

Medium erosion in the major part of the unit, except in the less vulnerable rocky zones. Relatively high sediment transport in the W part, but less vulnerable coastlines (cliff areas). E part is characterized by relatively high sediment transport in the Agiba (long) beach, and lower (medium) sediment transport in Obayet beaches, that are, however, more vulnerable (sandy beaches with some sea groins).

Flooding: Medium flooding at the W boundary (Maaten El Negela). High flooding at Marsa Matruh (W of the inlet) because of the low-lying vulnerable areas.

Saltwater intrusion:

The degree of saltwater intrusion along the coast within the unit is low.

Abiotic stress:

Low abiotic stress within the entire unit that lead to high presence of *Posidonia oceanica* meadows.

Port downtime:

High overtopping in Marsa Matruh Port, in which rates over 0.1 m³/s/m exceed 300 hours per year.

Siltation:

Medium siltation issues in Marsa Matruh inlets because of the medium gross longshore transport in the area. However the inlet is highly dynamical and dredging are required in the channels connecting the different lagoons.

DIAGNOSIS OF LONG TERM SITUATION

Erosion:

Erosion is expected to become medium all along the unit although it will increase due to shoreline retreat associated to sea level rise. Special attention has to be paid in the anthropization of the sand dunes of Ras Umm El Rakhm that could decrease the sediment input to SE beaches. Furthermore, the future Marsa Matruh fishing port can increase erosion issues in Marsa Matruh beaches.

Flooding:

Flooding is expected to remain unchanged in the W part, but is expected to become high, at long term, in the entire Marsa Matruh coastline due to sea level changes.

Saltwater intrusion: Saltwater intrusion is expected to be exacerbated by rising sea levels from low to medium degree in the near term and from medium to high degree in the long term.

Abiotic stress:

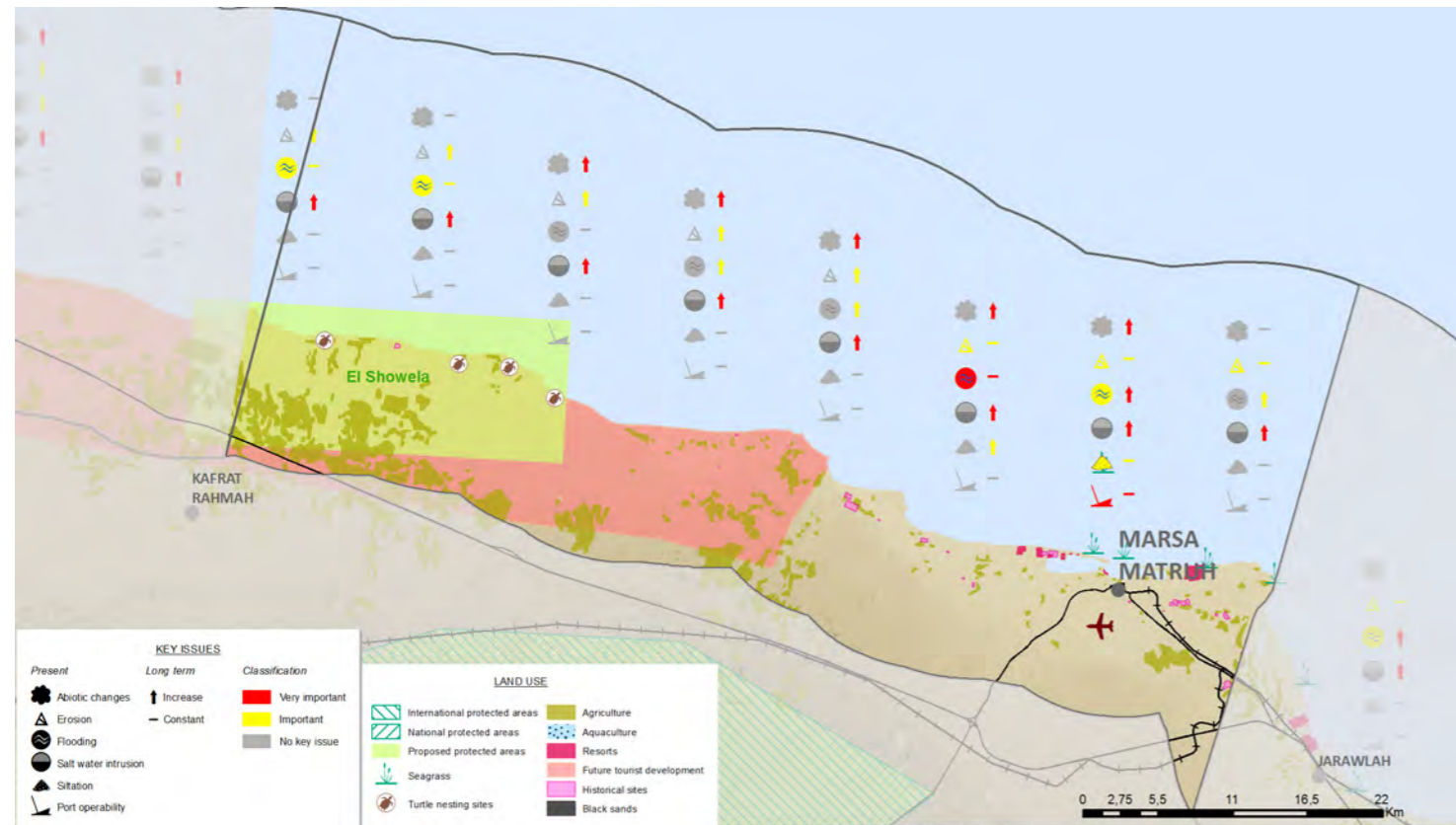
Changes in the mean value of the sea surface temperature will lead to medium degree of abiotic stress over the coming decades and, in the long term, medium degree near the W and E boundaries and high degree in the central part of the unit.

Port downtime:

Even higher overtopping mainly due to sea-level rise will lead to severe problems of downtown in the port of Marsa Matruh Port.

Siltation:

Siltation issues will remain medium in Marsa Matruh inlets, and are expected to be medium in the future Marsa Matruh fishing port because of the medium potential sediment transport in the area. The frequency of dredging actions will depend of the port design.



SWOT ANALYSIS

STRENGTHS

- Highly developed for recreational use.
- Existence of basic infrastructures as sewage system.
- Famous agricultural products, as olives.
- Famous touristic destination.
- Species with potential use.

WEAKNESSES

- Sediment transportation problems (erosion and sedimentation) in the lagoon.
- Pollution in beaches.
- Lack of fishing port.
- Weak economic activities for Bedouins.

OPPORTUNITIES

- Sustainable tourism development.
- Increased fishing activity.

THREATS

- Increased physical impacts due to climate change.
- Urban development on the coastal front.
- Conflicts between new tourism development and biodiversity values.
- Water availability from groundwater.

KEY ISSUES FOR COASTAL MANAGEMENT

PRESENT KEY ISSUES

The present Key Issues of CU03 are:

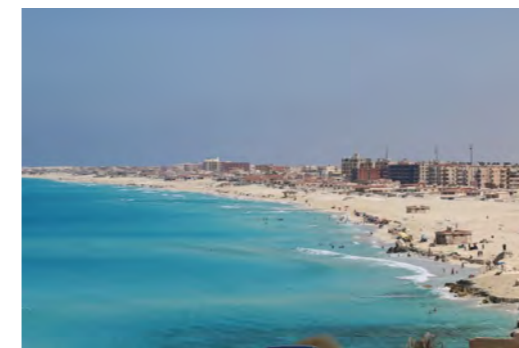
- Medium erosion level in i) Ras Umm el Rackham dune area, affecting existing resorts, as Carols Beau Rivage Matrouh resort, ii) Marsa Matruh (large urban centre).
- High flooding level can affect resorts in Ras Umm el Rackham.
- Flooding can inundate isolated crops on the coastal front.
- Siltation problems in the Matruh lagoon mouth.
- Medium port downtime.
- Additionally, the Marsa Matruh – El Sallum ICZM Plan identified roads crossing coastal dunes.
- Stakeholders identified flash flood as major problem in the unit.
- Stakeholders concerns focus on unsustainable groundwater extraction and lack of environmental studies.
- Lack of setbacks along roads.

LONG TERM KEY ISSUES

A variety of future initiatives take place in Marsa Matruh Coastal Unit: proposed protected area in the east, tourism developments in the pristine coastal zone and a new fishing port; that could be limited by climate change effects.

The upcoming issues are:

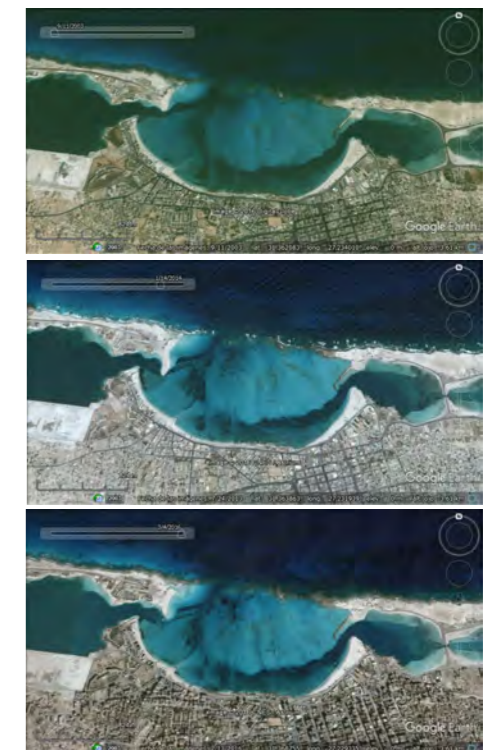
- Erosion level increases to medium along the whole Coastal Unit, which could affect the new touristic areas.
- High flooding levels could interact with new urban developments around Marsa Matruh and could provoke inundation in coastal front resorts in Ras Umm el Rackham and Marsa Matruh (large urban centre).
- Siltation problems remain similar to present situation.
- Increased salt-water intrusion.
- Tourism development on the western coast could affect biodiversity conservation (i.e: turtle nesting sites).
- Loss of *Posidonia oceanica* in El Showela proposed protected area.



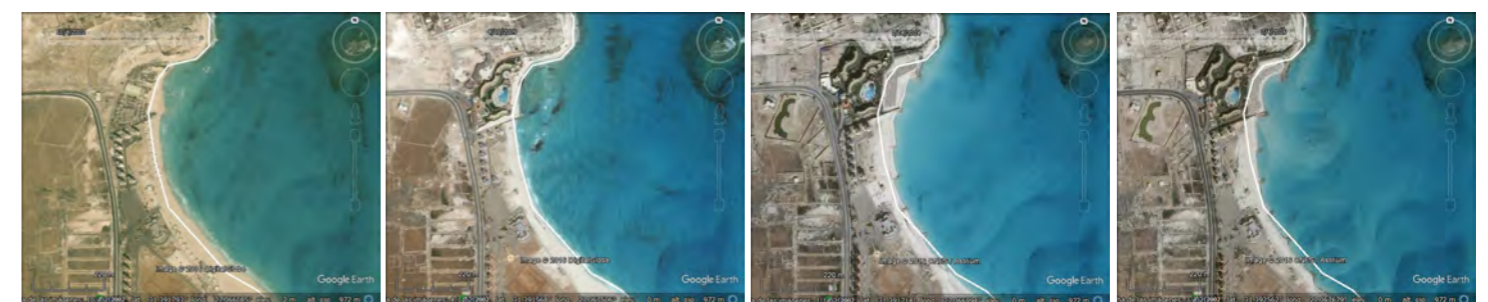
Tourist development in Agiba (long beach)



Potential conflicts between biodiversity and tourism developments



Sedimentation in Marsa Matruh inlet (West) and coastal protection structures (East). From top to bottom: 2003, 2014, 2016.



Erosion issues at Obayet beach due to the Resort groin extension and the sea groins. From left to right, 2003, 2009, 2014, 2016. The white line shows the 2009 coastline.

COASTAL UNIT 04 - ALMAZA



GENERAL DESCRIPTION OF THE COASTAL UNIT

Almaza Coastal Unit is in Matruh Governorate , east to Marsa Matruh. The most significant feature of this rural coastal unit is the presence of resorts at the bays sheltered by headlands.

- Coastal Length: 73 Km.
- Governorate: Matruh.
- Markaz: Matruh.

ECOLOGICAL SYSTEM

This sector includes natural areas intersected by summer resorts. The coastal belt comprises a coastal plain and a tableland. The sector belongs to the western province (from Sallum to Ras El Hekma) of the Western Mediterranean Coastal Desert where the coastal plain is narrow or missing and the limestone inland tableland reaches the shoreline. This plateau is traversed a number of drainage systems (wadis) that run northwards to the sea.

Habitats:

Five main groups are represented, lying on a north-south axes starting from the shoreline: coastal dunes, inland dunes, inland ridges, saline depression and non-saline depressions.

Flora:

Ammophila arenaria is found on active baby dunes at the shoreline, while the plant is associated with *Euphorbia paralias* and *Lotus polyphyllus* on partly stabilized sand dunes near the shoreline. Stabilized sand dunes support *Pancreatium maritimum* and *Thymelaea hirsuta* while *Pituranthos turtuosus* and *Echiochilon fruticosum* are present on coastal limestone ridge. In inland dunes, plant life is dominated by *Urgina maritima* and *Thymelaea hirsuta*.

Fauna:

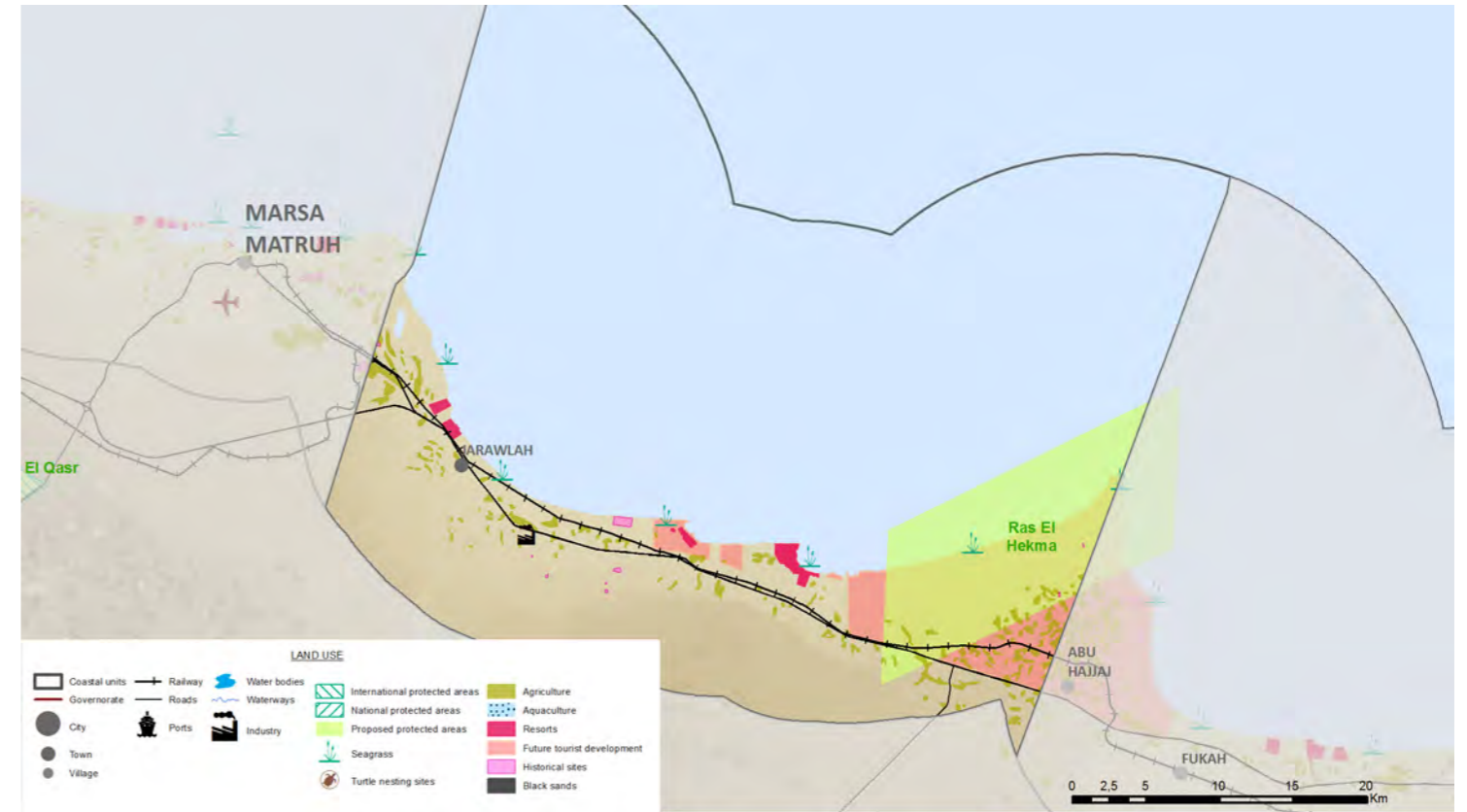
The Western Mediterranean Coastal Desert possesses one of the richest herpetofauna in Egypt. A total of 32 species of reptiles and two species of amphibians have been recorded from this area. At least 38 species of birds are known to breed in the Mediterranean Coastal Desert. Thirty-eight species of mammals have been recorded from this eco-region.



The beach at Bagoush



Houbara Bustard



DIAGNOSIS OF PRESENT SITUATION

Current impacts and threats

The main impacts to the sector are related to the development of summer resorts leaving fragments of natural habitats. Main impacts include:

- Urbanization and tourism development
- Agriculture and grazing
- Over-cutting and collection of medicinal plants
- Hunting and commercial exploitation of wildlife
- Impacts on marine biodiversity

Coastal unit status

Biodiversity:

- Extension of natural habitats: Medium
- Loss of natural habitats: Medium
- Existence of protected areas: No
- Extension of protected areas: NA
- Existence of IBAs: No
- Existence of Ramsar Sites: No
- Number of endemic/threatened species: Medium
- Number of protected species: Medium

Natural resources:

- Inland fisheries stocks: NA
- Species with potential use: High

Natural water bodies:

- Pollution and contaminants: NA

DIAGNOSIS OF LONG TERM SITUATION

Proposed protected areas:

Ras El Hekma proposed protected area

SOCIOECONOMIC SYSTEM

The total rural population was 38,776 in 2006, and there are neither towns nor cities.

- Economic activities: 20.2% agriculture (wheat, barley, fig, olives), grazing, and fishing, 16.4% whole sale and retail trade, and 13.8% public administration and defense
- Cultural and heritage: Ras El Hekma archeological hill.
- Social groups and ethnicities: Bedouins from Awlad Ali and Jumiaat Tribes, sons of the valley and rural residents.

DIAGNOSIS OF PRESENT SITUATION

- Lack of educational facilities: 229 schools and sections, 1523 classrooms, and 1 teacher per 17.5 students in 2010 (in urban & rural areas); and high illiteracy rates: 29%.
- Lack of health care facilities: 2 public hospitals, 4 specialized hospitals, 2 private hospitals, 198 physicians, and 47 ambulances in 2010 (in urban & rural areas).
- Unemployment rate: 8% .
- About 25.1% of the total population of the Matruh District was classified as poor in 2013.
- Low production of fish due to absence of fishing ports and associated services.
- Large mine fields still exist in the southern part of this stretch.

DIAGNOSIS OF LONG TERM SITUATION

- Utilization of rain and flashflood waters for agricultural reclamation.
- Legalization of all that pertains to the reclaimed and agricultural lands.
- Establish a cooperative for fattening sheep.
- There are proposed tourism development areas.
- There is no urban center (city) present or proposed serving this Coastal Unit.
- Development of the transportation network, through the main axis connecting all coastal units (International Coastal Highway).
- Construct a wind power plant.
- Limited involvement of the local communities in decision making and taking processes.
- Weak coordination and cooperation among resources local authorities.
- Insufficient resources for development plans which lead to delay its implementation.



Fig tree in CU 04

PLANS AND PROJECTS

EXISTING STUDIES

- ICZM Plan for the coastal area between Marsa Matruh and El Sallum (EEAA, 2011).
- Shoreline Management Plan - Cell NW3 (SPA, 2007) .
- MAP CAMP Project "Fuka—Matrouh", Egypt, Final Integrated report and selected documents (UNEP/MAP, 2001).

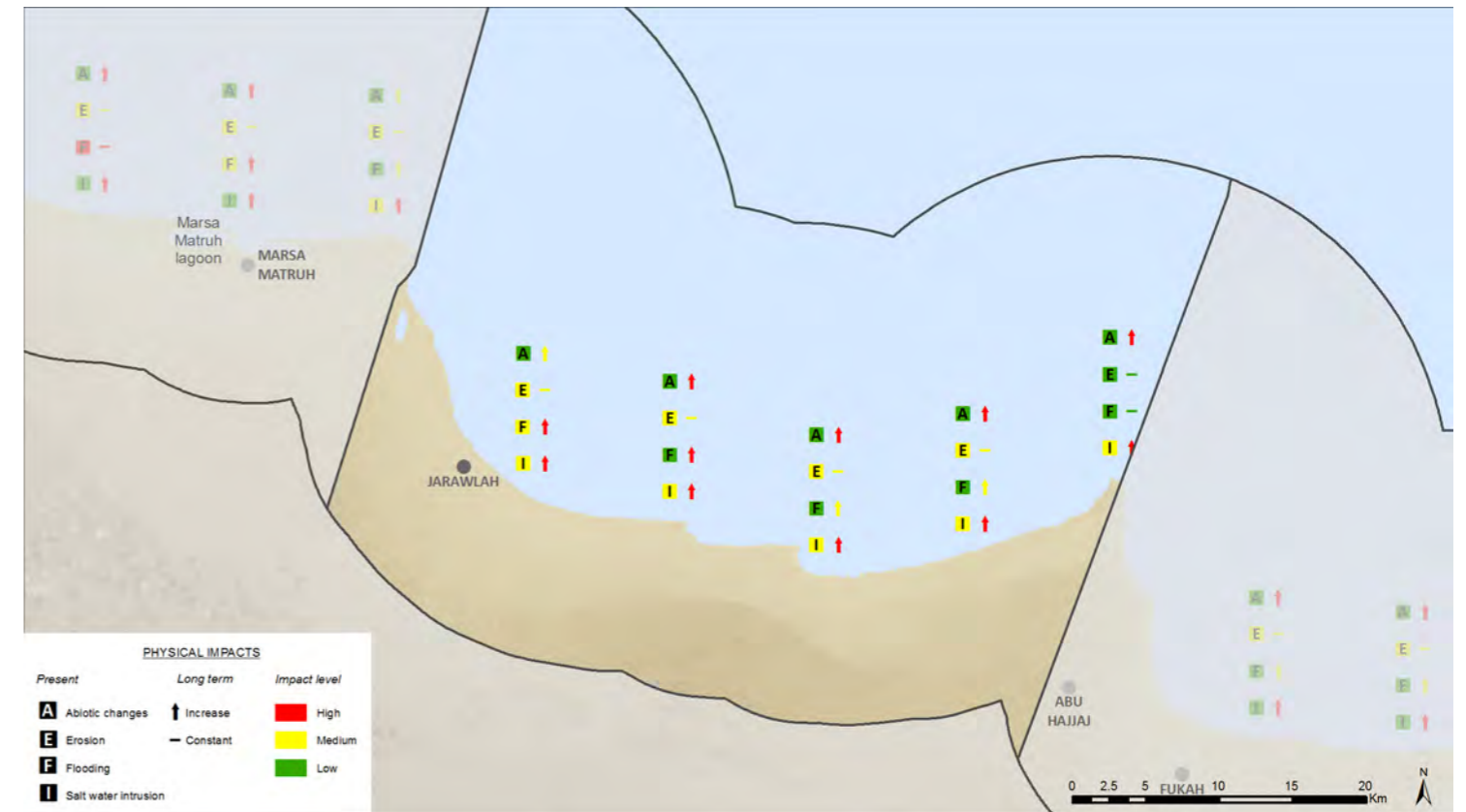
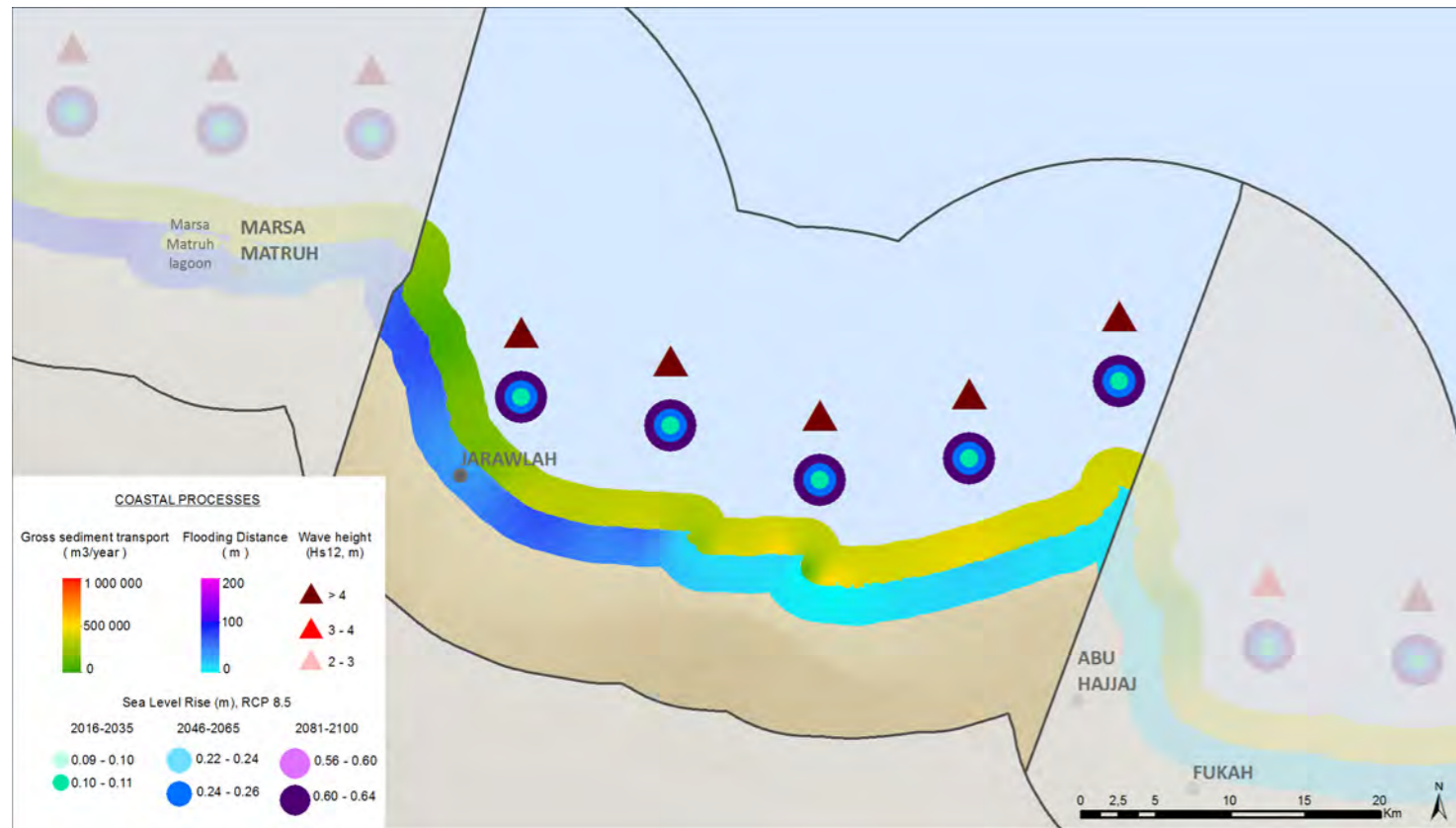
LONG TERM DEVELOPMENT PLANS

- Strategic Development Plan for Northern-Western Coast and Its Desert Hinterland 2032 (GOPP, 2011)
- Integrated Development of Egypt's Northwestern Coastal Zone (SPA, 2004)
- Stakeholders identified a planned fishing port in this unit.

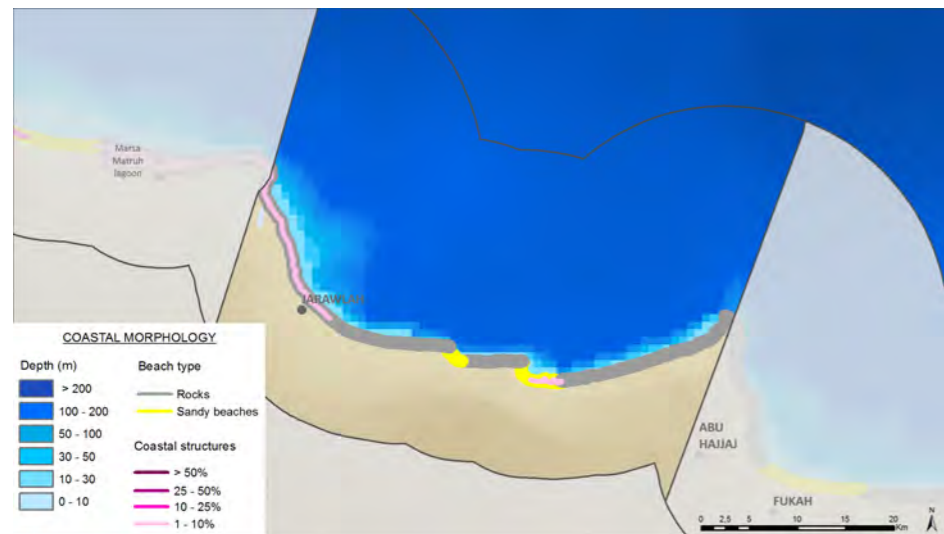
LOCAL STAKEHOLDERS

Name	Type	Website
Matruh Governorate	Authority	http://www.matrouh.gov.eg/
Shore Protection Authority - Matruh Administration	Authority	http://www.mwri.gov.eg/ShoreProtectionflowchart.aspx
EEAA West Delta Regional Branch Office in Alexandria	Authority	http://www.eeaa.gov.eg/
GAFRD Western Region	Authority	http://www.gafrd.org/

Name	Type	Website
Al Fouka Industrial Zone	Private sector (Industrial)	
Jaz Almaza resort	Private sector (Resorts)	
Al Abd Resort	Private sector (Resorts)	



PHYSICAL SYSTEM



General description:

The coastal unit extends from Marsa Matruh (Ras Alam El Rum headland) to Ras El Kanayis headland. The coast is characterized by calcareous rocky formations with several headlands forming a bay eastward: Garawlah, Almaza bay and Sidi Haneish bay from W to E. The E boundary shows vertical cliffs.

Beaches:

Sandy beaches are almost inexistent in the W and E boundaries. Sparse sandy beaches are located in Garawlah (mostly rocky) and wider and longer sandy beaches are seen in Almaza bay and in Sidi Haneish bay (Bagoush beach, Disney beach).

Coastal structures:

Sparse sea groins in Bagoush beach (outfall protection). Sandy tombolos have been artificially created at Disney beach (W of Sidi Haneish bay) connecting the coastline to natural rocks acting as natural breakwater.

DIAGNOSIS OF PRESENT SITUATION

Erosion:

Medium erosion in the major part of the unit, except in the less vulnerable rocky zones (low erosion in the E part, Ras El Kanayis headland). The coastal stretches located eastward of the different headland are protected (smaller sediment transport) but the closest beach shows sand deficit due to the lack of sediment input (Sidi Haneish beach). Furthermore the sea groins can cause sand deficit eastward (Garawlah). The nourishment at Disney beach (nourished tombolo) is not stable because of the long-shore sediment transport.

Flooding:

Low flooding in the major part of the unit because of the relatively low flooding levels associated with the low vulnerable coastline. Medium flooding in the lowest lands at Garawlah.

Saltwater intrusion:

The degree of current saltwater intrusion within this unit is low.

Abiotic stress:

Low degree of abiotic stress within the entire unit, fostering the development of seagrasses.

DIAGNOSIS OF LONG TERM SITUATION

Erosion:

Erosion issues are expected to become unchanged even in the worst long term scenario. Medium erosion in the entire coastline except at Ras El Kanayis headland.

Flooding:

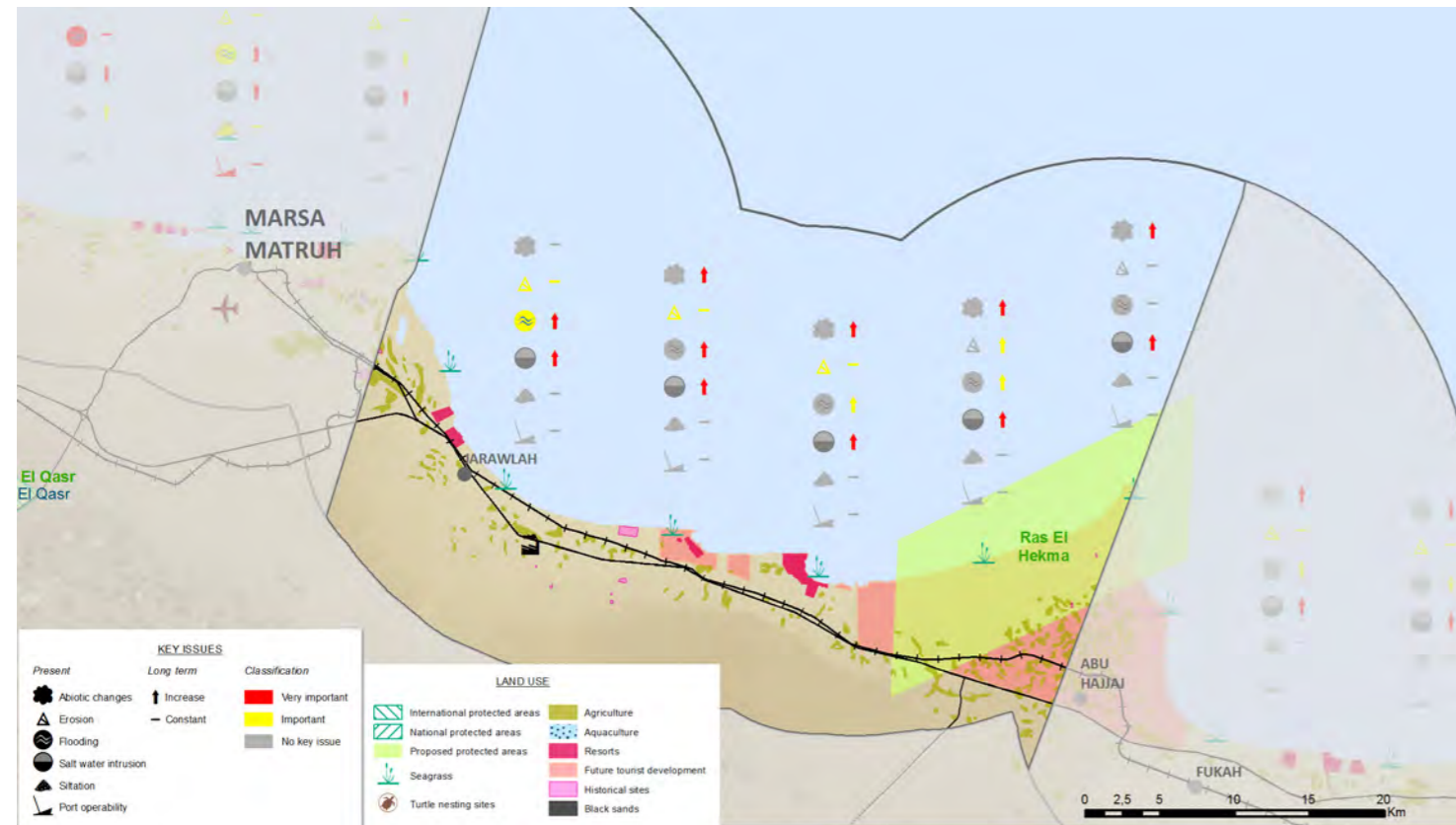
Small changes in the flooding at near term, but it will become high at Garawlah at long term. No changes expected at Almaza bay and Sidi Haneish bay except in the worst long term scenario (medium flooding expected)

Saltwater intrusion:

Sea-level rise will bring higher saltwater intrusion within the whole unit. The degree of impact will be medium in the near term and high in the long term.

Abiotic stress:

The future physical conditions given within this unit will change the current low degree of abiotic stress into medium in the near term and into high degree in the long term, with the exception of the nearest area to Marsa Matruh that will remain with medium degree of impact.



SWOT ANALYSIS

STRENGTHS

- Remaining natural areas.
- Species with potential use.
- High rate of precipitation.

WEAKNESSES

- No protected areas.
- Lack of services and infrastructures.

OPPORTUNITIES

- Sustainable tourism development
- Rainfall harvesting projects, valuable for agriculture and urban development

THREATS

- Loss of biodiversity and natural coastal areas.
- Water availability from groundwater.
- Stakeholders note the need to assess environmental impacts of tourism development on fisheries and natural environment.

KEY ISSUES FOR COASTAL MANAGEMENT

PRESENT KEY ISSUES

Erosion is medium in the most part of the unit, and flooding is medium only in the lowest lands of Garawlah. Then, Key Issues of CU 04 are the following:

- Medium erosion level in the resorts area along the CU.
- Medium flooding level at Garawlah area.
- Stakeholders identified flash flood as major problem in the unit.
- Stakeholders concerns focus on unsustainable groundwater extraction and lack of environmental studies.
- Stakeholders shoed their concern about unplanned developments.

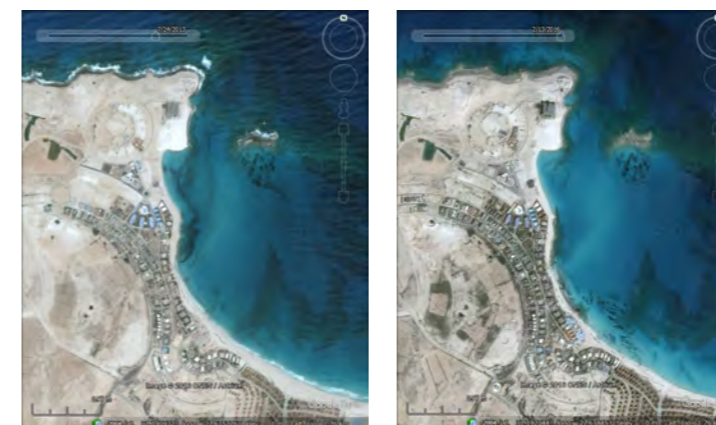
LONG TERM KEY ISSUES

The eastern part of the Coastal Unit, including Ras El Kanayis headland is subject to tourism development that could be affected by medium erosion processes. Long term Key Issues are:

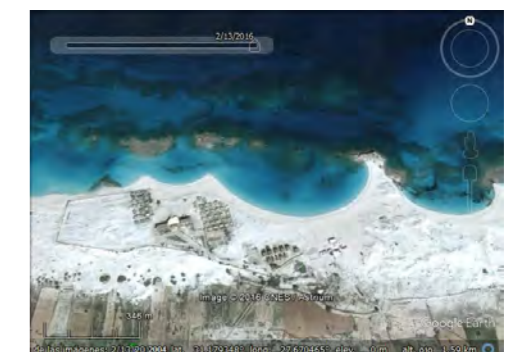
- Medium erosion level on the eastern part of the unit, where planned tourism development.
- Increased flooding at Garawlah area that could affect resort facilities.
- Increased saltwater intrusion.
- Potential conflict between new resorts and Ras El Hekma protected area.
- Loss of posidonia meadows.



Potential conflict between biodiversity conservation and tourism developments



Erosion at Sidi Haneish bay reducing the natural protection of the tourist village against erosion and flooding. From left to right: 2012, 2016.



Disney beach: the tombolo built from nourishment did not held, clear erosion issues. From up to bottom: 2004, 2012, 2016

COASTAL UNIT 05 - EL DABAA



GENERAL DESCRIPTION OF THE COASTAL UNIT

This unit is located in Matruh Governorate. The main urban area is El Dabaa. This Coastal Unit includes extended natural areas intersected by some summer resorts as Marassi.

- Coastal Length: 123 Km.
- Governorate: Matruh.
- Markaz: Matruh, El Dabaa, El Alamein.

ECOLOGICAL SYSTEM

The coastal belt comprises a coastal plain and a tableland. The sector belongs to the eastern province (from Ras El Hekma to Alexandria) of the Western Mediterranean Coastal Desert where the coastal plain is wide and characterized by a series of long ridges (bars) alternating with long depression all running parallel to the coast. In certain parts, nine limestone ridges may be noted; they represent a Pleistocene sequence of shoreline bars.

Habitats:

Five main groups are represented, lying on a north-south axes starting from the shoreline: coastal dunes, inland dunes, inland ridges, saline depression and non-saline depressions.

Flora:

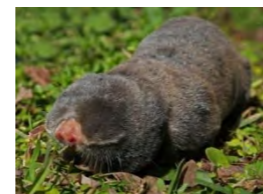
Ammophila arenaria is found on active baby dunes at the shoreline, while the plant is associated with *Euphorbia paralias* and *Lotus polyphyllus* on partly stabilized sand dunes near the shoreline. Stabilized sand dunes support *Pancratium maritimum* and *Thymelaea hirsuta* while *Pituranthos turtuosus* and *Echiochilon fruticosum* are present on coastal limestone ridge. In inland dunes, plant life is dominated by *Urgina maritima* and *Thymelaea hirsuta*. Areas of siliceous deposits are cultivated with barley and orchards. The rain-fed barley fields flourish after the rainy season.

Fauna:

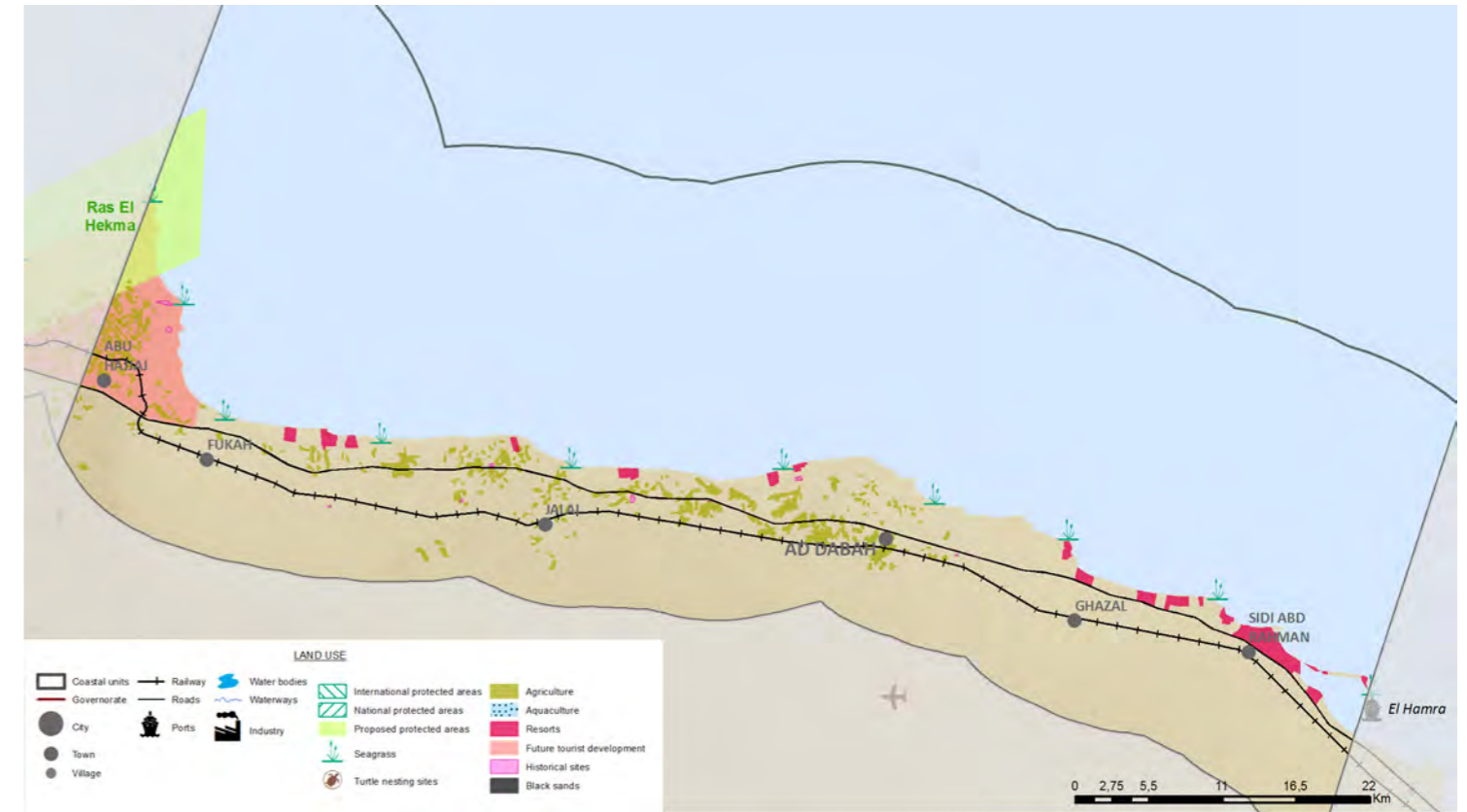
The Western Mediterranean Coastal Desert possesses one of the richest herpetofauna in Egypt. A total of 32 species of reptiles and two species of amphibians have been recorded from this area. At least 38 species of birds are known to breed in the Mediterranean Coastal Desert. Thirty-eight species of mammals have been recorded from this eco-region.



Greater Egyptian Jerboa



Lesser Morelat



DIAGNOSIS OF PRESENT SITUATION

Current impacts and threats

The main impacts to the sector are related to the development of summer resorts leaving fragments of natural habitats. Construction of a nuclear plant is planned in the area of El Dabaa representing a major threat to this sector. Main impacts include:

- Urbanization and tourism development
- Agriculture and grazing
- Over-cutting and collection of medicinal plants
- Hunting and commercial exploitation of wildlife
- Impacts on marine biodiversity

Coastal unit status

Biodiversity:

- Extension of natural habitats: High
- Loss of natural habitats: Medium
- Existence of protected areas: No
- Extension of protected areas: NA
- Existence of IBAs: No
- Existence of Ramsar Sites: No
- Number of endemic/threatened species: Medium
- Number of protected species: Medium

Natural resources:

- Inland fisheries stocks: NA
- Species with potential use: High

Natural water bodies:

- Pollution and contaminants: NA

DIAGNOSIS OF LONG TERM SITUATION

Proposed protected areas:

Ras El Hekma proposed protected area in the western part of CU05.

SOCIOECONOMIC SYSTEM

The largest markaz in this unit is El Dabaa, that had 39,178 inhabitants in 2006, of which about 42.3% lived in urban areas and about 57.7% in rural areas.

- Economic activities: 37.7% agriculture (wheat, barley, fig, olives), grazing, and fishing, and 24.1% whole sale and retail trade
- Cultural and heritage: no cultural or heritage sites
- Social groups and ethnicities: Bedouins from awlad Ali and Jumiaat Tribes, sons of the valley, urban residents, as well as workers in tourism.

DIAGNOSIS OF PRESENT SITUATION

- Moderate educational facilities: 99 schools and sections, 491 classrooms, and 1 teacher per 4.4 students in 2010; but illiteracy rate: 43%.
- Lack of health care facilities: 1 public hospital, 23 physicians, and 15 ambulances in 2010.
- Unemployment rate: 5%.
- About 37.5% of the total population of the District was classified as poor in 2013.
- Weak agricultural and grazing activities
- Low production of fish due to absence of fishing ports and associated services
- Lack of tourism development
- El Dabaa is served by the water treatment plant of New Al Amiriyah in Alexandria, outside of Coastal Unit.

DIAGNOSIS OF LONG TERM SITUATION

- A factory producing medical and herbal extracts from plants.
- Utilization of rain and flashflood waters for agricultural reclamation.
- Legalization of all that pertains to the reclaimed and agricultural lands.
- Livestock projects, mainly sheep herding.
- There are proposed tourism development areas.
- Establishing an industrial zone over 50 km² in South El Dabaa.
- A project of establishing an industrial free zone.
- Projects depending on petrochemical and mineral resources industries.
- Nuclear power plant in El Dabaa.
- Development of the transportation network, through the main axis connecting all coastal units (International Coastal Highway).
- Development is concentrated to the narrow coastal strip.
- Limited involvement of the local communities in decision making and taking processes.
- Weak coordination and cooperation among resources local authorities.
- Insufficient resources for development plans which lead to delay its implementation.

PLANS AND PROJECTS

EXISTING STUDIES

- ICZM Plan for the coastal area between Marsa Matruh and El Sallum (EEAA, 2011).
- Shoreline Management Plan - Cell NW3 (SPA, 2007).
- Environmental analysis of the area of Fuka in Ras El Hekma—North Coast (TDA, 1996).
- MAP CAMP Project “Fuka—Matrouh”, Egypt, Final Integrated report and selected documents (UNEP/MAP, 2001).

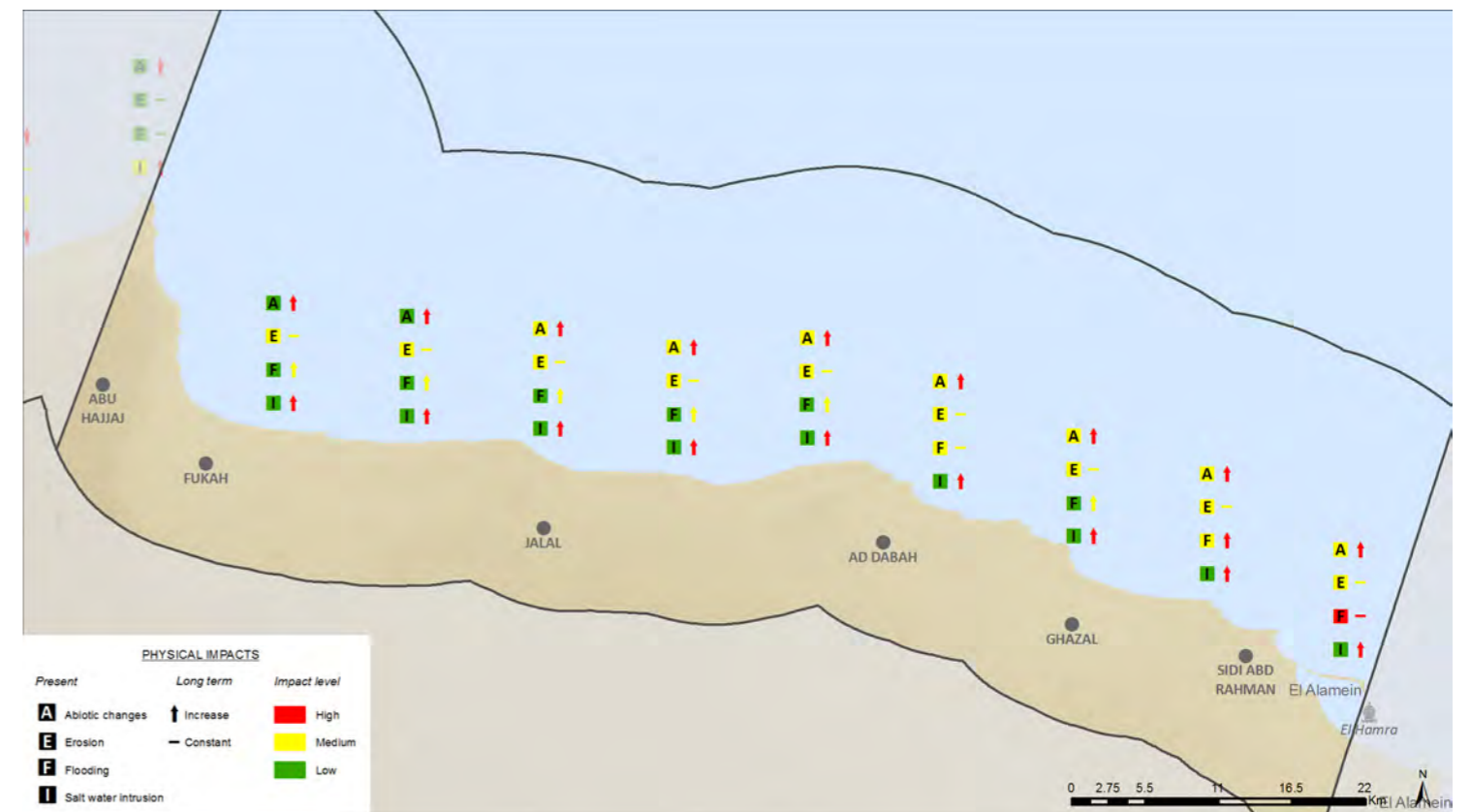
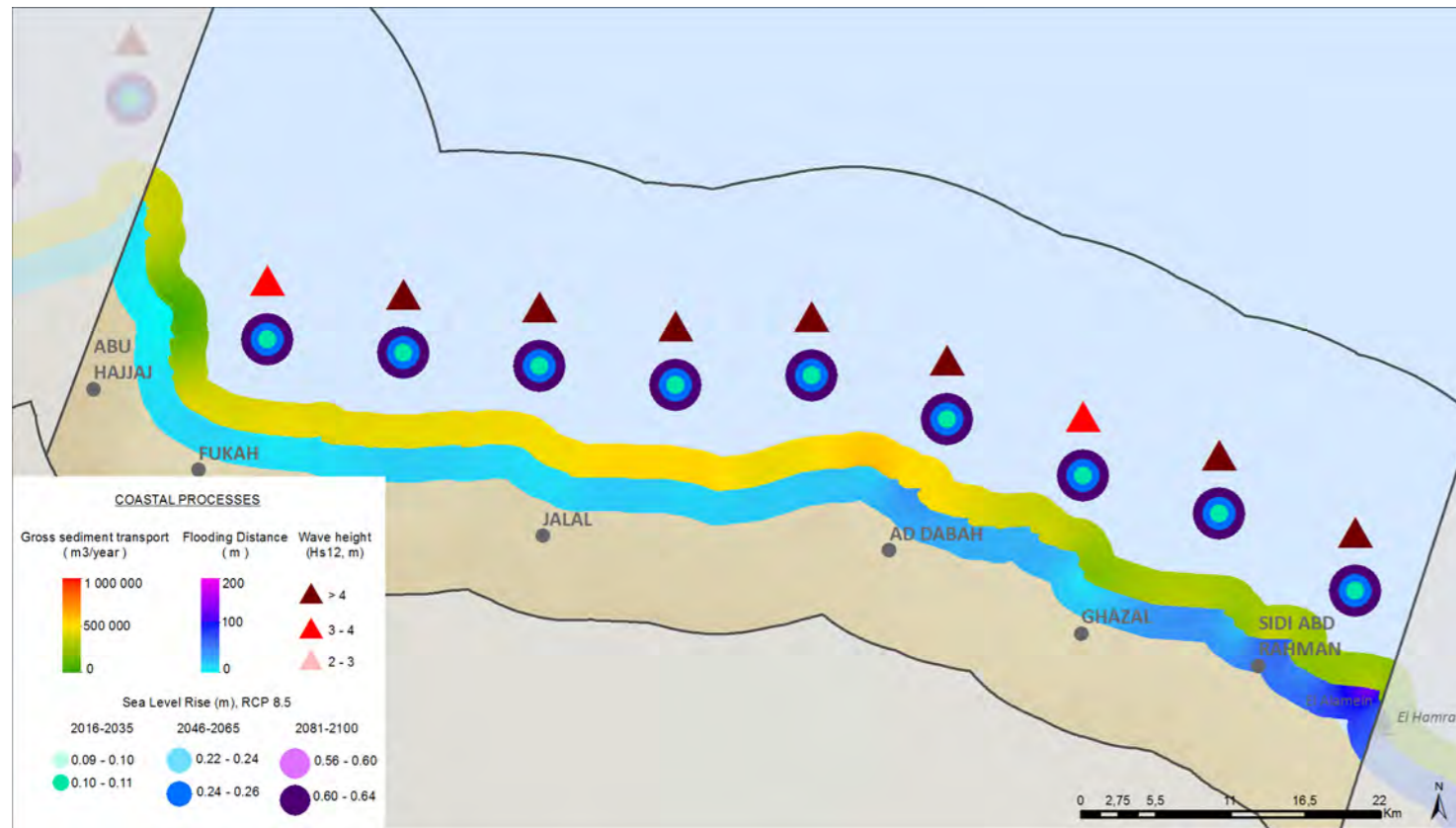
LONG TERM DEVELOPMENT STUDIES

- Strategic Development Plan for Northern-Western Coast and Its Desert Hinterland 2032 (GOPP, 2011).
- Integrated Development of Egypt's Northwestern Coastal Zone (SPA, 2004).

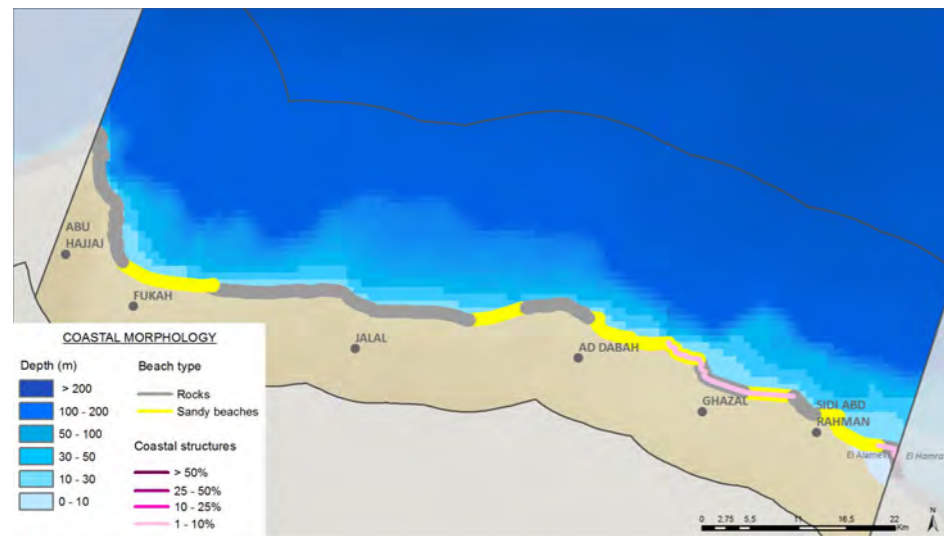
LOCAL STAKEHOLDERS

Name	Type	Website
Matruh Governorate	Authority	http://www.matrouh.gov.eg/
Shore Protection Authority - Matruh Administration	Authority	http://www.mwri.gov.eg/ShoreProtectionflowchart.aspx
EEAA West Delta Regional Branch Office in Alexandria	Authority	http://www.eeaa.gov.eg/
GAFRD Western Region	Authority	http://www.gafrd.org/

Name	Type	Website
Reclamation Farms Surrounding El Dabaa City	Private sector (agriculture)	
Marassi resort	Private sector (tourism)	
Sidi Abd Al Rahman	Private sector (tourism)	
Hacienda Bay	Private Sector (tourism)	



PHYSICAL SYSTEM



General description:

The coastal unit extends from Ras El Kanayis headland to El Hamra headland. Vertical cliffs are present at the extreme W along the E part of Ras El Kanayis headland. The W part of the unit is characterized by a series of gently protruding cliffy headlands with some isolated long beach in between (at Ceaser bay or at La Vista). The E part (from Saba to the E end) is characterized by a series of small sharp headlands retaining beaches and showing sand dune systems (Marassi, El Hamra headland).

Beaches:

Sandy beaches are inexistent in Ras El Kanayis, and sparse up to Dabah. Two long sandy beaches stand in this W part: the beaches of Ceaser bay, and at La Vista. More sandy beaches in the E part, sometimes rocky dominant. The longest widest beaches are located westward of the different headlands, such that Marassi beaches.

Coastal structures:

The W part (Ras El Kanayis headland to El Dabaa) are preserved from coastal protection structures. Sparse coastal protections in the E part. Coastal protection works and sea groins at Ghazala Bay village (extension of the headland). Sea groins at Hacienda bay. Groins at El Hamra headland.

DIAGNOSIS OF PRESENT SITUATION

Erosion:

Medium erosion all along the unit although the cliff stretches are not affected. Alongshore sediment transport decreases from W to E, but beach vulnerability increases.

Sea groin at Ghazala Bay village W headland led to the extension of the headland, this can have a negative effect on Ghazala Bay beaches.

Special attention has to be paid in the anthropization of the sand dunes that can affect the natural dynamics of the dune beach system. Constructions close to the Marassi headland sand dunes that can affect the SE beaches, and over the dunes of El Hamra headland that can decrease the sediment input to the next coastal unit.

Flooding:

Low flooding in the W part (Ras El Kanayis headland to El Dabaa) due to the low flooding distances where cliffs are present. In the E part, medium flooding in general, but high flooding impact in low lying areas, the sabkhas can be flooded especially at the eastern end (Marassi, El Hamra).

Special attention has to be paid in Marassi sabkha that is anthropized and may cause side effects.

Saltwater intrusion:

Low degree of saltwater intrusion within the entire unit.

Abiotic stress:

Low abiotic stress near the W boundary, where physical conditions are propitious for the development of seagrasses such as *Posidonia oceanica*. Medium degree of abiotic stress within the rest of the unit.

DIAGNOSIS OF LONG TERM SITUATION

Erosion:

Erosion issues are expected to become unchanged even in the worst long term scenario, unless coastal development changes the natural dynamics.

Flooding:

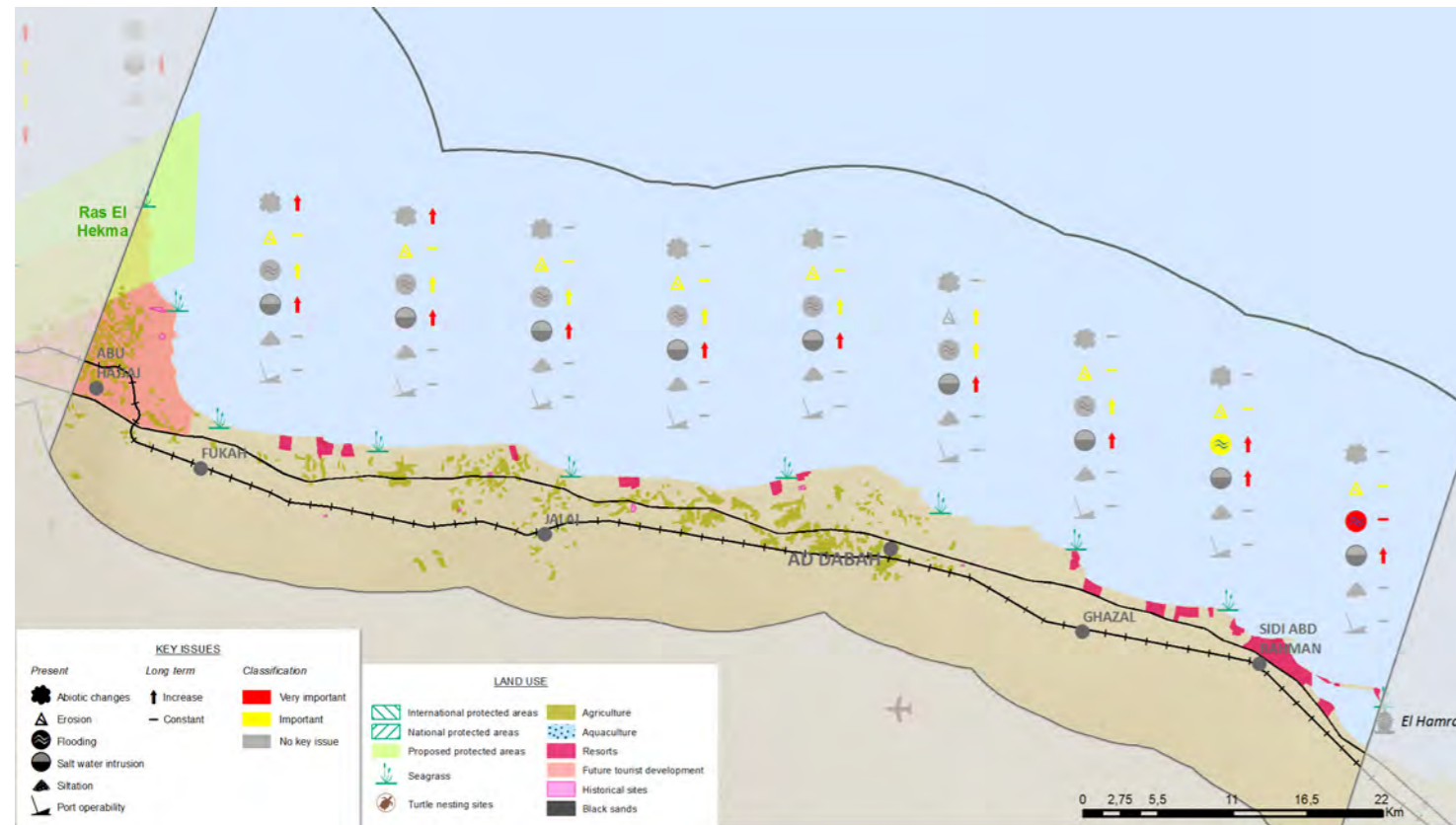
Almost no changes expected at near term. Increasing flooding impact at long term: medium flooding in the major part of the unit, but high in the most E part, in Marassi - El Hamra area. Future changes can be exacerbated if sabkha areas are further developed (side effects).

Saltwater intrusion:

The degree of saltwater intrusion within the unit will worsen as sea level rises over the twenty-first century. It will result in medium in the near term and in high in the long term.

Abiotic stress:

Medium degree of abiotic stress within the whole unit, with the exception of the coastal area near El Dabaa and the E boundary, in which the impact appears to be high, mainly due to increases in sea surface temperature.



SWOT ANALYSIS

STRENGTHS

- Large extension of natural areas.
- Available fresh water from Alexandria.
- Consolidated luxury tourism area.

WEAKNESSES

- Loss of sabkhas and lack of protection.

OPPORTUNITIES

- Potential for ecotourism.

THREATS

- Negative impacts of the nuclear power plant on biodiversity.
- Negative impacts of the nuclear power plant in tourism activities.
- Water availability from groundwater.

KEY ISSUES FOR COASTAL MANAGEMENT

PRESENT KEY ISSUES

Coastal Unit 05 corresponds to a semi developed area with isolated luxury tourist resorts on the coastal front as Marassi. The main Key Issues of this unit are:

- Medium erosion level in resort areas along the unit.
- High flooding level at El Hamra headland, where there is a resort.
- Loss of sabkhas.
- Stakeholders identified flash flood as major problem in the unit.
- Stakeholders concerns focus on unsustainable groundwater extraction and lack of environmental studies.
- Stakeholders showed their concern about unplanned developments.

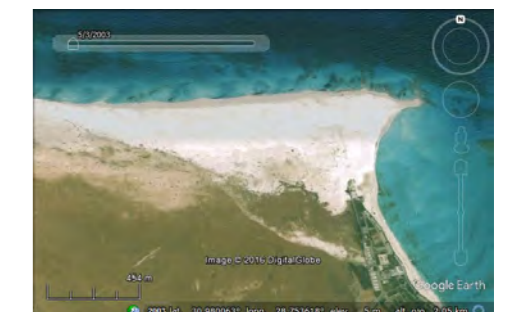
LONG TERM KEY ISSUES

Different from other Coastal Units of Matruh Governorate, CU05 is not under tourism plans, even this unit is near to the famous El Alamein touristic area. However, there is a plan to build a power plant in El Dabaa. The long term Key Issues are:

- Medium erosion level in resort areas along the unit affecting new urban development around El Dabaa.
- High flooding level at Hacienda Bay and El Hamra headland, where there are some resorts.
- Increased salt water intrusion to the coastal aquifer.
- Potential negative impact of the nuclear power plant in tourism quality and environmental biodiversity.



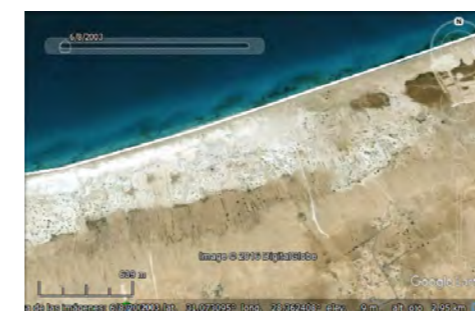
Marassi resort



Ghazala Bay village, extension of headland (Hotel Charm Life Resort)



Marassi resort development in a dune / sabkha system facing a highly dynamical barred beach.



Development of the Disney beach resort in a highly dynamical barred beach / dune system.

COASTAL UNIT 06 - ALAMEIN



GENERAL DESCRIPTION OF THE COASTAL UNIT

This unit is located in Matruh Governorate, bordering with Alexandria Governorate. The most famous town in this unit is El Alamein, due its strategic role during the II World War. This unit is characterized by the presence of an almost continuous coastal strip of summer resorts.

- Coastal Length: 83 Km.
- Governorate: Matruh
- Markaz: El Alamein, El Hammam.

ECOLOGICAL SYSTEM

This Coastal Unit includes El Omayed Biosphere Reserve which is heavily affected by anthropogenic activities. The coastal belt comprises a coastal plain and a tableland. The sector belongs to the eastern province (from Ras El Hekma to Alexandria) of the Western Mediterranean Coastal Desert where the coastal plain is wide and characterized by a series of long ridges (bars) alternating with long depression all running parallel to the coast. In certain parts, nine limestone ridges may be noted; they represent a Pleistocene sequence of shoreline bars.

Habitats:

Five main groups are represented, lying on a north-south axes starting from the shoreline: coastal dunes, inland dunes, inland ridges, saline depression and non-saline depressions. Man-made habitats include the built environment and reclaimed agricultural lands.

Flora:

Ammophila arenaria is found on active baby dunes at the shoreline, while the plant is associated with *Euphorbia paralias* and *Lotus polyphyllus* on partly stabilized sand dunes near the shoreline. Stabilized sand dunes support *Pancratium maritimum* and *Thymelaea hirsuta* while *Pituranthos turtuosus* and *Echiochilon fruticosum* are present on coastal limestone ridge. In inland dunes, plant life is dominated by *Urgina maritima* and *Thymelaea hirsuta*. Areas of siliceous deposits are cultivated with barley and orchards. The rain-fed barley fields flourish after the rainy season.

Fauna:

The Western Mediterranean Coastal Desert possesses one of the richest herpetofauna in Egypt. A total of 32 species of reptiles and two species of amphibians have been recorded from this area. At least 38 species of birds are known to breed in the Mediterranean Coastal Desert. Thirty-eight species of mammals have been recorded from this eco-region.

El Omayed Biosphere Reserve:

Established according to Prime Minister Decree No. 671 of 1986 amended by decree 3276 of 1996. It covers an area of about 700 km², and is located in Matrouh Governorate, about 80 km west of Alexandria. Being a biosphere reserve, the area is expected to serve as a site for sustainable development of natural resources by rationalizing ecotourism, rangeland management, propagating multipurpose woody species, and promoting local industries. It also has an important function in long-term ecological monitoring. However, most of the impacts affecting this sector also directly affect the Omayed reserve too, due to a lack of funds and efficient management procedures.



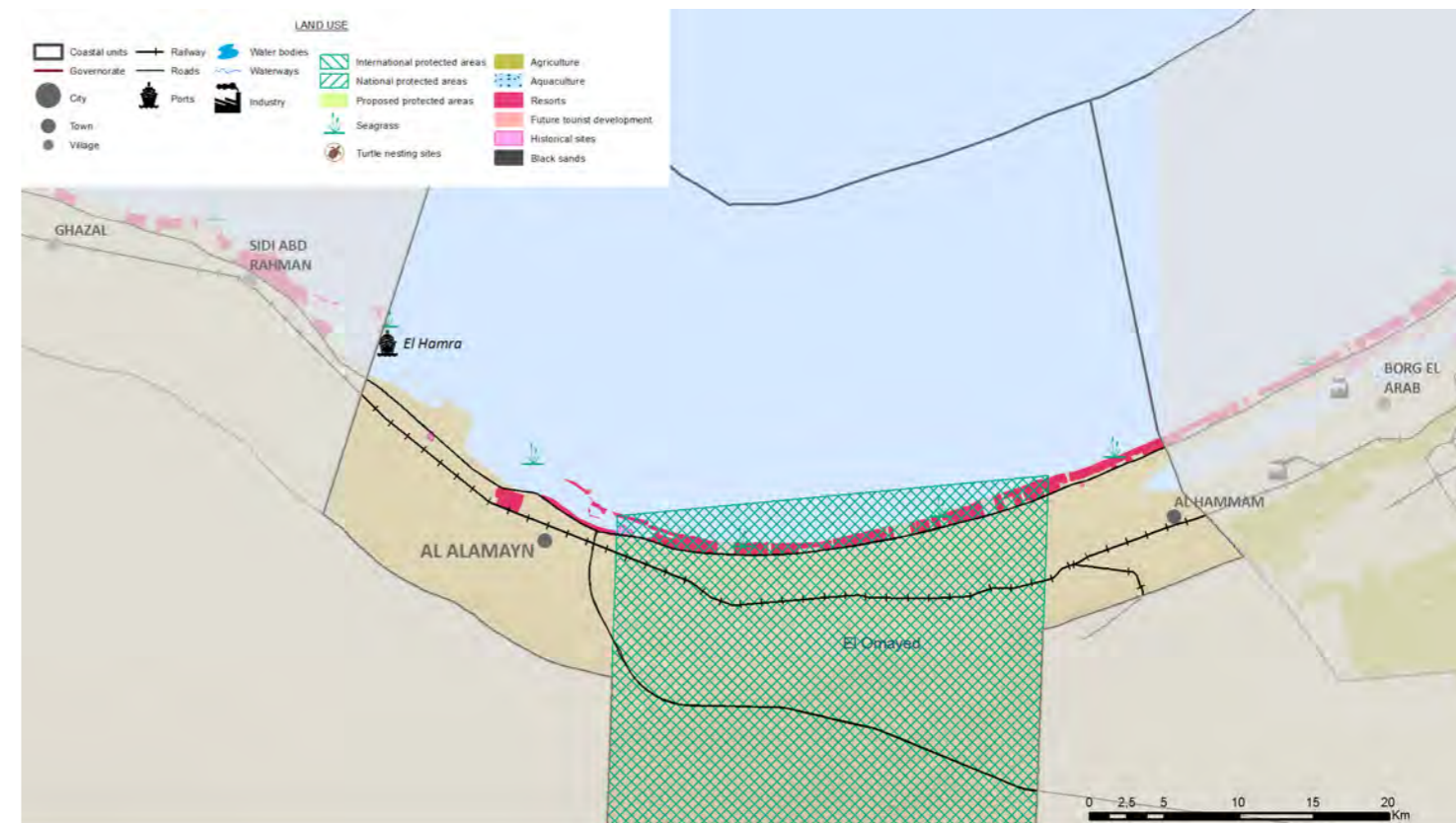
El Omayed Biosphere Reserve



Fennec Fox



Four-toed Jerboa



DIAGNOSIS OF PRESENT SITUATION

Current impacts and threats

The main impacts to the sector are related to the development of summer resorts leaving fragments of natural habitats. Main impacts include:

- Urbanization and tourism development
- Domestic wastewater
- Agriculture and grazing, decrease water availability for natural areas.
- Over-cutting and collection of medicinal plants
- Hunting and commercial exploitation of wildlife
- Impacts on marine biodiversity

Coastal unit status

Biodiversity:

- Extension of natural habitats: Medium
- Loss of natural habitats: High
- Existence of protected areas: Yes
- Extension of protected areas: Medium
- Existence of IBAs: No
- Existence of Ramsar Sites: No
- Number of endemic/threatened species: Medium
- Number of protected species: Medium

Natural resources:

- Inland fisheries stocks: NA
- Species with potential use: High

Natural water bodies:

- Pollution and contaminants: NA

DIAGNOSIS OF LONG TERM SITUATION

Proposed protected areas: No.

SOCIOECONOMIC SYSTEM

El Alamein and El Hammam are the largest urban communities where most of the population live. El Alamein and El Hammam districts host more than 56,000 inhabitants; many of them are single males who migrated to the area to work for tourism and related services. This unit is characterized by the large resorts as Marina El Alamein.

- Economic activities: 41.7% agriculture, grazing, and fishing, 11.9% whole sale and retail trade, and 8.9% in building & construction
- Cultural and heritage: Marina El Alameen Ancient City, German-Italian World War II Cemeteries, El Aameen war museum, Wadi El Halafawi Cemetery
- Social groups and ethnicities: Bedouins from Awlad Ali and Jumiaat Tribes, sons of the valey, urban residents

DIAGNOSIS OF PRESENT SITUATION

- Lack of educational facilities: 103 schools and sections, 637 classrooms, and 1 teacher per 22.1 students in 2010. The illiteracy rate reaches 41% in El Hamam district.
- Lack of health care facilities: 3 public hospital, 86 physicians, and 33 ambulances in 2010.
- Low unemployment rate: <5%.
- About 32.4% of the total population of the District was classified as poor in 2013.
- El Alamein is a major center of domestic coastal tourism
- Connected with the Capital through Wadi Natrun - El Alamein road, and heading northeast until intersects with international coastal road near the village of El Alamein and the tourist marina.
- El Alamein and El Hammam are served by the water treatment plant of New Al Amiriyah in Alexandria, outside of Coastal Unit.
- Landmines are spread across the area, which hampers proposed development.

DIAGNOSIS OF LONG TERM SITUATION

- El Alamein eco-city will accommodate 1 million people until 2027 as a part of the Northwest Coast Development Project that expected completion in 2052.
- Legalization of all that pertains to the reclaimed and agricultural lands.
- There are proposed tourism development areas, even most of the territory is already occupied by resorts.
- Over crowdedness in the summer season due to the high occupancy rates in most resorts and summer compounds.
- Development of the transportation network, through the main axis connecting all coastal units (International Coastal Highway).
- Expected a deficit in sewage service in El Hammam and El Alamein on long term.
- Development is concentrated to the narrow coastal strip where the resorts are located.
- Limited involvement of the local communities in decision making and taking processes.
- Weak coordination and cooperation among resources local authorities.

PLANS AND PROJECTS

EXISTING STUDIES

- MWRI implements a rain-fed agriculture project with 250 ground storage tanks of 100 m³ to be used in the no rain season.
- Study the coastal problems and design the protection work at El Ahlam tourist village, Northwest coast of Egypt (CoRI, 2009).
- Study the coastal problems and design the protection work for the area east of Marina El Alamin tourist village (CoRI, 2009).
- Support to the Egyptian Protected Areas Project (EEAA, unknown).

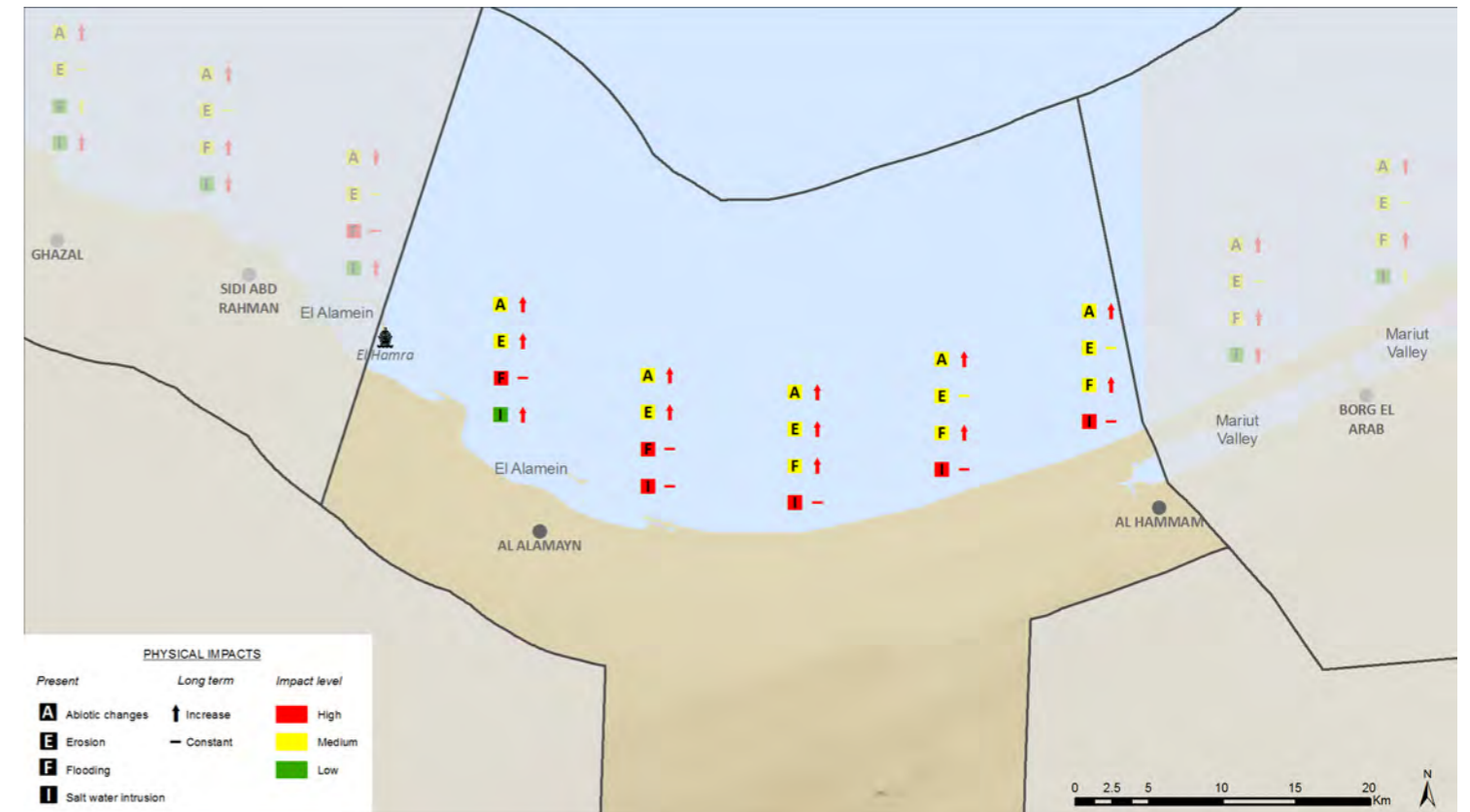
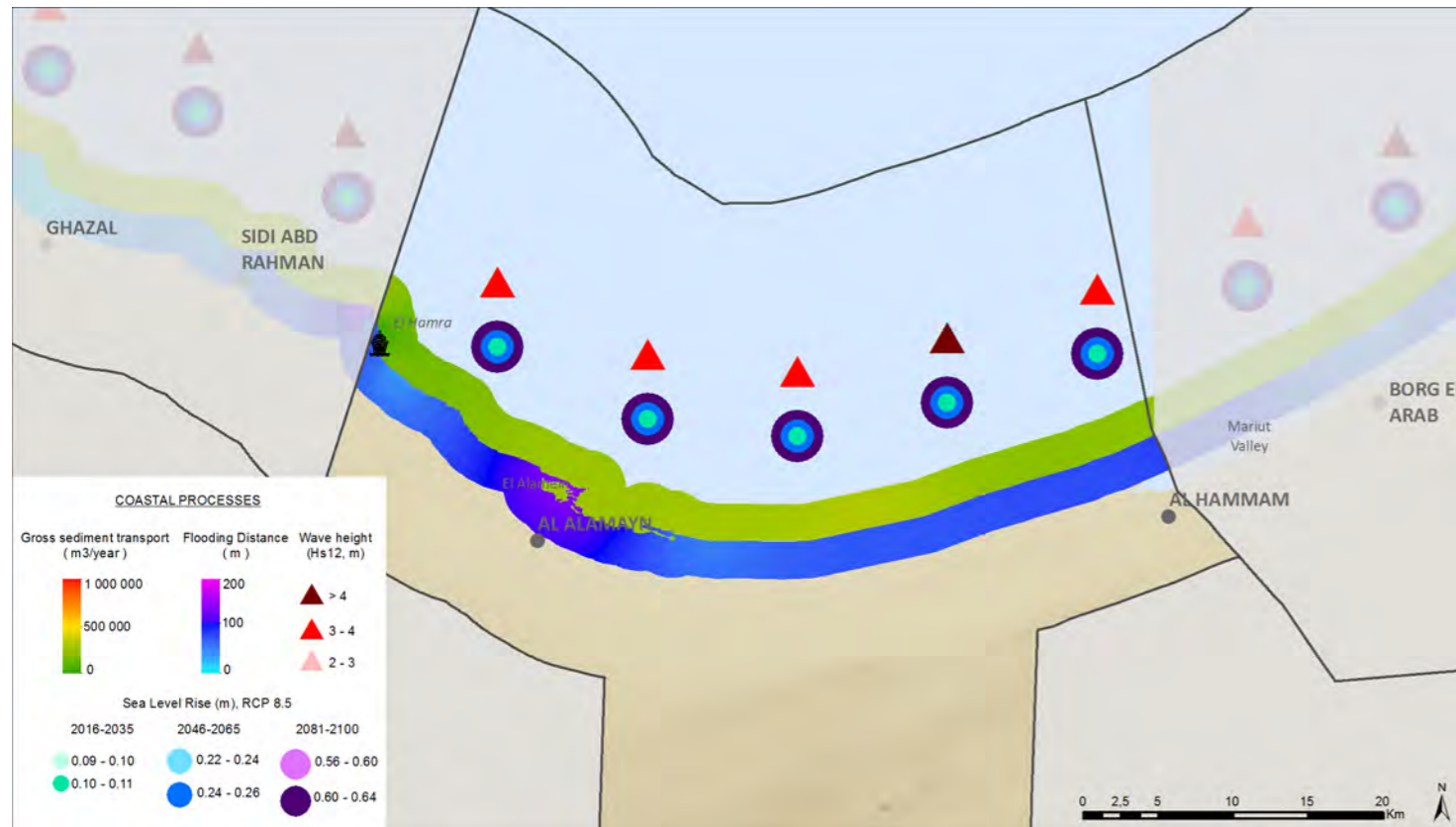
LONG TERM DEVELOPMENT PLANS

- National Strategic Plan for Urban Development (GOPP, 2015).
- Strategic Development Plan for Northern-Western Coast and Its Desert Hinterland 2032 (GOPP, 2011).
- Integrated Development of Egypt's Northwestern Coastal Zone (SPA, 2004).

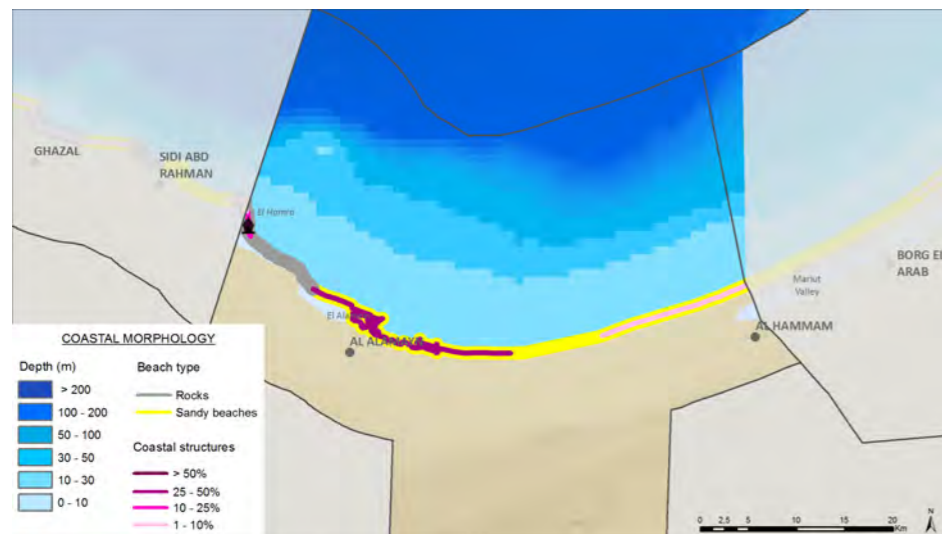
LOCAL STAKEHOLDERS

Name	Type	Website
Matruh Governorate	Authority	http://www.matrouh.gov.eg/
Shore Protection Authority - Matruh Administration	Authority	http://www.mwri.gov.eg/ShoreProtectionflowchart.aspx
EEAA West Delta Regional Branch Office in Alexandria	Authority	http://www.eeaa.gov.eg/
GAFRD Western Region	Authority	http://www.gafrd.org/
Petroleum General Egyptian Authority. El Hamra Petroleum Port.	Authority	www.eeaa.gov.eg

Name	Type	Website
Marina El Alamein	Private sector (tourism)	
Lotus Village	Private sector (tourism)	
Badr Village	Private sector (tourism)	
Reclamation Farms Surrounding Al Hammam City	Private sector (agriculture)	
Local tribes and communities	Society	



PHYSICAL SYSTEM



General description:

The coastal unit extends from El Hamra headland to Al Hammam (W boundary, W end of Mariut valley). It is characterized, from W to E, by: (1) low relieves with calcareous rocks and consolidated sands at El Hamra, (2) the Alamein sabkha / lagoon system bounded northward by a thin sand barrier (minimum width 100 m) and (3) a long open beach coastline from Alamein to Al Hammam. Several channels insure the connection of the Alamein lagoon system with the sea, the main one is 100 m wide.

Beaches:

Sandy beaches are present all along the unit. The W beaches of El Hamra / the World War Italian cemetery are mainly composed by consolidated sand. The sandy beaches of the Alamein lagoon barrier have variable widths and shape, most of them have been artificially remodeled by different coastal protection structures. The coastline from Alamein to Al Hammam is characterized by long open beaches with nearshore bars. Although they are naturally wide beaches, their width is sometimes limited because of the small coastal setbacks of certain properties.

Coastal structures:

Coastal structures are concentrated in the Alamein lagoon barrier and consist of multiple sea groins built for beach protection or for navigation purpose. E of the lagoon, there is a system of groins and detached breakwaters at Al Ahlam resort. The other coastal structures are located at the W boundary (El Hamra oil plant groin) and at the E boundary (Al Hammam detached breakwaters).

DIAGNOSIS OF PRESENT SITUATION

Erosion:

Medium erosion in the entire unit in relation with the medium longshore and cross-shore sediment transport all along the unit (except the extreme W boundary). There are local problems due to the presence of coastal protection structures acting as sediment transport barriers and increasing erosion eastward. These local erosion hot spots are observed along the Alamein lagoon barrier, just eastward of the lagoon (Al Ahlam resort) showing chain reaction issues. Local erosion problems detected at Al Hammam and eastward, where breakwaters have been built from consequence of short coastal setbacks.

Flooding: Strong flooding W of Alamein lagoon because of the the low-lying areas that can be flooded (sabkhas). Flooding in the other part is medium. The flooding issues can be locally stronger in Alamein lagoon because of side effect caused by coastal works.

Saltwater intrusion: The degree of saltwater intrusion is low within the whole unit, which currently does not pose a problem.

Abiotic stress: Medium degree of abiotic stress within the entire unit, hence leading to medium presence of seagrasses.

Port downtime: The port of El Hamra Port currently exceeds 200 hours per year of downtime due to overtopping, hence leading to medium degree of impact.

Siltation: Medium siltation issues in El Hamra port and in Alamein lagoon inlets because of the medium longshore sediment transport in the area. However issues are stronger in the lagoon inlets and the coastal protection groins built for navigation purpose are not enough long to fully impede siltation because of the shallow waters and gentle slope bathymetries.

DIAGNOSIS OF LONG TERM SITUATION

Erosion:

Erosion is expected to increase to high in the Alamein barrier beaches in the different long term scenarios mainly due to shoreline retreat associated to sea level rise (no changes are expected at near term). Although erosion remains medium in the E part, it will increase and shoreline retreat is expected to cause problems in low coastal setback areas.

Flooding:

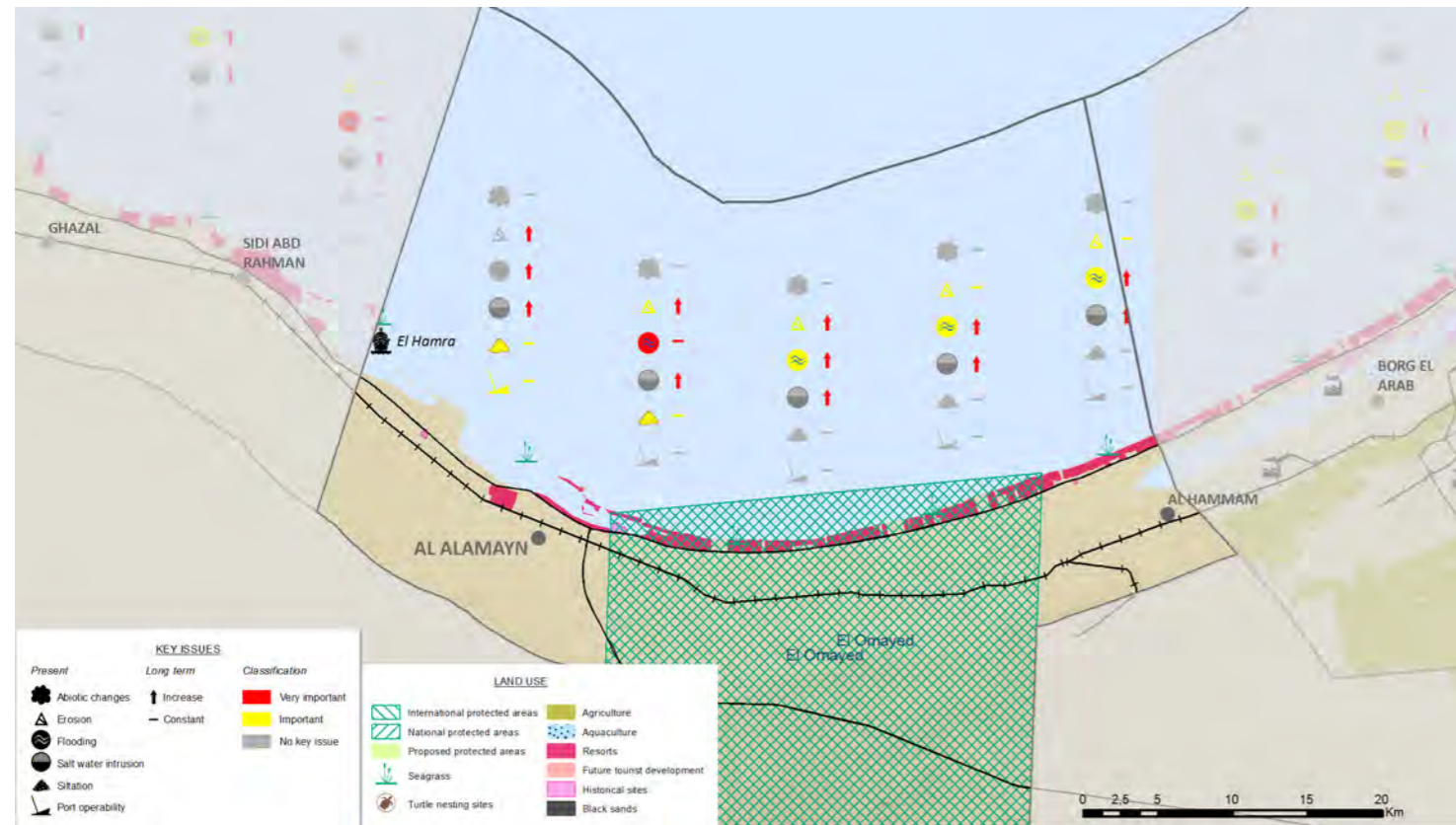
For the different scenarios flooding is expected to be high in the entire unit at long term and at near term for the worst scenario because of sea level rise.

Saltwater intrusion: The degree of saltwater intrusion will become medium in the near term. Those changes, particularly caused by sea-level rise, are expected to be even exacerbated in the long-term, reaching the impact a high degree of severity.

Abiotic stress: Projected increases in sea surface temperature will bring high degree of abiotic stress both in the near and the long term, leading to low presence or even absence of *Posidonia oceanica* meadows in the area.

Port downtime: Small increase in the number of hours per year that El Hamra Port is inoperable due to overtopping. Thus, port downtime will remain at a medium degree both in the near and the long term.

Siltation: Siltation issues will remain medium in El Hamra port and at Alamein inlets (change in sediment transport <1% in the worst scenario).



SWOT ANALYSIS

STRENGTHS

- El Omayed Biosphere Reserve is expected to serve as a site for sustainable development of natural resources.
- High amount of species with potential use.
- Major centre for domestic tourism.
- Well connected to Cairo and Alexandria.
- Fish resources.

OPPORTUNITIES

- Increased protected area, supporting eco-tourism activities.
- Stakeholder pointed out changes in precipitation due to climate change.

WEAKNESSES

- Protected areas do not limit enough land uses.
- Almost continuous summer resorts on coastal strip.
- El Omayed Biosphere Reserve is heavily affected by anthropogenic activities.
- Mine fields.

THREATS

- Negative impacts of the nuclear power plant on biodiversity.
- Negative impacts of the nuclear power plant in tourism activities.
- Long term plans should take into consideration all development issues, as wadi system.

KEY ISSUES FOR COASTAL MANAGEMENT

PRESENT KEY ISSUES

The current Key Issues of CU06 are:

- Medium erosion level in resort areas along the unit.
- High flooding level in the area of El Alamein lagoon.
- Medium flooding level on resorts areas along the unit.
- Medium level of erosion and flooding can affect regional roads.
- Medium siltation level in El Hamra Petroleum Port and El Alamein lagoon inlets.
- Medium overtopping level in El Hamra Petroleum Port.
- High level of saltwater intrusion.
- Environmental impact to Omayed protected area, including the anthropization of El Alamein lagoon and sabkha.
- Stakeholders identified flash flood as major problem in the unit.
- Stakeholders concerns focus on unsustainable groundwater extraction and lack of environmental studies.
- Stakeholders find beaches dangerous for swimmers due to rip currents.

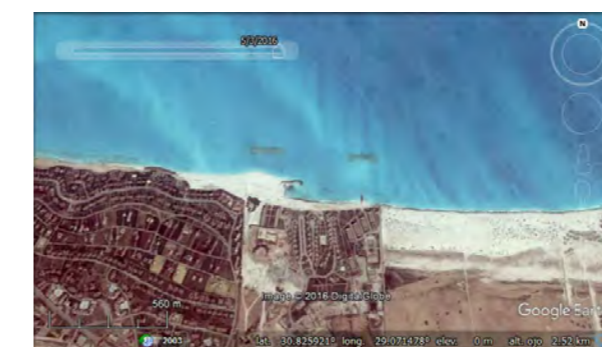
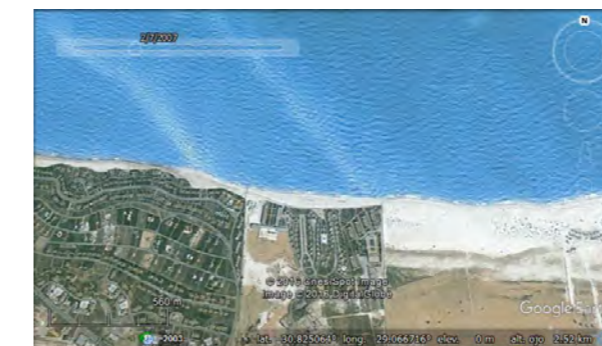
LONG TERM KEY ISSUES

The National Strategic Plan for Urban Development (GOPP, 2015) plans the creation of a new city in El Alamein to host 1,000,000 inhabitants.

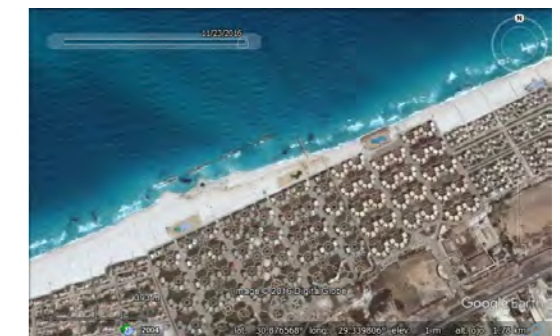
- High erosion level in new urban areas (western part of the coastal unit).
- High erosion level in resort areas along the unit.
- High flooding level in new urban areas (western part of the coastal unit).
- High flooding level in resorts areas along the unit.
- Medium siltation level in El Hamra Petroleum Port and El Alamein lagoon inlets (remain similar to present situation).
- Medium overtopping level in El Hamra Petroleum Port (remain similar to present situation).
- Erosion and flooding could affect Alexandria-Matruh Road.
- Increased saltwater intrusion.



Coastal protection Works in El Ahlam resort.



El Ahlam resort: erosion eastward the coastal groin. From top to bottom: 2007, 2016



Al Hammam. Erosion issues eastward the breakwater system and rip current systems dangerous for swimmers.



El Hamra Petroleum Port. Building of the sea groins in a highly dynamical environment. Erosion and saltation issues



El Alamein new city plan. Source: National Strategic Plan for Urban Development (GOPP, 2015)

COASTAL UNIT 07 - ALEXANDRIA



GENERAL DESCRIPTION OF THE COASTAL UNIT

CU 07 corresponds to Alexandria Governorate, located in the North West of the Delta. Alexandria is the second most populated city in Egypt and hosts an intense urban, industrial, port and tourism activity. Other populated centers are Borg El Arab and Abu Qir.

- Coastal Length: 147 km.
- Governorate: Alexandria.
- Alexandria Districts: Montazah, Sharq, Wasat, El Gomrok, Gharb, El Amreya. Borg El arab Markaz and City has its own authority and do not fall under these districts.

ECOLOGICAL SYSTEM

The Coastal Unit belongs to the eastern province (from Ras El Hekma to Alexandria) of the Western Mediterranean Coastal Desert where the coastal belt comprises a coastal plain and a tableland. The coastal plain is wide and characterized by a series of long ridges (bars) alternating with long depression all running parallel to the coast. This eastern part of this unit mainly includes urban and suburban environments, including the city of Alexandria, where Lake Mariout (although heavily polluted and impacted by land reclamation) represents one of the few natural spots of the sector. West of Alexandria, the coast is mostly occupied by summer resorts.

Habitats:

Close to Burg El Arab city the soil is composed of maritime calcareous sand dunes. The area is characterized by high limestone rocks. The lower elevations of the coastal dune are planted with rain-fed fig trees. Main habitats include: sand dunes, reclaimed agricultural lands and built environment.

Flora:

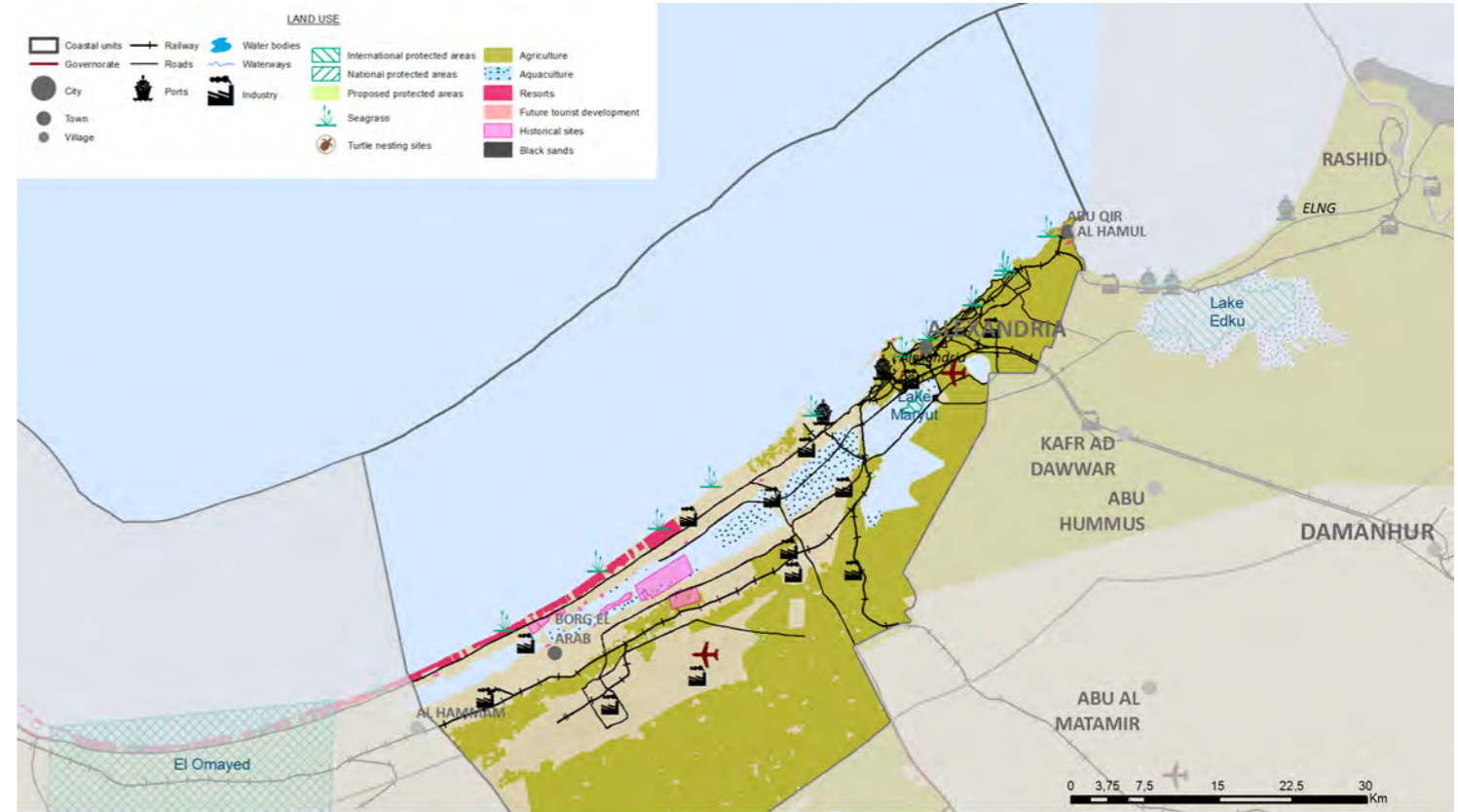
The area is dominated by psammophytes, characteristic of limestone soils. Main plant species include *Mesembryanthemum crystallinum*, *Fagonia cretica*, *Hordeum marinum*, *Ononis vaginalis*, *Euphorbia paralias* and *Thymelaea hirsuta*. Much of Lake Mariout shore is fringed by extensive *Typha* and *Phragmites* marshes. South of Lake Mariout, the site is an inland salt marsh dominated by Mediterranean halophytes including *Suaeda fruticosa*, *Halocnemon strobilaceum*, *Limoniastrum monopetalum*, *Halimione portulacoides*, *Spergularia marina*, *Atriplex halimus* and *Arthrocnemum glaucum*.

Fauna:

Common amphibians include the Square-marked Toad (*Amietophrynus regularis*) and the Green Toad (*Bufo viridis*); the latter is found in more arid environments. Reptiles include geckos and some snakes. Birds are mostly common and widespread species of urban and agricultural areas, while Lake Mariout supports a more important ornithological fauna. Mammals are mainly represented by common commensal species such as the House Mouse (*Mus musculus*), Brown Rat (*Rattus norvegicus*) and Red Fox (*Vulpes vulpes*).

Lake Mariout:

Lake Mariout is the westernmost of the northern Delta wetlands, though its history and origin are different. The lake has been reduced by over 75% of its original area and is still shrinking. Formerly, the lake was fairly large but late in the nineteenth century the western half was cut off by a railway embankment and transformed into an extensive Salina, now known as Malahet Mariout, which is seasonally flooded (usually during winter). Today, the remaining part of this lake is made up of several fragments, dissected by roads and embankments, and lies practically within the boundaries of greater Alexandria and its sprawling suburbs. The lake has no direct connection with the Mediterranean, and is maintained at a level of about 2.8 m below sea level by a pumping station at El Max. The importance of Lake Mariout for birds has diminished greatly over the last two or three decades due to habitat loss, ecological changes and increased disturbance and hunting pressure. Numbers of wintering waterbirds are modest; however, the lake is included among the "Important Bird Areas" (IBAs) of Egypt (IBA Criteria: A4i). Several waterbirds are known to breed in the lake, but it is not expected that there would be any significant concentrations



DIAGNOSIS OF PRESENT SITUATION

Current impacts and threats

The area is heavily impacted by anthropogenic activities.

Main impacts include:

- Land reclamation and urbanization.
- Industrial pollution.
- Solid waste.
- Wastewater discharge.
- Reclamation and pollution of Lake Mariout.
- Grazing of domestic animals.

Stakeholders also identified the following impacts:

- Extreme fishing and catching very small fish during the spawning season due to the usage of small meshed nets.
- Pollution from inland and river ports activities.
- Accidental oil pollution from petroleum ports.

Coastal unit status

Biodiversity:

- Extension of natural habitats: Low.
- Loss of natural habitats: High.
- Existence of protected areas: No.
- Existence of IBAs: Yes (1).
- Number of endemic/threatened species: Low.
- Number of protected species: Low.

Natural resources:

- Inland fisheries stocks: Low.
- Species with potential use: Low.

Natural water bodies:

- Pollution and contaminants: High.

DIAGNOSIS OF LONG-TERM SITUATION

Proposed protected areas: No.



Limestone Plateau cultivated with fig and clover



Limestone Plateau with date palms

SOCIOECONOMIC SYSTEM

Alexandria hosted 4,084,672 inhabitants in 2006, of which a total of 99% lived in urban areas. Alexandria city is the second capital of Egypt. Other population centers are New Borg El Arab City and Abu Qir. Alexandria hosts the prime ports in Egypt in addition to two airports: Borg El Arab and El Nozha. Main products are livestock, poultry, fisheries, food products in addition to oil & gas, and a variety of industries and manufactures.

- Economic activities: 19.9% manufacturers (Industrial areas in El Dekhelia, Marghem and El Ameryia), 19.8% whole sale and retail trade, and 11.2% in building & construction.
- Cultural and heritage: Alexandria hosts a huge variety of Ptolemaic, Greco-Roman historical sites & museums, Palaces and museums of the Royal family, open gardens, different cemeteries, & the Bibliotheca of Alexandria.
- Social groups and ethnicities: Urban population in the majority and Bedouins and rural population on the fringes, and visitors from all over Egypt during the summer.



Industrial and salt extraction in Lake Mariut.

DIAGNOSIS OF PRESENT SITUATION

- Fair educational facilities: 2,700 schools and sections, 24,380 classrooms, and 1 teacher per 19.1 students in 2010. Illiteracy rate: 19% at governorate level.
- Fair health care facilities: 6 public hospital, 12 specialized hospitals, 5,775 physicians, and 9 ambulances in 2010.
- Unemployment rate: 10%
- About 28.6% of the total population of the districts was classified as poor in 2013.
- Alexandria suffers from the typical problems in urban Egypt, e.g., overpopulation, crowded traffic, lack of infrastructure services, especially wastewater treatment plants.
- Poor housing conditions around Lake Mariut.
- Fishermen have a poor quality of life and poor health conditions.

DIAGNOSIS OF LONG-TERM SITUATION

- Industrial development through the establishment of new industrial cities. Completion of industrial free zone in Alexandria.
- Limit the expansion of industrial activities within existing cities and allocation of alternative locations in desert areas.
- Development of existing industrial projects with large production capacities and employ large number of workers such as textile and iron and steel factories.
- Development of El Mahmodyia canal to taking advantage of being navigational pathway uses as a cheap means of river transport.
- Development of West Alexandria Airport and increasing its efficiency to become international airport with high capacity.
- Redistribution of the population through establishing new urban communities and centers on the road of Wadi El Natroun – El Alamein cities.
- Coastal zone management project to address the pollution of water resources and preserve the fisheries’ resources of Alexandria.
- Development of infrastructure services to abate the pollution of the water resources of Alexandria.

PLANS AND PROJECTS

EXISTING STUDIES

- Adaptation to Climate Change in the Nile Delta through ICZM (CORI-SPA , 2009-2016).
- Mariut Lake and Valley ICZM Plan (EEAA, 2016).
- Environmental implementation plan in Alexandria Governorate (EEAA).
- Exploration and evaluation of sediment dredged from harbors and pathways off the Nile Delta coast for better environmental and economic use, with Academy of scientific Research and Technology, Egypt (CORI, 2009-2013).
- Innovative means to protect water resources in the mediterranean coastal areas through re-injection of the treated water (EEAA, 2013).
- The industrial development in Alexandria report (IDA, 2011).

- Physical Parameters related to climate change along the Mediterranean coastal zone of Egypt (CORI, 2012).
- Head Master Initiative for the Nile Delta Coastal Hydrodynamics, Sediment Transport, Erosion, and Defense Schemes in View of Climate Change and ICZM (CORI, 2012).
- Coastal Protection works on Nile Delta, as seen on Google Earth (ACCNDP, 2010).
- Environmental description for the Alexandria Governorate (EEAA, 2007)
- Study the sedimentation and pollution problem at Montaza bay, Alexandria (CORI, 2005).
- Integrated Development of Egypt’s Northwestern Coastal Zone (SPA, 2004)
- Environmental Impact Assessment of Sidi Kerair Village and Sedi Kerair Oil Port (CORI ,2003).
- Positioning and mapping the set-backline along the Nile Delta coast and Ale-

- Alexandria coast (CORI, 2001).
- Alexandria Lake Maryut Integrated Management (ALAMIN) (EEAA CEDARE).
- PEGASO Project (NARSS NIOF).
- The environmental perspective of urban development strategy of Alexandria región (NCPSLU).
- Policies for dealing with urban growth in Delta (GOPP).

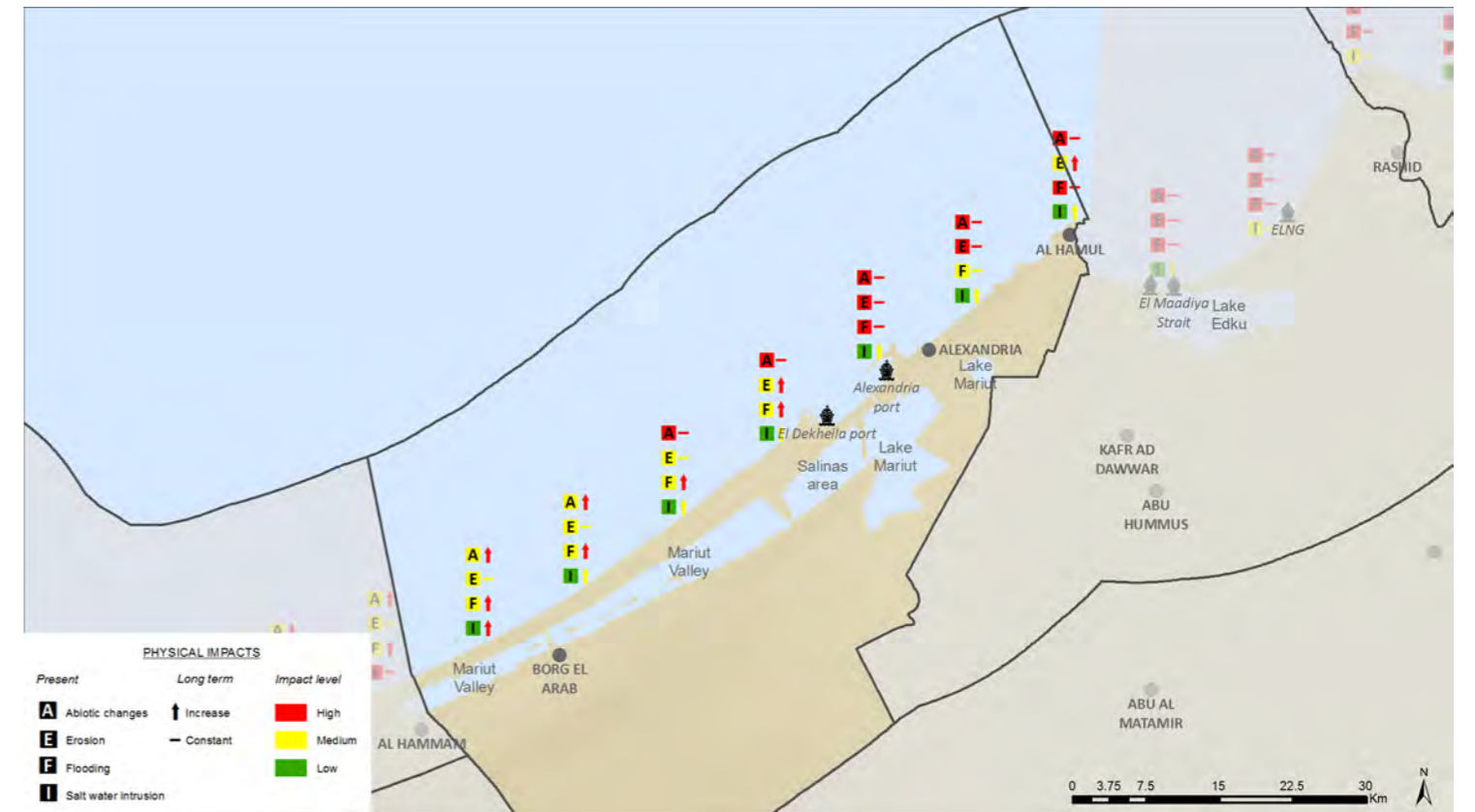
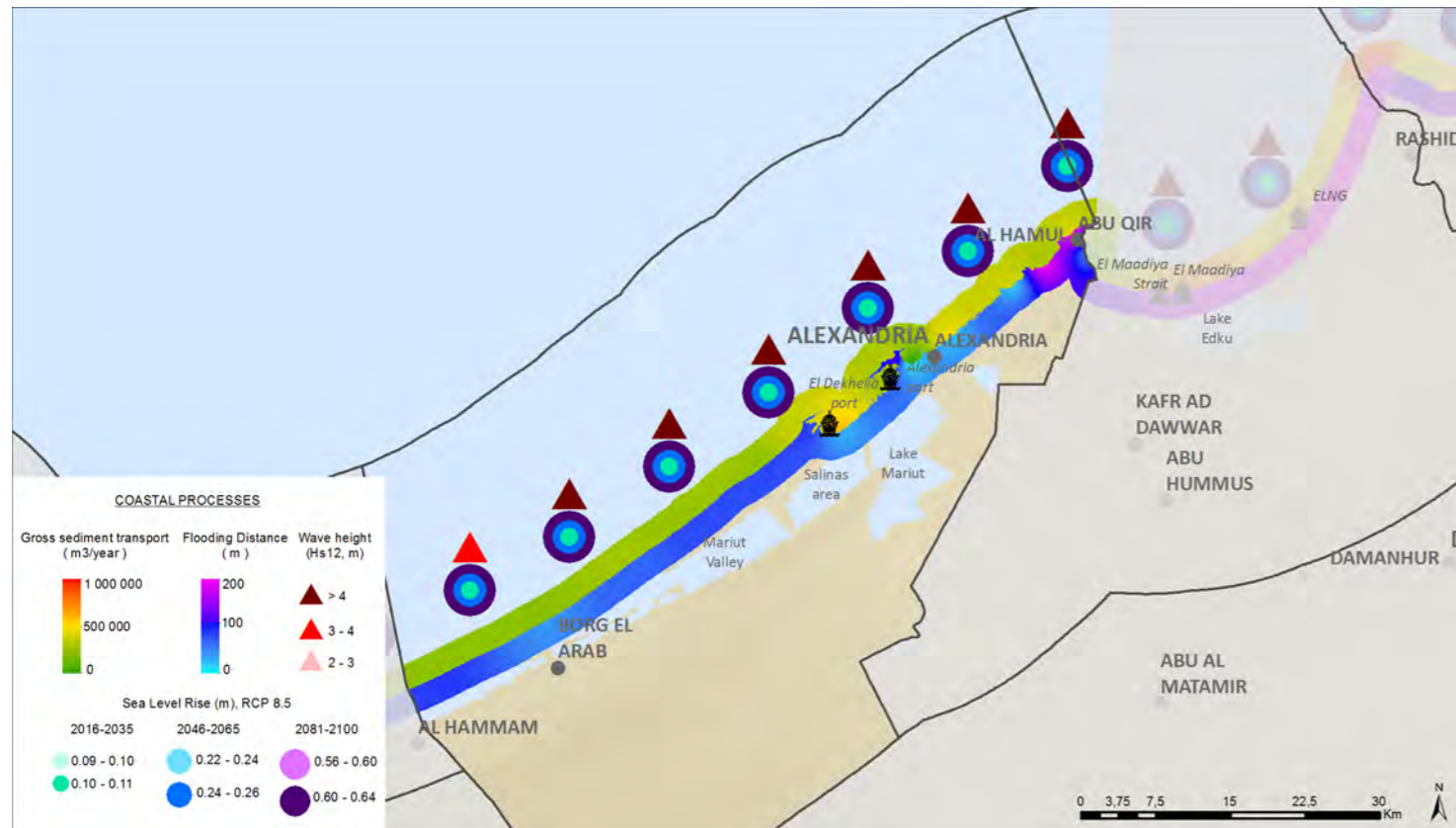
LONG-TERM DEVELOPMENT PLANS

- Strategic Urban Development Plan for Alexandria City 2032 SUP (GOPPP, 2008).

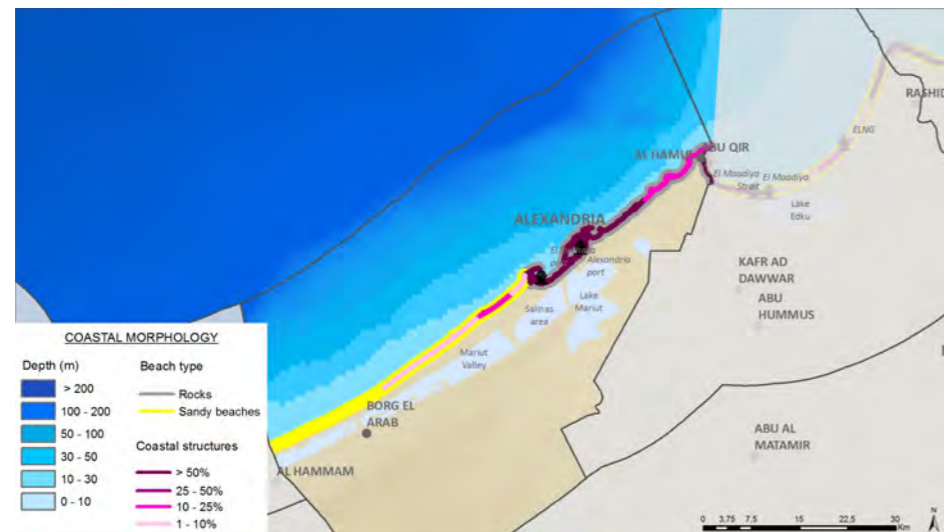
LOCAL STAKEHOLDERS

Name	Type	Website
Alexandria Governorate	Authority	http://www.alexandria.gov.eg/Alex/english/index.aspx
EEAA West Delta Regional Branch Office in Alexandria	Authority	http://www.eeaa.gov.eg/
Shore Protection Authority– Alexandria Administration	Authority	http://www.mwri.gov.eg/ShoreProtectionflowchart.aspx
GAFRD Western Region	Authority	http://www.gafrd.org/
Lake Mariut Development Committee	Authority	http://www.gafrd.org/
Alexandria Port Authority	Authority	http://www.apa.gov.eg/index.php?lang=en
Radisson Blu Hotel	Private sector	(tourism)

Name	Type	Website
Reclamation Farms in Borg Al Arab	Private sector (agriculture)	
Mariut Fish Farms	Private sector (aquaculture)	
Al Ameria Industrial Zone	Private sector (industrial)	
Al Margham Industrial Zone	Private sector (industrial)	
Borg Al Arab	Private sector (industrial)	
Sidi Kerir	Private sector (industrial)	
Iberotel Borg El Arab	Private sector	



PHYSICAL SYSTEM



General description:

Alexandria coastal unit extends from Al Hammam (W boundary) to Abu Qir headland. The landscape is characterized by low relieves from elongated ridges running parallel to the coast bounding a coastal lagoon system composed by Mariut valley (W) draining at Nobarria drain and by Mariut lagoon draining in Al Max bay. These two lagoons are not connected and are separated by the Salinas salt mines. The coastline is characterized by (1) a 50 km-long straight coast with long sandy beaches from Al Hammam to El Dekheila along Mariut valley, (2) Al Max bay between El Dekheila port and Alexandria port where Mariut lagoon drains, (3) The Cornishe road 14 km-long straight coastline from Alexandria E harbor to El Mandara, and (4) the bays of El Montazah / El Mamurah up to Abu Qir.

Beaches:

Different types of beaches are observed, from W to E: (1) long open sandy beaches with sparse rocks (2, 3) small patches of sandy beaches interrupted by rocks / ripraps (4) longer pocket beaches.

Coastal structures:

(1) W part preserved, E part: sparse breakwaters, ports and groins. Coastal protections concentrated at Al Agami breakwaters / Nobarria drain groins. (2,3) Walls / ripraps and coastal protections covers almost entirely this coastal stretch, works extensively described by CoRI (2012). (4) Series of sea groins up to Abu Qir.

DIAGNOSIS OF PRESENT SITUATION

Erosion:

Medium erosion in the W part (1), strong erosion in the E part (3,4). Along-shore sediment transport directed eastward increases from W to E. Cross-shore sediment transport is relatively high in the entire units.
 (1) Coastal work at Nobarria (groins) and Agami (breakwaters) cause adverse effects eastward by interrupting sediment transport.
 (2,3) Sand deficit in the area, many coastal protection work interrupting alongshore sediment transport. Beach nourishment is needed to maintain the remaining beaches.
 (4) Erosion problems in the W part of the bays (Montazah bay, Mamurah beaches) requiring protection.

Flooding:

Flooding is medium in the major part of the unit, but high in the areas near-by Mariut lagoon and Abu Qir due to the low-lying areas that can be flooded (sabkhas).

Saltwater intrusion: Low saltwater intrusion near the W boundary and medium within the rest part of the unit.

Abiotic stress: The high probability of occurrence of *Posidonia oceanica* near Al Hammam highly contrasts with the absence of meadows within the rest of the unit.

Port downtime: Overtopping-based downtime currently exceeds in both ports 300 hours per year, hence leading to a high degree of the impact.

Siltation: Low siltation issues in Nobarria drain because of the relatively small longshore transport in the area. Other channels show strong siltation issues because of high longshore transports. Periodic dredging performed below Montazah bay bridge.

DIAGNOSIS OF LONG-TERM SITUATION

Erosion:

Erosion remains medium in the most W part of the unit, even in the worst scenario. High erosion is expected in the coast of Alexandria for the different long-term scenarios due mainly due to shoreline retreat associated to sea level rise.

Flooding:

For the different scenarios, flooding is expected to be high in almost the entire unit due to projected sea level rise affecting the lower areas.

Saltwater intrusion:

Rising sea level up to 25 cm in the long-term will give rise to high saltwater intrusion near the W boundary and medium within the rest of the unit.

Abiotic stress:

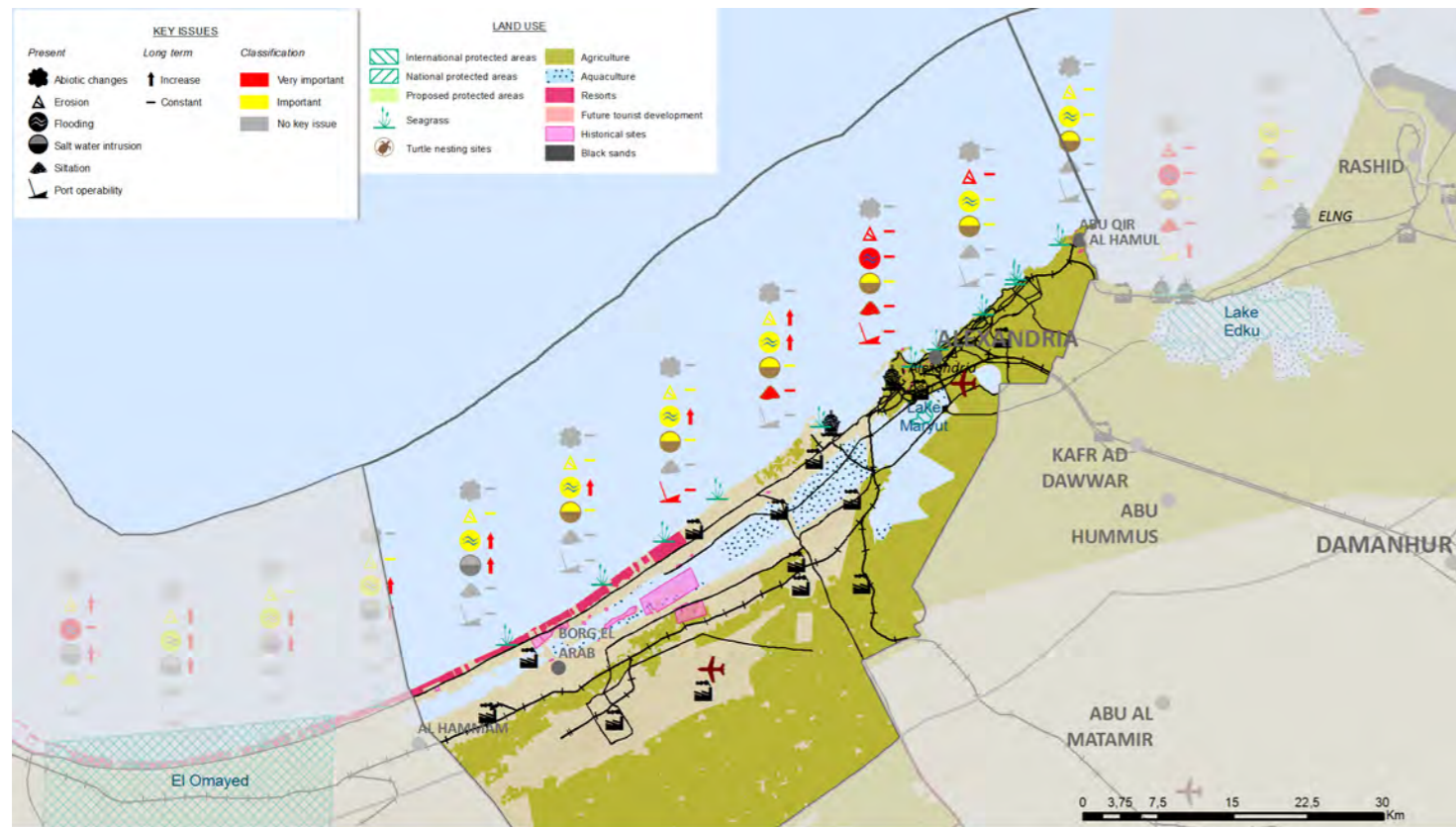
Probabilities of occurrence of *Posidonia oceanica* are decreasing in the coming decades, leading to absence through the whole unit.

Port downtime:

Port downtime due to overtopping will remain at high degree unless adaptation measures are implemented.

Siltation:

Siltation issues are expected to remains unchanged in all the scenarios due to small differences in projected sediment transport (<3%).



SWOT ANALYSIS

STRENGTHS

- Strong economic activities as industry and agriculture.
- Consolidated tourism destination.
- Two commercial ports, as well as petroleum and fishing facilities.
- Good communication infrastructures.
- Variety of coastal stakeholders.

WEAKNESSES

- Water quality in Lake Mariut.
- Beach erosion and high level of flooding.
- Lack of natural areas on the coast.
- Fishermen social conditions.
- High vulnerability to climate change.
- High population density.

OPPORTUNITIES

- Planned urban sprawl.
- Strong Governorate willing to implement Mariut Lake and Valley ICZM Plan.

THREATS

- Climate change impacts, especially due to SLR.
- Loss of fisheries stocks.

KEY ISSUES FOR COASTAL MANAGEMENT

PRESENT KEY ISSUES

The Key Issues of Alexandria Coast Unit are:

- High erosion level along Alexandria city (large urban centre), affecting urban and touristic facilities.
- High flooding level along Alexandria city (large urban centre), affecting urban and touristic facilities and Abu Qir (small urban centre).
- Medium erosion level affecting resorts in the western part of the unit.
- Medium flooding level affecting resorts in the western part of the unit.
- Medium overtopping and flooding affecting the area of Sidi Kerir industries (SUMED).
- High siltation and overtopping level in El Dekhiela and Alexandria Port.
- Flooding can affect agricultural areas around Lake Mariut.
- Severe water quality challenges in Lake Mariut and Invasive species threatening lake biodiversity.
- Social conditions of fishermen communities around Lake Mariut.
- Development on large low-lying areas.

LONG-TERM KEY ISSUES

Alexandria coastal area is crowded and most of the coastal stretch is already covered by urban, tourist and industrial uses. The Alexandria Urban Plan for 2032 plans new developments in inner areas as Burg El Arab. The long-term Key Issues of Alexandria unit will be:

- Increased erosion problems around Alexandria city centre (large urban centre) and Abu Qir (small city centre).
- Increased (high) flooding level along the unit, affecting urban areas in Alexandria city (large urban centre), Abu Qir (small urban centre), resorts in the western area of the unit, Sidi Kerir and ports.
- Increased level of saltwater intrusion.
- Loss of agricultural lands due to flooding.
- Potential decrease of water quality in Mariut Valley.
- Loss of fisheries in Mariut Lake.
- Loss of agricultural lands due to industrial developments



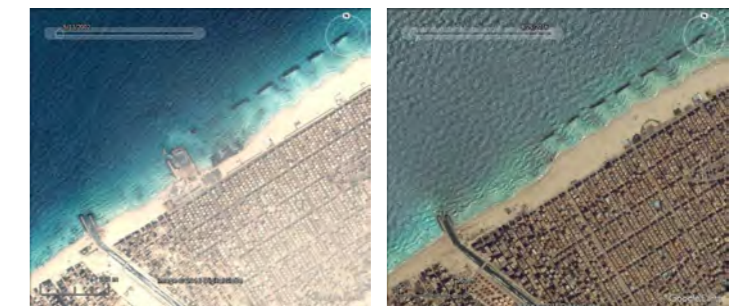
Fishermen at a discharge point



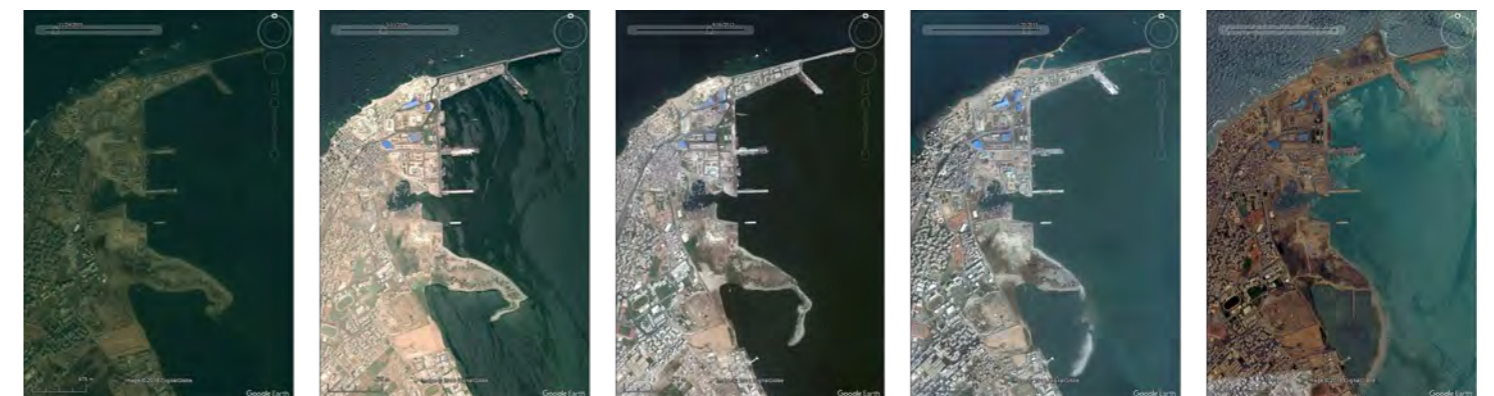
Lake Mariut



Crowded beach in Alexandria



El Agami breakwaters. Erosion issues reduced after removing westward harbor. Rip currents can be strong in this area. Left: 2002, right: 2016.



Abu Qir ports. Construction of the northern jetty and morphological evolution of the southern spit. From left to right: 2005, 2009, 2012, 2015, 2016

COASTAL UNIT 08 - BEHEIRA



GENERAL DESCRIPTION OF THE COASTAL UNIT

CU 08 corresponds to Beheira Governorate, in the North West of Nile Delta. This Coastal Unit includes Abu Qir bay, Idku Lake and the eastern part of Rosetta Nile branch. Beheira Governorate is mainly rural. However, this unit suffers an intense coastal development related to gas and petroleum industry.

- Coastal Length: 55Km.
- Governorate: Beheira.
- Markaz: Abu Hommos, Abu Matamir, Damanhour, Idku, El Mahmoudia, Kafr El Dawar, Rashid.

ECOLOGICAL SYSTEM

This Coastal Unit comprises a zone of arid coastal land, intensive coastal development, farmlands, the Rosetta Branch of the Nile and Lake Idku. The Abu Qir area, where almost continuous succession of industrial establishments and other structures are present, is the less interesting in biodiversity due to human disturbing and polluting activities that have highly affected the coastal zone. Nelson Island is an important touristic feature. The Idku area is also characterized by the presence of numerous industrial establishments, particularly in the Oil & Gas Sector.

Habitats:

The main habitats of this sector are as follows: beach, sabkha, salt marshes, sand dunes, cultivations, towns and villages and Lake Idku.

Flora:

The following plant species were recorded in the Idku area. The leeward slopes of the loose dunes support only a small number of species, such as *Elymus farctus* and *Ifloga spicata*. The fixed dunes exhibit a richer habitat, with common perennials such as *Echinops spinosissimus*, *Echium sericeum*, *Ephedra alata* and *Artemisia monosperma*, and annuals such as *Rumex pictus*, *Ifloga spicata*, *Daucus litoralis*, *Centaurea glomerata* and *Plantago squarrosa brachystachys*. New sand depositions cover vast saltmarsh areas and are co-dominated by *Stipagrostis lanata* and *Inula crithmoides*. Common annual species include *Ifloga spicata*, *Ononis serrata* and *Erodium gruinum*. The maritime saltmarshes extend from the foot of the youngest dunes to the seashore to the true sabkha and are co-dominated by *Arthrocnemum macrostachyum*, *Halocnemum strobilaceum*, *Juncus acutus* and *Salicornia fruticosa*. The most common annuals are *Halopeplis amplexicaulis*, *Spergularia marina* and *Senecio desfontainei*. The inland saltmarshes are co-dominated by *Schanginia aegyptiaca* and *Salicornia fruticosa*.

Fauna:

Most species of the area are relatively common and are species able to live in close proximity to man. On the other hand, the Desert Monitor (*Varanus griseus*) was recorded for the first time in the Delta from the Idku sand dunes.

This Coastal Unit includes Lake Idku and Nile River.

Lake Idku:

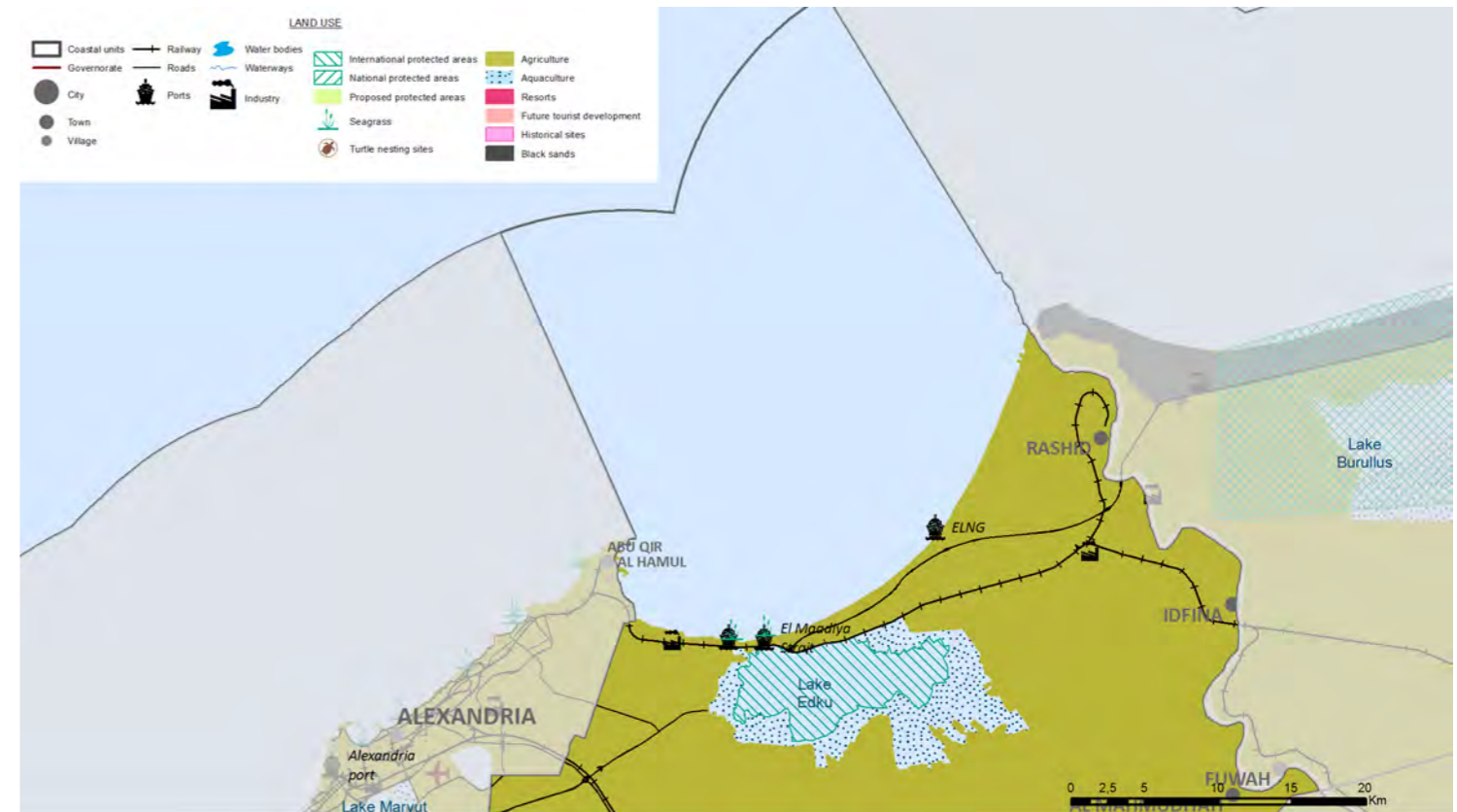
Lake Idku is a shallow coastal wetland located west of the Rosetta Nile Branch. Three main drains discharge into the lake, while Bughaz El Maadia provides a connection with the sea. The water in the lake is mainly fresh, but increases in salinity towards the Bughaz and during summer. Salt marshes, Salinas and high dunes as well as some orchards are found on the sandbar separating the lake from the Mediterranean. The lake supports a fishery of moderate importance. Lake Idku is of moderate importance for both wintering and breeding waterbirds. However, it is included among the "Important Bird Areas" of Egypt (IBA Criteria: A4iii). The lake probably supports important numbers of breeding birds associated with reed swamps such as: Purple Gallinule (*Porphyrio porphyrio*), Little Bittern (*Ixobrychus minutus*) and Senegal Coucal (*Centropus senegalensis*).

Nile River:

It empties into the Mediterranean Sea at Rosetta. There is a considerable amount of urbanization along the Nile.



Disturbed vegetated sand mounds, El Tabia



DIAGNOSIS OF PRESENT SITUATION

Current impacts and threats

The coastal zone is highly affected by anthropogenic activities. Major landscape changes have taken place during the last decades. The area is almost entirely occupied by factories and other establishments which prevent access to the beach in many parts of the sector. As a result, the main subsystems that characterize the Deltaic Mediterranean Coast are absent or partially represented. Main impacts include:

- Atmospheric pollution
- Wastewater discharge
- Solid waste
- Impacts on Lake Idku and lake reclamation
- Fishing and aquaculture
- Agriculture and land reclamation
- Use of pesticides
- Grazing of domestic animals
- Commercial exploitation of wildlife

Coastal unit status

Biodiversity:

- Extension of natural habitats: Low
- Loss of natural habitats: High
- Existence of protected areas: No
- Existence of IBAs: Yes (1)
- Number of endemic/threatened species: Low
- Number of protected species: Low

Natural resources:

- Inland fisheries stocks: Medium
- Species with potential use: High

Natural water bodies:

- Pollution and contaminants: High

DIAGNOSIS OF LONG-TERM SITUATION

Proposed protected areas: No

SOCIOECONOMIC SYSTEM

The unit hosted 1,762,410 inhabitants in 2006, of which 80.2% lived in rural areas (Al Mahmudiyah, Abo Hummus, Kafr Ad Dawwar, Idku and Rashid villages). The unit is considered one of the largest agricultural areas in the delta. Industrial activity is also significant; the food industry represents the major percentage of industrial sector followed by textile industries as well as petrochemical industries between Idku and Rashid Ports. Also, the Abu Qir industrial area is located within this unit.

- Economic activities: 44.6% agriculture (cotton, wheat, rice, corn, beans, onions, and peanuts) and fishing, 14% manufacturers (weaving, wood, paper, food, beverages, tobacco, basic chemicals, ceramics, basic metallurgy, and other manufacturing industries).
- Cultural and heritage: Rosetta stone, Citadel of Qaitbay and many of the ancient buildings in Rosetta. Also, 68 site scattered in delta such as Kom el Ghoraf, Kom el Abd, Kom el Barka and Kom Aziza.
- Social groups and ethnicities: rural and urban residents.



Industrial area in Abu Qir bay.

DIAGNOSIS OF PRESENT SITUATION

- Fair educational facilities: 1,260 schools and sections, 12,261 classrooms, and 1 teacher per 25.8 students in 2010. High illiteracy rate reaches 37% at governorate level.
- Lack of health care facilities: 7 public hospital, 1 specialized hospital, 1 insurance authority hospital, 5 private hospitals, 1,063 physicians, and 31 ambulances in 2010.
- Unemployment rate: 9.5% .
- About 35.7% of the population was classified as poor in 2013.
- Lack of infrastructure services, especially sanitation and potable water.
- There are many ports, Idku port liquefied gas, El Maadiya fishing port and river fishing dock at Rashid city.
- Allocation of services to rural and urban areas is disproportionate, with poor quality services at rural clusters.
- Stakeholders propose enhancing the lifestyle of fishermen and their families through:
 - (i) Inland water purification/treatment/rehabilitation and increasing the size of free fishing, and
 - (ii) educating and guiding fisherman in order to increase their awareness on environmental problems.

DIAGNOSIS OF LONG-TERM SITUATION

- Proposed to construct an industrial area at El Boseli.
- Develop fishing ports.
- Different developments in Idku area: tourism, residential and 140 acres of industrial area.
- Proposed industrial area of 200 acres at Rashid.
- Proposed to construct sanitary wastewater treatment plant at Rashid, Abo hams, and Idku.
- Improving efficiency of roads connecting rural clusters.
- Utilizing overpopulation of coastal Delta sectors for urban development of under populated sectors and new cities.
- Limited involvement of the local communities in decision making and taking processes.
- Weak coordination and cooperation among resources local authorities.
- Insufficient resources for development plans which lead to delay its implementation.

PLANS AND PROJECTS

EXISTING STUDIES

- Adaptation to Climate Change in the Nile Delta through ICZM (CORI-SPA (MWRI), 2009-2016).
- Exploration and evaluation of sediment dredged from harbors and pathways off the Nile Delta coast for better environmental and economic use, with Academy of scientific Research and Technology, Egypt (CORI, 2009-2013).
- Historical shoreline changes and measures the hydrodynamic forces at LNG Plant Site, Idku - Abu-Quir Bay (CORI, 2007).
- Base map studies for the coastal area at LNG Plant Site, Idku - Abu-Quir Bay with HR Wallingford (CORI , 2001).
- Studying the wave climate at Abu-Quir bay (CORI, 2003-2004).
- Studying the erosion problem west of the western revetment of Rosetta (CORI 2003-2004).
- Studying the drainage problems on Lake Idku, Delta coast (CORI, 2003).
- Environmental Assessment for the coastal area in Rasheed and Idku 1996 (TDA, 1996).
- Protection of Rashed shores (stag 1,2,3) (SAP).

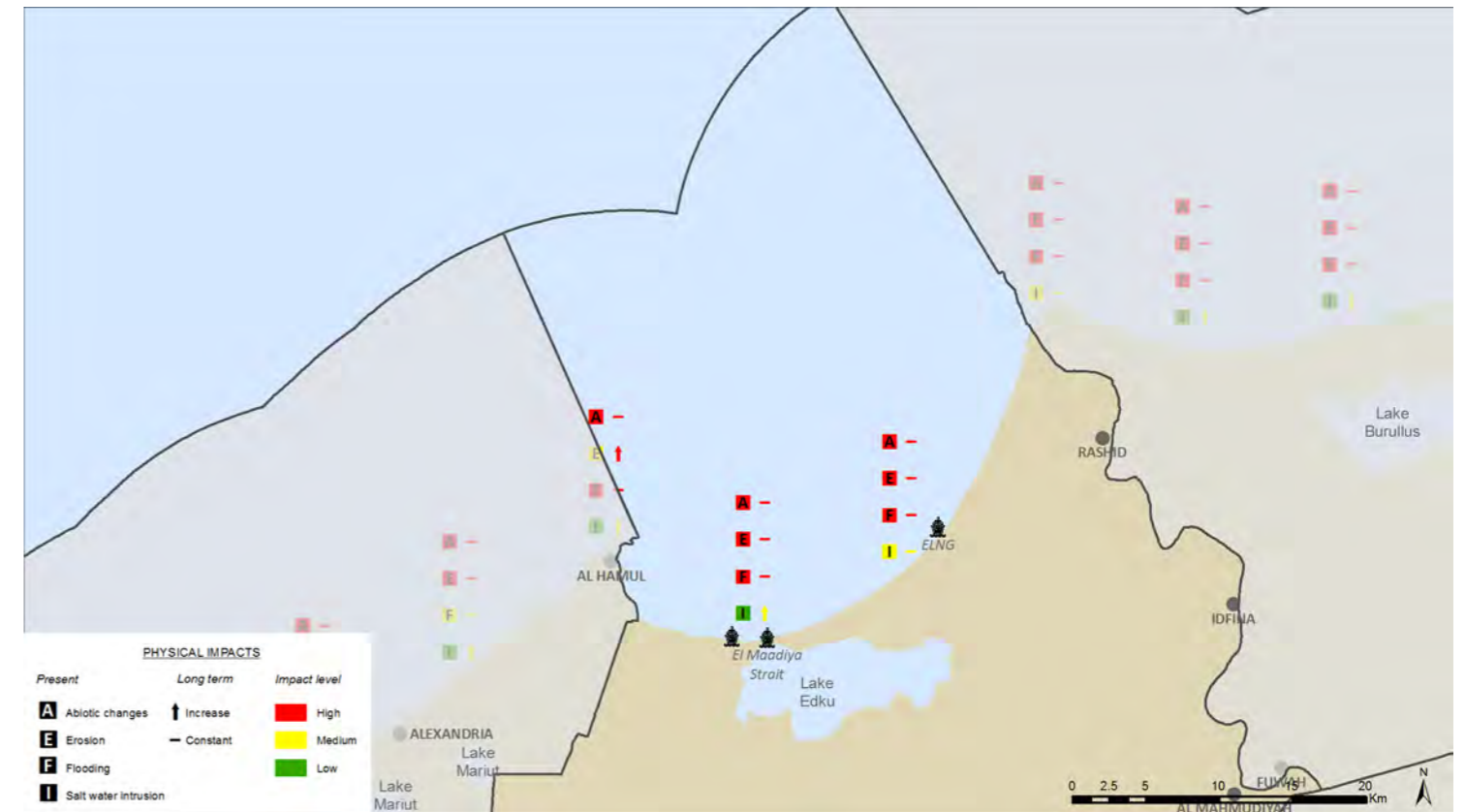
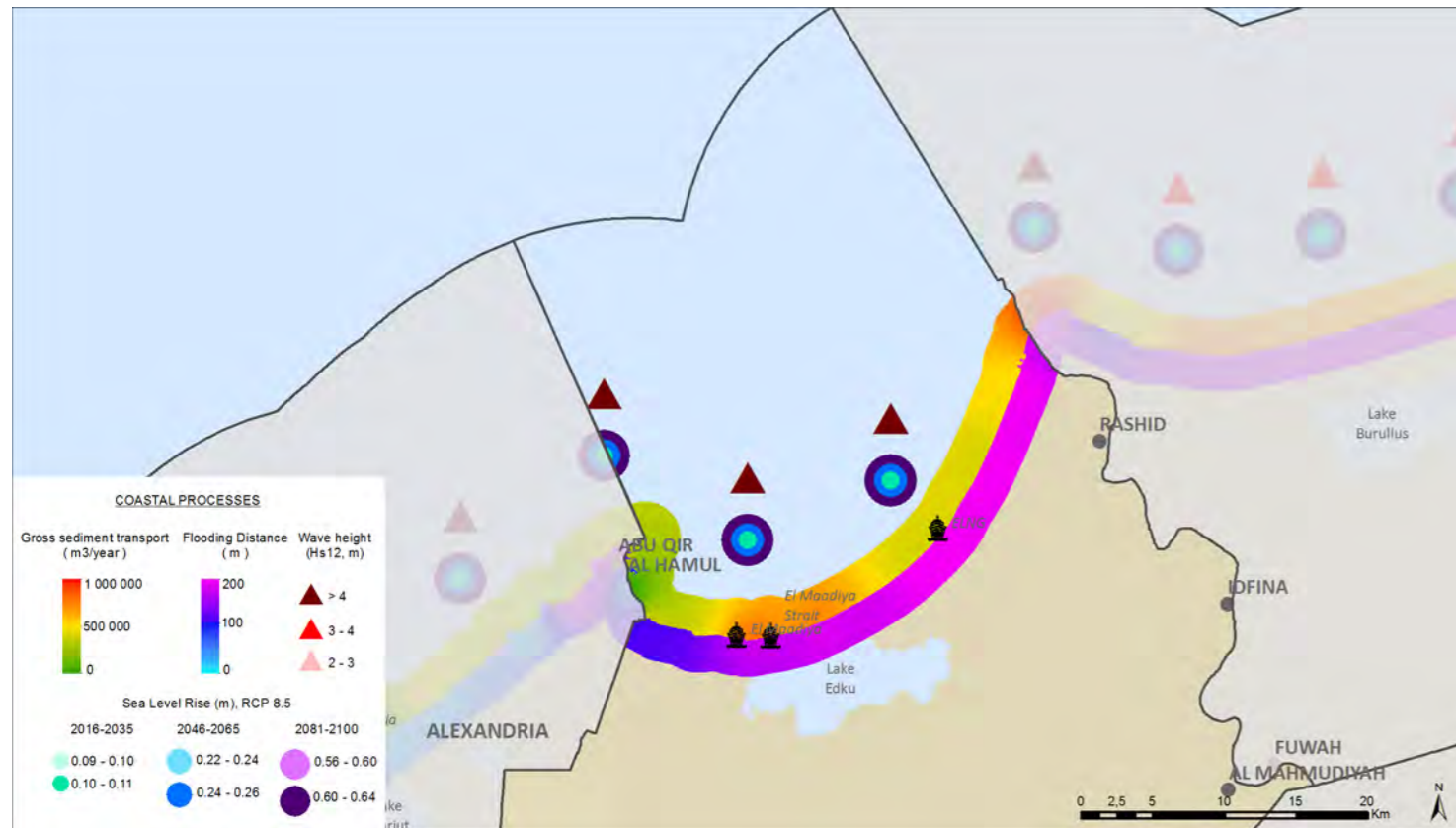
LONG-TERM DEVELOPMENT STUDIES

- Strategic Urban Plan for Beheira Governorate (GOPP, 2008).

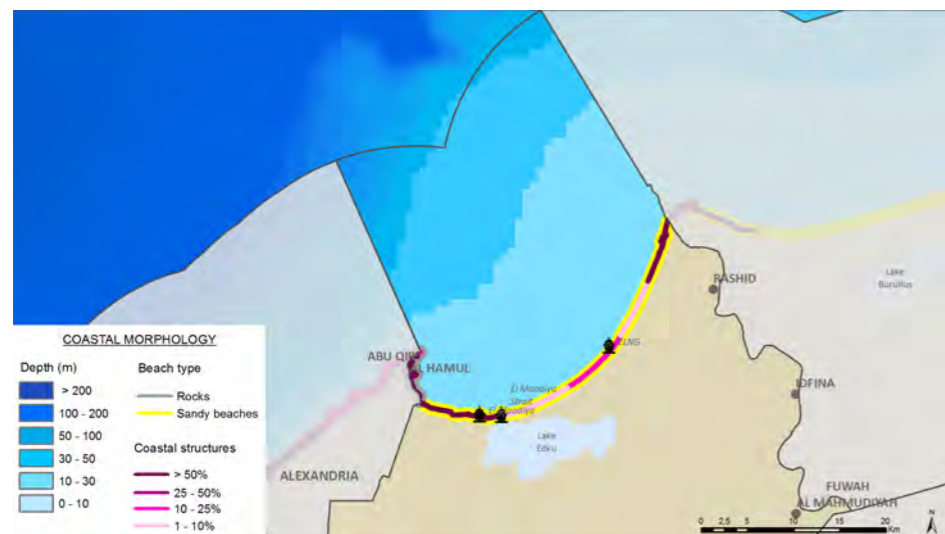
LOCAL STAKEHOLDERS

Name	Type	Website
Beheira Governorate	Authority	https://en.wikipedia.org/wiki/Beheira_Governorate
EEAA West Delta Regional Branch Office in Alexandria	Authority	http://www.eeaa.gov.eg/
Shore Protection Authority– Alexandria Administration	Authority	http://www.mwri.gov.eg/ShoreProtectionflowchart.aspx
GAFRD Western Region	Authority	http://www.gafrd.org/
Central administration for the fishing wealth affairs in the western area El Beheira Area	Authority	

Name	Type	Website
Egyptian Company for Liquefied Natural Gas	Authority (Port Management)	
Fish farms by Idku Lake	Private sector (aquaculture)	
Idku City Industrial Zone	Private sector (industrial)	
Idku for Liquefied Natural Gas Company	Private sector (industrial)	
Rosetta Oil Company	Private sector (industrial)	
Petrojet Company– Petrojet Ma'adiya	Private sector (industrial)	



PHYSICAL SYSTEM



General description:

The coastal unit is the unit of the bay of Abu Qir. It extends from Abu Qir headland (W boundary) to Rosetta promontory (E boundary) and includes the Idku lagoon which drains into the sea at Maadia (Idku strait). As all the Nile delta units the landscape is characterized by low relieves and a large part of the cells is formed by wetlands (sabkhas). The Maadia outlet can be seen as a boundary between (1) the highly entropized W coastline (Abu Qir - Maadia) as an extension of Alexandria W coastal unit and (2) the more preserved coastline with larger coastal setbacks (apart at Abu Qir LNG plant) and some sand dunes systems.

Beaches:

Because of the high anthropization, beaches are almost inexistent in the W part (Abu Qir port - Maadia). The exception is at the beginning (El Amia drain) / end of Muhammed Ali Sea Wall and at Maadia. From Maadia to Rosetta, beaches are long open sandy beaches with gentle slope and fine deltaic sediment.

Coastal structures:

(1) The W part is almost entirely rigidified with the Abu Qir Port coastline, the Mohamed Ali Seawall and the protection structures built by the different industries. (2) Sea groins for nav-

DIAGNOSIS OF PRESENT SITUATION

Erosion:

Erosion is high all along the unit apart the most W part (Abu Qir ports) where sediment transport is weak. Erosion issues in the W part (Abu Qir port - Maadia) are however limited because of the presence of hard structures, the issues concern the no-rigid coastal stretches. From Maadia to Rosetta promontory the alongshore sediment transport changes in direction. It is directed SW at Rosetta promontory and has a concentration point around Idku ELNG port. A specific local study including wave diffraction processes is needed for a more accurate description of the alongshore sediment transport in the area. Cross-shore sediment transport is maximum (maximum values of the entire Egyptian coastline) in the W coastal unit. Erosion issues are also limited in the E boundary where coastal structures are present, they are displaced toward the SW because of the SW directed longshore transport.

Flooding:

Flooding is medium in the most W part and high from Muhammed Ali sea wall to the Rosetta promontory (although the issues are smaller than indicated in the protected areas).

The coastal protection structures can cause side effects in the neighborhood coastal stretches. This high flooding is mainly related to the strong wave exposition (high wave setup/runup) associated to low-lying topographies.

Saltwater intrusion: Medium saltwater intrusion all along the whole unit.

Abiotic stress: High degree of abiotic stress due to the physical conditions given within the unit, which leads to the absence of neither *Posidonia oceanica* nor any other seagrass meadows.

Port downtime: Currently, the number of hours that El Maadiya Port is inoperable due to overtopping rates over 0.1 m³/s/m exceeds 200, leading to a medium degree of the impact.

Siltation: High siltation issues in Idku strait because of the strong gross longshore transport in the area. Medium issues at Idku ELNG port because of the medium gross longshore transport. However the problems can be exacerbated because of the location of the port in an area of sediment transport concentration.

DIAGNOSIS OF LONG-TERM SITUATION

Erosion: Erosion issues remain the same at long-term (high from Maadia to Rosetta promontory), although problems can be exacerbated due to shoreline retreat associated to sea level rise.

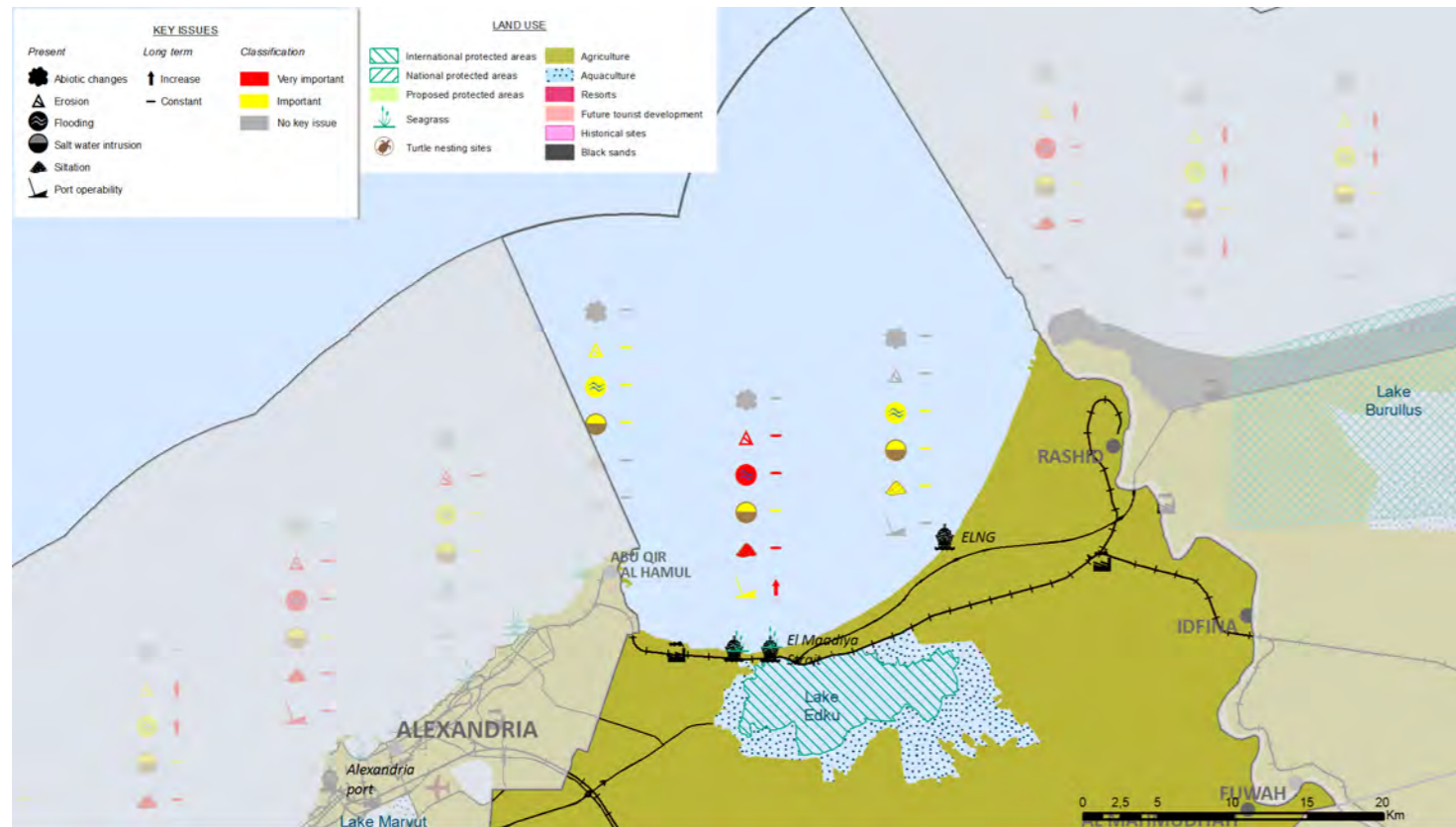
Flooding: For the different scenarios (including near term scenario), flooding is expected to be high all along the unit due to projected sea level rise affecting the lower areas.

Saltwater intrusion: Saltwater intrusion is expected to remain at medium degree in both the near and the long-term.

Abiotic stress: Increases in mean sea surface temperature will even exacerbate physical conditions, hence impeding the development and growing of seagrass meadows neither in near nor in long-term.

Port downtime: The degree of port downtime in El Maadiya Port will change from medium to high in the near and the long-term, exceeding in both cases 300 hours per year of overtopping rates higher than 0.1 m³/s/m

Siltation: Siltation issues are expected to remain unchanged in all the scenarios due to small differences in projected sediment transport (<2%). High at Idku strait and medium at Idku ELNG port.



SWOT ANALYSIS

STRENGTHS

- Strong industrial and agricultural activities.
- Oil & gas sector well established.

WEAKNESSES

- Pollution in Lake Idku from agriculture drains, industrial activities and untreated sewage have highly affected the coastal zone.
- Pollution in Lake Idku due to aquaculture activities.
- Environmental pollution due to petrol and gas activities.
- Reduced area and sedimentation of Lake Idku.
- Poor quality services at rural clusters .
- Lack of infrastructure services, specially sanitation and portable water .
- High population density.

OPPORTUNITIES

- Implementing Strategic urban Plan.

THREATS

- Loss of biodiversity in Lake Idku.
- Loss of lake due to shrinking and sedimentation.
- Loss of free catching area in the lake.

KEY ISSUES FOR COASTAL MANAGEMENT

PRESENT KEY ISSUES

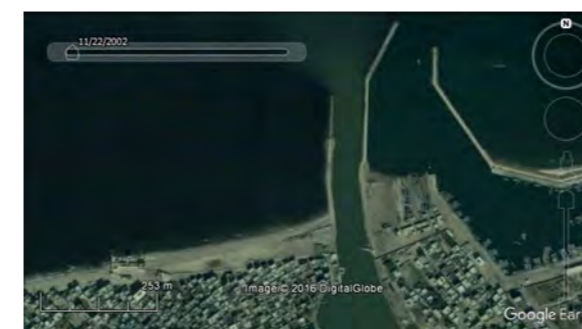
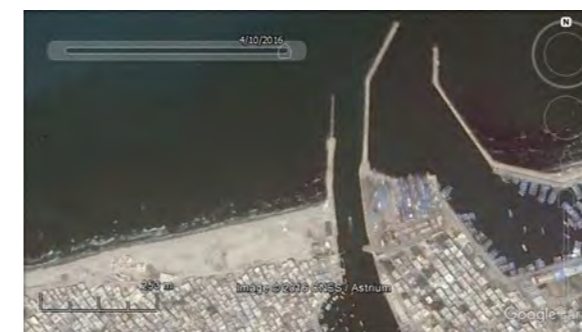
Key Issues of CU 08 are:

- High erosion level along the unit that can provoke derived impacts on industries in Abu Qir area.
- High flooding level along the unit that can provoke derived impacts on industries in Abu Qir area.
- Flooding on agricultural areas.
- Medium overtopping level in El Maadiya petroleum and fishing ports.
- High siltation level El Maadiya petroleum and fishing ports.
- Medium siltation level in ELNG petroleum port.
- Loss of biodiversity in Lake Idku.
- Polluted sea and lake waters. Abu Qir bay is one hotspot for the Eastern Mediterranean Large Marine Ecosystem, caused by factories, oil companies and other sources.
- Developments on low lying areas.

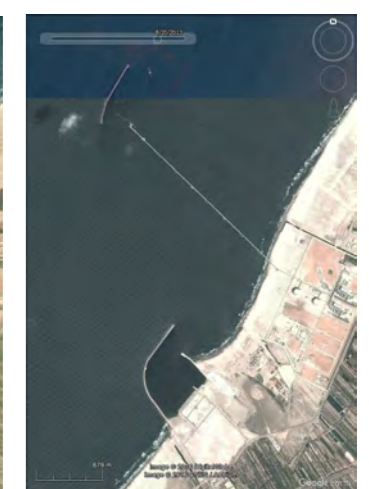
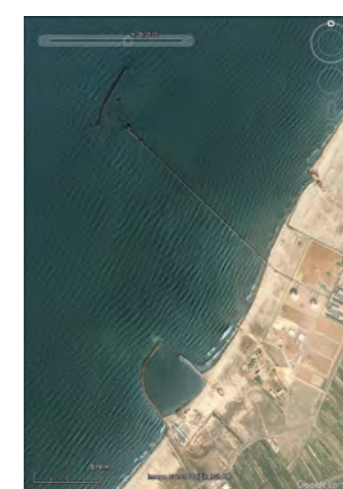
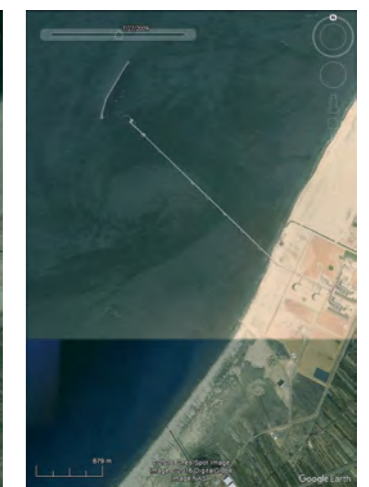
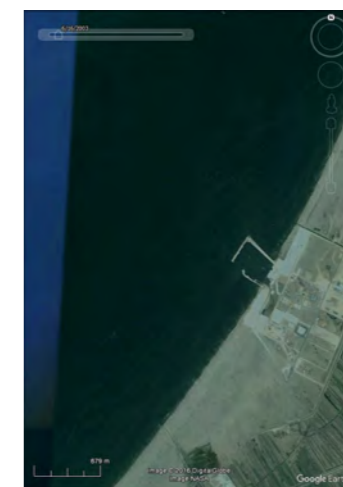
LONG-TERM KEY ISSUES

Development plans were not identified for Beheira Coastal Unit. Therefore, the changes in long-term Key Issues correspond to changes in physical impacts due to climate change:

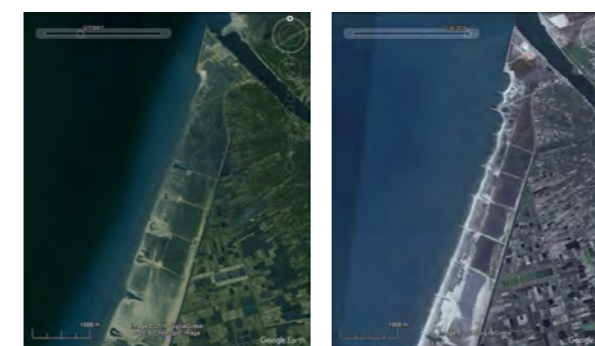
- Increased overtopping in El Maadiya ports, decreasing port operability.
- According to stakeholders opinion, negative impacts of the Western delta projects (western delta group) on the lake and their effects on the managing and developing plans of the GARFD and their direct effects on the lake ecosystem.



Maadia beach. Sediment deposition westward of Idku inlet because of the presence of the groin. This means sediment deficit eastward.



Abu Qir ENLG port. Up: Destruction of previous port and construction of off-shore breakwater (left: 2003, right: 2009). Down: deposition eastward the port, leading to siltation issues and erosion westward.



Coastal protection structures at Rosetta promontory . Construction of new sea groins (left: 2007, right: 2016)

COASTAL UNIT 09 - BURULLUS



GENERAL DESCRIPTION OF THE COASTAL UNIT

Burullus Coast Unit covers the western Nile Delta and includes its apex. This unit is completely included within Kafr El Sheikh Governorate. Most of the area of this unit is occupied by Lake Burullus, protected under national and international figures.

- Coastal Length: 64 Km.
- Governorate: Kafr El Sheikh.
- Markaz: Desouk, El Burullus, El Hamoul, El Riad, Fowa, Motubas, Sidi Salem.

ECOLOGICAL SYSTEM

This sector has a high percentage of natural habitats and includes Lake Burullus Protected Area. A power plant is under construction within the coastal part of the protected area resulting in the destruction of valuable habitats. The protected area boundaries are currently being modified by the EEAA to exclude the coastal area.

Habitats:

The following habitats are present in this sector: sandy beaches, sand formations, saltmarshes, sabkha, agricultural fields, irrigation canals and drains, villages and human settlements. Tell El Aqoula is located on the eastern boundary of the power plant construction site. It is an archaeological site covered with sand forming an elevated area, and one of the richest sandy habitats on the sand bar.

Flora:

There are 197 species of plants recorded from the Burullus wetland (100 annuals and 97 perennials, including 12 hydrophytes). Reedbeds within Lake Burullus are estimated to cover about 7,000 ha and represent one of the most important reedbeds in the Mediterranean region. *Pancreatium maritimum* is restricted to the area of Tell El Aqoula.

Fauna:

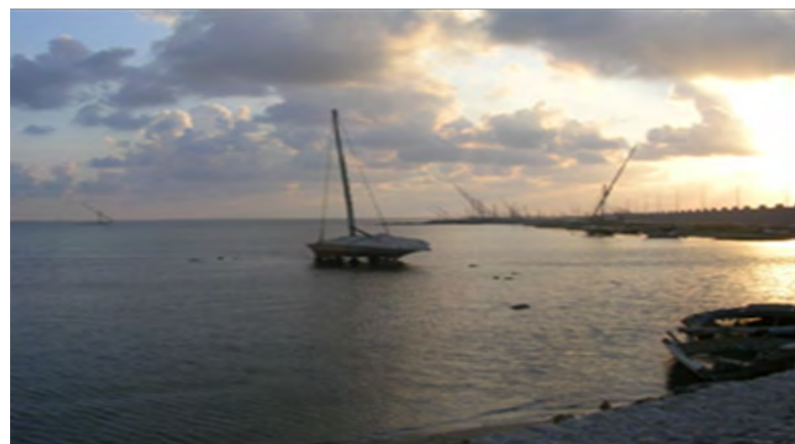
Five amphibians and 18 reptiles have been reported from the Lake Burullus area, in addition to 112 species of birds and 18 species of mammals. Several species are threatened, rare and/or endemic.

Lake Burullus Protected Area:

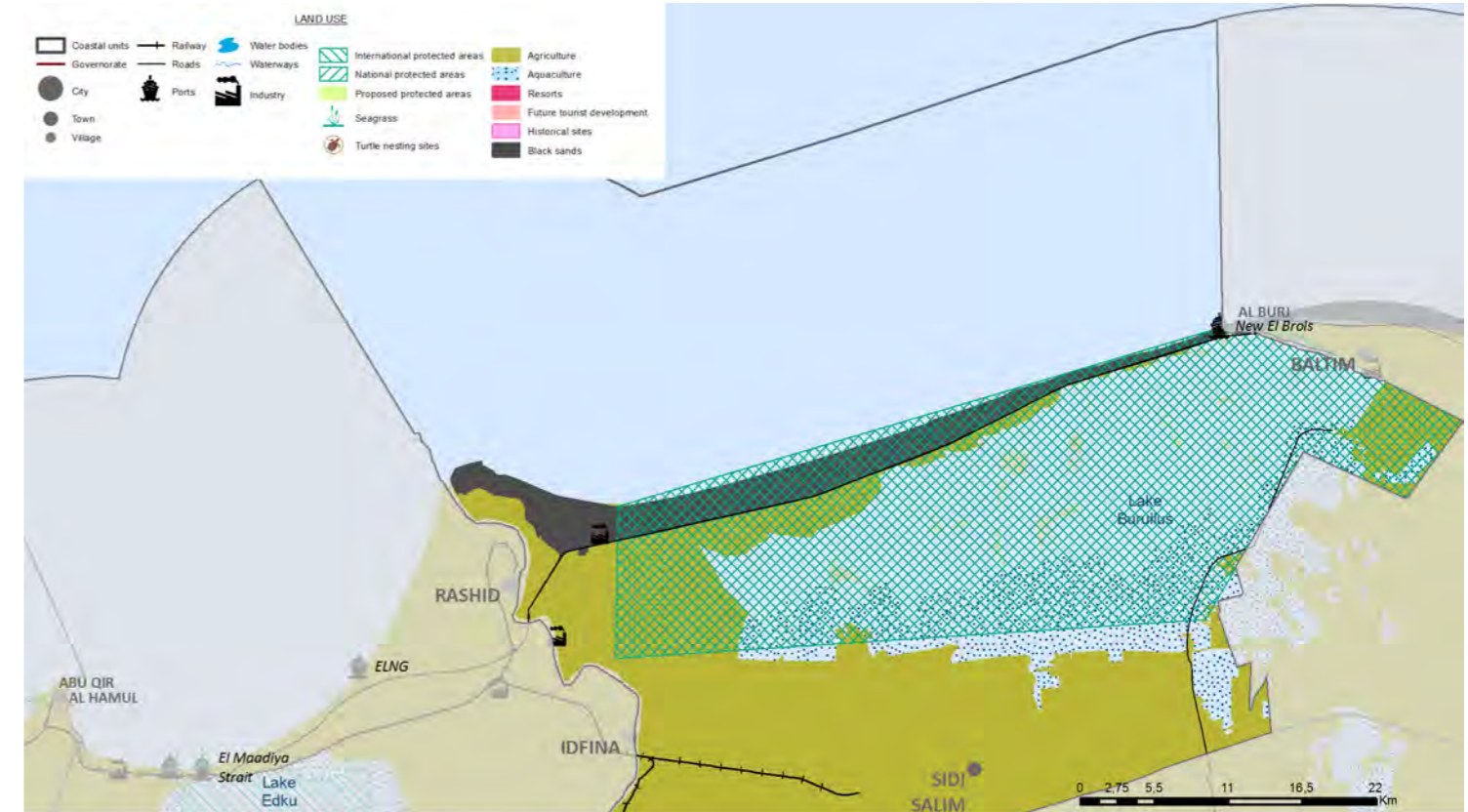
Established according to Prime Minister's Decree 1444/1998. The protected area currently includes the lake and the coastal area to the Mediterranean shoreline. Lake Burullus is one of Egypt's most important wetlands for wintering waterfowls. It is a Ramsar site and is included among the "Important Bird Areas" (IBAs) of Egypt (IBA Criteria: A1, A4i, A4iii). The lake is a shallow brackish lake, connected with the sea by a small outlet (Bug haz), about 50m wide near Burg El Burullus. The length of the lake is about 65 km, and the width varies between 6 and 16 km, with an average of about 11 km. The depth of the lake ranges between 0.42 and 2.07 m. The lake is separated from the sea by a broad, dune-covered, sand barrier, which varies in width from a few hundred meters in the east to five km in the west. The present area of lake Burullus is 420 km² of which 370 km² is open water. There are some 50 islands scattered throughout the lake with a total area of 0.7 km². Three groups of habitat types are common in this lake: Reed swamps in brackish water sites. These are often adjoined with submerged hydrophytes in deeper water areas; salt marsh habitat in islands and coastal fringes of the lake; Sand formations (sheets and dunes) in sea coastal belt.

Nile River

It empties into the Mediterranean Sea at Rosetta. There is a considerable amount of urbanization along the Nile.



Lake Burullus



DIAGNOSIS OF PRESENT SITUATION

Current impacts and threats

Construction of a power plant has resulted in the destruction of valuable habitats containing important sets of biodiversity. Potential modification of the protected area boundaries might result in the exclusion of the sandy biotopes of the coastal area, which are, from an ecological perspective, of even greater importance than the lake. The lake itself is subject to a strong salinity gradient and suffers from the inflow of large amounts of water contaminated with fertilizers and pesticides causing nutrient-enrichment. Other impacts include:

- Reclamation of Lake Burullus.
- Fishing and aquaculture.
- Agriculture and land reclamation.
- Use of pesticides.
- Grazing of domestic animals.
- Feral animals.
- Invasive species.
- Hunting and commercial exploitation of wildlife.

Coastal unit status

Biodiversity:

- Extension of natural habitats: High.
- Loss of natural habitats: Medium.
- Existence of protected areas: Yes.
- Existence of IBAs: Yes (1).
- Existence of Ramsar Sites: Yes.
- Number of endemic/threatened species: High.
- Number of protected species: High.

Natural resources:

- Inland fisheries stocks: High.
- Species with potential use: High.

Natural water bodies:

- Pollution and contaminants: High.

DIAGNOSIS OF LONG-TERM SITUATION

Proposed protected areas: No.

SOCIOECONOMIC SYSTEM

The unit hosted about 949,485 inhabitants in 2006, of which a total of 81.0% lived in rural areas, as Sidi Saum village. The unit hosts a variety of industries, e.g., oil & gas in Motobas, handmade kleem and carpet in Fowa. The areas falling on the mouth of the Mediterranean Sea (mainly Motobas district) are famous spots for illegal migration to North Africa and then to North of the Mediterranean in Europe.

- Economic activities: 55.0% agriculture (rice, sugar beet, wheat, and cotton) and fishing (Motobas is an important fishing spot in the Nile and the Sea, in addition to fish cages and fish farms in Burullus lake), 8.9% whole sale and retail trade. There is an industrial area in Motobas.
- Cultural and heritage: About 35 sites such as Kom Mattawbas, Tall El Felows, Tall Sidi Salem.
- Social groups and ethnicities: Rural and urban residents.

DIAGNOSIS OF THE PRESENT SITUATION

- Lack of educational facilities: 2620 schools and sections, 6,009 classrooms, and 1 teacher per 22.1 students in 2010. High illiteracy rate: 37.7% .
- Lack of health care facilities: 5 public hospital, 1 insurance authority hospital, 923 physicians, and 20 ambulances in 2010.
- Unemployment rate: 8.5% .
- About 21.6% of the population was classified as poor in 2013.
- The unit suffers from typical problems in rural Egypt, e.g., lack of infrastructure services, especially wastewater treatment plants and potable water. Level of services provided is lower than the national standard level.
- The pollution of waterways which affects the fish resources in the area.
- Unsafe management procedures for fish farms due to ecosystem deterioration.

DIAGNOSIS OF LONG-TERM SITUATION

- Installing agricultural wastewater treatment plant with the wetland & biofilter system before discharge to Burullus Lake.
- Establish touristic camps within Burullus protectorates islands that include services area and landscape.
- Establishing Burullus power plant which will produce 4,800 megawatts.
- Construct fishes manufacturing, preparing, packaging plants.
- Increase the efficiency of the important transverse axis in the governorate from Blkas in the east extending west passing by EL-Hamol, EL-Ryad, Sidi Salem ending in the west of the governorate at Motobas.
- Non compliance with the strategic plans for this area by establishing Burullus power plant within the protectorates borders and in the area of eco-touristic activities.
- Utilizing overpopulation of coastal Delta sectors for urban development of under populated sectors and new cities.
- Improving efficiency of roads connecting rural clusters.
- Limited involvement of the local communities in decision making and taking processes.
- Weak coordination and cooperation among resources local authorities.
- Insufficient resources for development plans which lead to delay its implementation.
- SFD is diagnosing cluster problems of local industries, e.g., handmade kleem & carpet in Fowa.



Ship construction works, Burullus fishing port.

PLANS AND PROJECTS

EXISTING STUDIES

- Adaptation to Cimate Change in the Nile Delta through ICZM (CORI SPA, 2009-2016).
- The Burullus and Baltim sand dune system and surrounding areas, Kafr el Sheikh Governoratte, Nile Delta (MWRI, 2013).
- Ebrahim M. Eid, Kamal H. Shaltout, 2013. Evaluation of carbon sequestration potentiality of Lake Burullus, Egypt to mitigate climate change. <http://dx.doi.org/10.1016/j.ejar.2013.04.002>.
- Exploration and evaluation of sediment dredged from harbors and pathways off the Nile Delta coast for better environmental and economic use, with Academy of scientific Research and Technology, Egypt (CORI, 2009-2013).
- Study the Sedimentation of Lake Outlets and Coastal Openings (CORI, 2002).
- Support to the Egyptian Protected Areas Project (EAA).

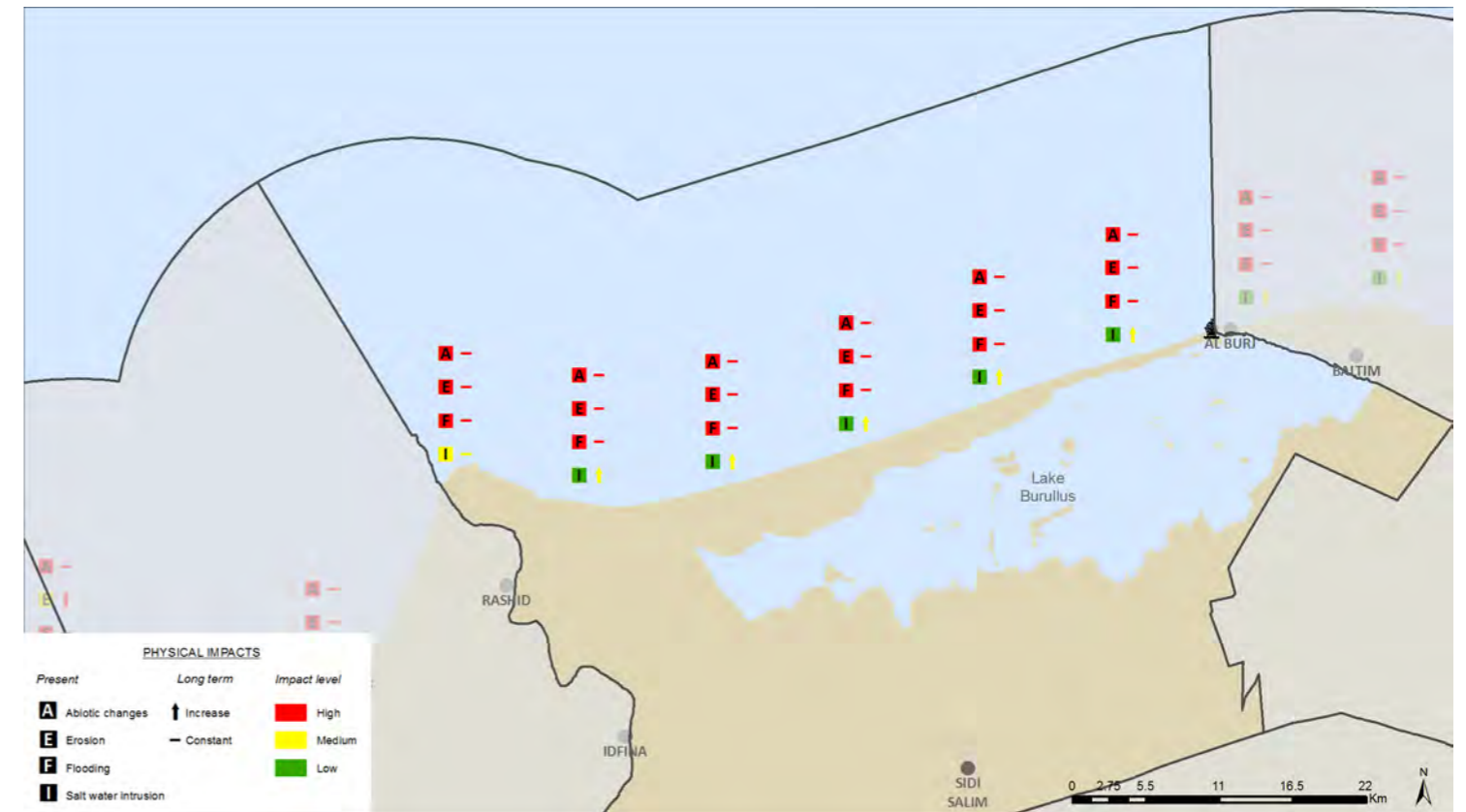
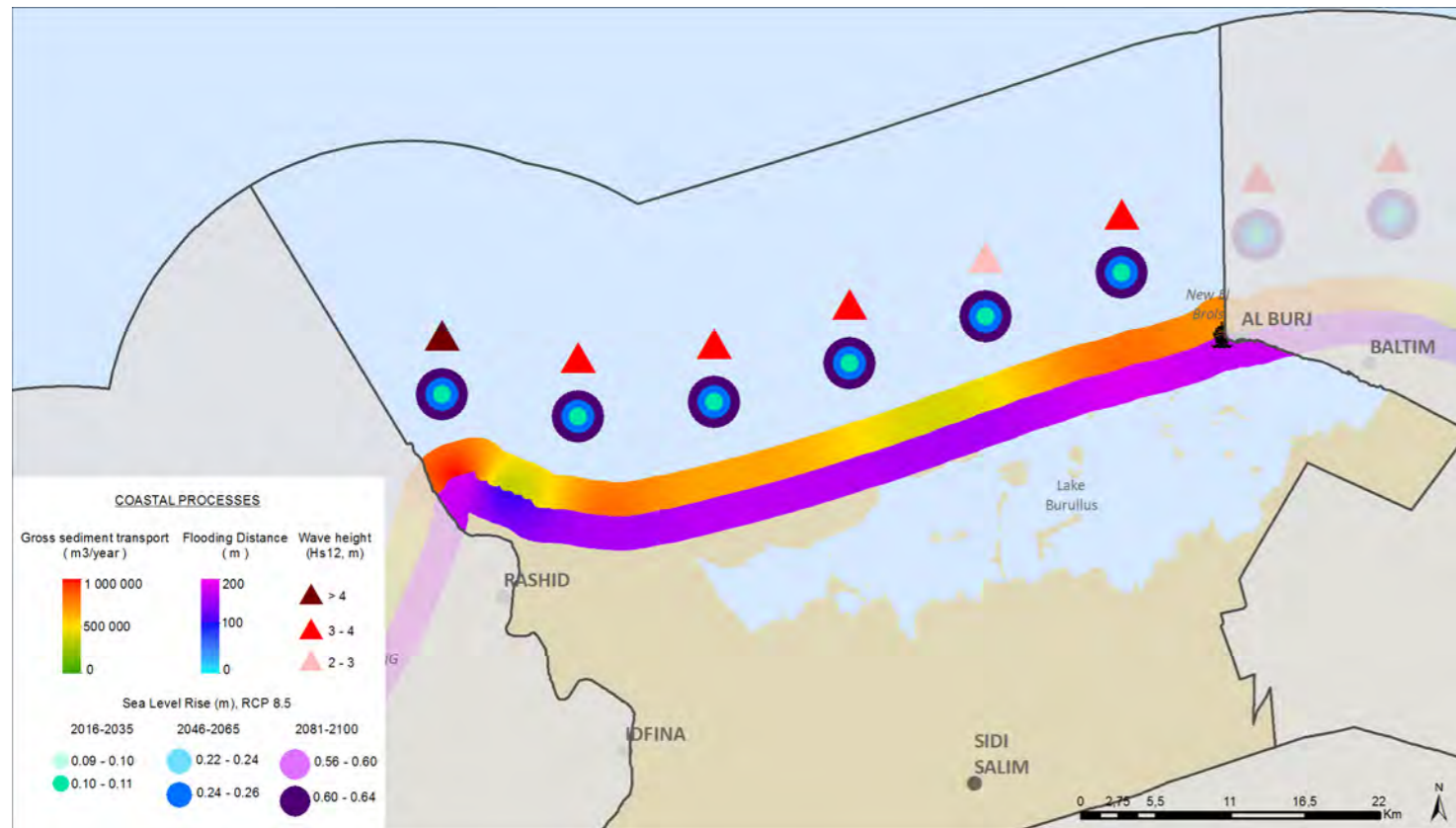
LONG-TERM DEVELOPMENT PLANS

- Under the Strategic Plan for the Northern Coast (GOPP, 2010) it is planned to create a new a city east to Rosetta, tourism development between Rosetta and Al Burj fishing port and industrial development westward Rosetta.
- Strategic Development Plan for Kafr El-Sheikh Governorate (GOPP, 2015).
- Stakeholders identified the following planned developments: i) Black sands extraction in Burullus area, ii) Power plant in Burullus, iii) the dredging in Burullus inlet and lake, iv) the new inlet in Rosetta and the aquaculture westward to Rosetta, v) aquaculture in Burullus Lake.

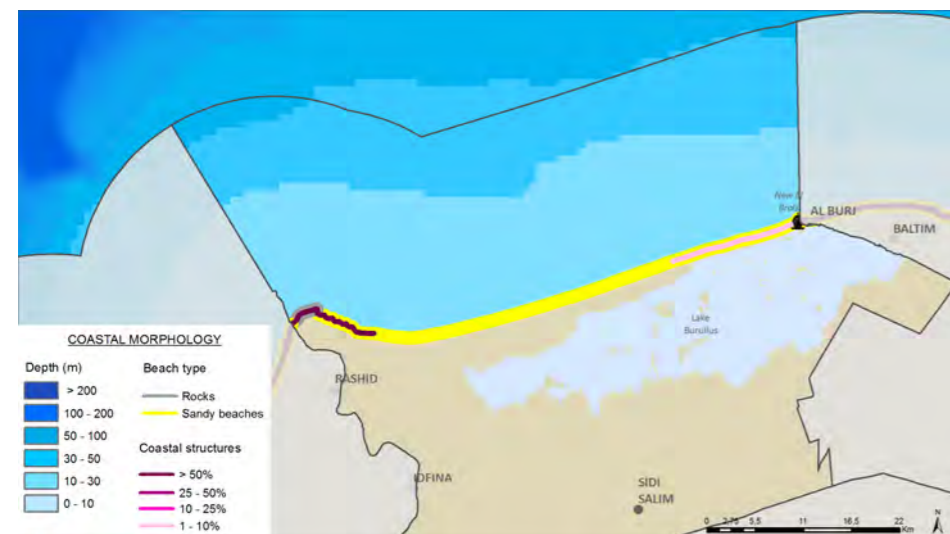
LOCAL STAKEHOLDERS

Name	Type	Website
Kafr el Sheikh Governorate	Authority	www.kafrelsheikh.gov.eg/default.aspx
EEAA Gharbeya Regional Branch Office	Authority	
Shore Protection Authority– Kafr el Sheikh Administration	Authority	http://www.mwri.gov.eg/ShoreProtectionflowchart.aspx
GAFRD Central Delta	Authority	http://www.gafrd.org/
Central administration for the fishing wealth affairs in Mid Delta Area	Authority	

Name	Type	Website
Burullus Protectorate	Authority (environmental protection)	
Egyptian Electricity Holding Company– Burullus Power Plant	Egyptian Company	
Reclamation Farms by Al Burullus	Private sector (farms)	
Reclamation Farms by Burj Mighazil Viillage	Private sector (farms)	
Motobas City Industrial Zone	Private sector (farms)	



PHYSICAL SYSTEM



General description:

The coastal unit extends from Rosetta channel entrance up to Burullus inlet. It contains the Burullus lagoon that is separated from the sea by a 65 km long sand ridge with a minimum width of 500 m close to the lagoon inlet. A coastal dune system acts as natural protection.

Beaches:

Beaches are long open sandy beaches with gentle slope and fine deltaic sediment along the entire unit (except at Rosetta channel entrance).

Coastal structures:

Coastal protection structure located at W and E boundaries of the cell. Sea walls cover the channel entrance and the N part of the Rosetta promontory. A series of breakwaters cover the E part of the promontory over 5 km. Sea groins at the W end of the unit (Burullus lagoon entrance).

DIAGNOSIS OF PRESENT SITUATION

Erosion:

Erosion is high in the entire unit due to strong longshore and cross-shore sediment transport associated with high vulnerability deltaic sandy coast and strong shoreline retreat observed from past observations. Also erosion is fully stopped at Rosetta sea wall and is reduced at Rosetta breakwaters, these hard coastal protections have side effects on the E coastal stretches. However erosion impacts will be reduced in areas protected by coastal sand dunes.

Flooding:

Flooding is high in all the unit because of high flooding level associated with gentle slopes topographies. Whereas the Rosetta sea walls have been designed for high flooding level, this coastal stretch is associated to high flooding because of possible adverse effects on nearby stretches. Coastal dunes will also act as protection for flooding.

Saltwater intrusion:

Medium saltwater intrusion within the entire unit.

Abiotic stress:

High degree of abiotic stress due to the physical conditions given within the unit, which leads to the absence of neither *Posidonia oceanica* nor any other seagrass meadows.

Siltation:

High siltation issues at Rosetta channel entrance and at Burullus channel entrance due to the strong longshore sediment transports in the vicinity (the strongest values of the Egyptian coastline).

DIAGNOSIS OF LONG-TERM SITUATION

Erosion:

The presently observed high erosion will increase in all the scenarios principally due to shoreline retreat due to sea level rise.

Flooding:

The presently observed high flooding will increase in all the scenarios.

Saltwater intrusion:

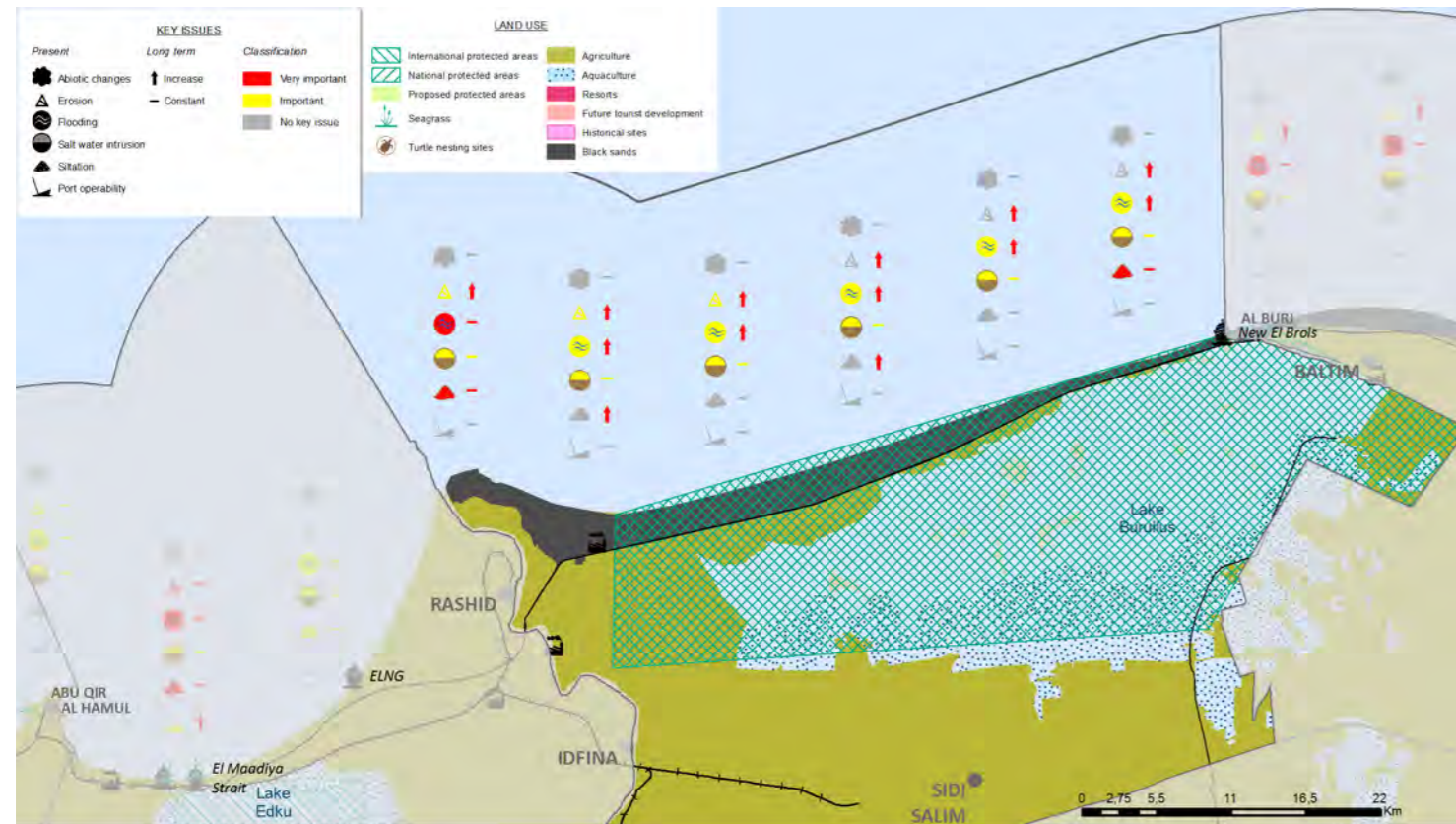
The current medium degree of saltwater intrusion within the unit is expected to remain the same in both the near and the long-term.

Abiotic stress:

Increases in mean sea surface temperature will even exacerbate physical conditions, hence impeding the development and growing of seagrass meadows neither in near nor in long-term.

Siltation:

No changes are expected (siltation issues remain high) as changes in longshore sediment transport are less than 3% in the different channels. Siltation issues are expected to be high in the new Rosetta inlet and Burullus lagoon inlet as gross longshore transport is maximum in this area.



SWOT ANALYSIS

STRENGTHS

- Protected area (national and international protection).
- Most important wetlands for wintering waterfowls.
- Existence of black sand as valuable resource.
- Job opportunities for local communities.
- Regular dredging and seawater coming from inlet.

OPPORTUNITIES

- Sustainable tourism development.

THREATS

- Change in the limits of the protected areas.
- Loss of coastal dunes.
- Loss of biodiversity interest due to pollution.
- Irreversible environmental impact from black sands.

WEAKNESSES

- Construction of power plant is on valuable coastal habitats.
- A considerable amount of urbanization along the Nile and high population density.
- Strong salinity gradient in the lake.
- Inflow of large amounts of water contaminated with fertilizers and pesticides into the lake.
- The protected area boundaries are being currently modified to exclude the coastal area.
- Overfishing.
- Lack of transportation and market facilities.
- Lack of tourism facilities.
- Lack of investment of small projects for local communities.
- Insufficient NGO activities for local communities.
- Irregular income along the year.
- Need for alternatives for fishermen in banning months.
- Lack of security.
- Lack of sewage and solid waste management facilities in villages.

KEY ISSUES FOR COASTAL MANAGEMENT

PRESENT KEY ISSUES

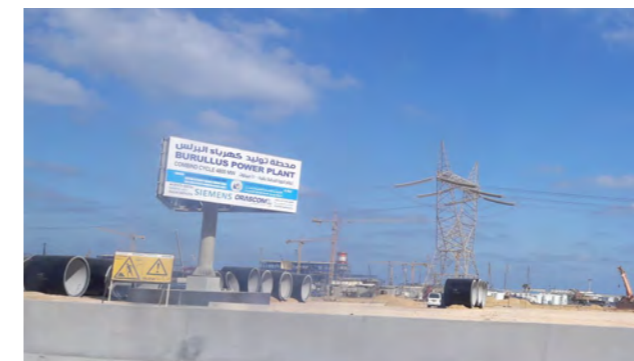
The present Key Issues for CU09 are:

- High erosion level along the whole unit.
- High flooding level along the whole unit
- High flooding level can affect the urban areas around Rashid.
- Flooding can inundate crops on the delta area.
- International Coastal Road could be affected by coastal erosion and flooding.
- High siltation level in Rosetta inlet and El Burullus fishing port.
- Important area for bird conservation.
- Pollution of lake Burullus due to agricultural and industrial activities.
- Invasive species threatening lake biodiversity.
- Environmental impacts due to black sands extraction.
- Stakeholders identified overfishing in Lake Burullus.
- Developments on low lying areas.

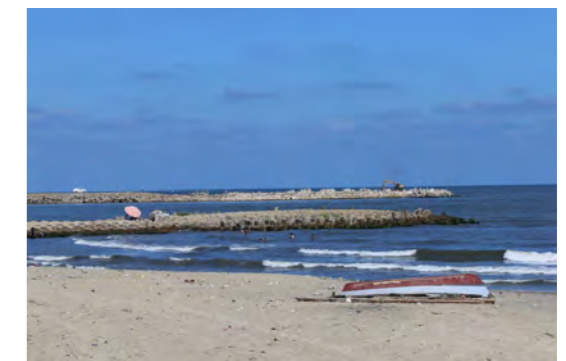
LONG-TERM KEY ISSUES

A variety of future initiatives take place in the coastal front of Burullus Coastal Unit including urban, tourism and industrial developments. High level of physical impacts could limit these developments. All present Key issues remain in the long-term, added to the following:

- High erosion level would affect new Rosetta urban areas and industrial developments.
- High erosion level along the coast affecting new tourism developments.
- High flooding level would affect new Rosetta urban areas and industrial developments.
- High flooding level along the Coastal Unit affecting new tourism developments.
- High siltation level in new inlets identified by stakeholders.
- Loss of coastal dunes (important to protect the coast and support biodiversity) due to tourism and industrial developments.
- Decrease of the extension of the protected area.
- Potential conflict between water quality and aquaculture projects.
- Environmental impacts due to black sands extraction.



Construction works, Burullus Power Plant



Burullus inlet



Rosetta sea wall and sea groins. The groins reduced erosion locally, the problem is transferred eastward. From left to right: 2003, 2009, 2016. The white line corresponds to the 2009 coastline.



Siltation issues at Rosetta channel. From left to right: 2003, 2009, 2016.

COASTAL UNIT 10 - BALTIM



GENERAL DESCRIPTION OF THE COASTAL UNIT

Baltim Coastal Unit encompasses the eastern part of the Nile Delta, between the apex and the Damietta spit. This unit covers partially two Governorates: Kafr El Sheikh and Dakahlia. The main settlements are Baltim, at Lake Burullus, and Gamassa.

- Coastal Length: 65 Km.
- Governorate: Dakhila and Kafr El Sheikh.
- Markaz: Bella, El Burullus, El Hamoul, Belkas, Sherbeen, Gamassa.

ECOLOGICAL SYSTEM

This unit has a high percentage of natural habitats and includes the Burullus sand dune belt north of the coastal road (known as the "Black Sands" area), and farmlands south of the coastal road.

Habitats:

The following habitats are present in this sector: bare sandy beaches, sand dunes, saltmarshes, agricultural fields, irrigation canals and drains, villages and human settlements. The sand dune belt is the most important among these habitats and the richest in biodiversity.

Flora:

Three main sub-habitats are recognized along the coastal sand dune formations: the top of the dune, the slopes and the interdunal sand sheets. A total of 69 plant species (27 perennials and 42 annuals) were recorded along the different sub-habitats. Cultivations are also present in interdunal areas. Several plants have commercial and social applications.

Fauna:

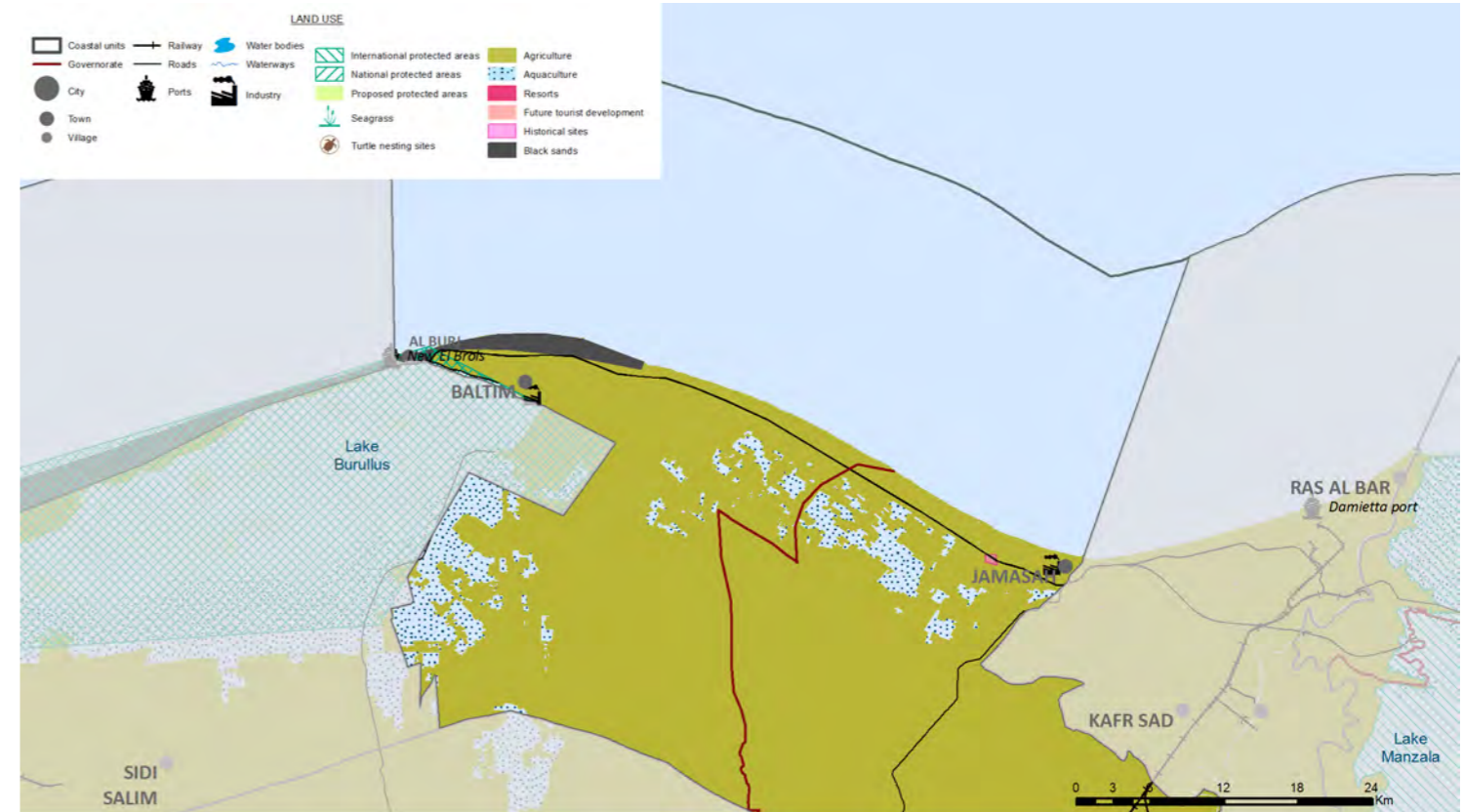
Five of a possible nine Egyptian amphibian species have been recorded in this portion of the Nile Delta region. At least 17 species of reptiles are present, six of which are of conservation concern. Most birds are associated with Lake Burullus. However, 51 species of birds have been recorded in the sand dunes and arable lands of this sector. At least 20 species of mammals are potentially present in this sector, many of which are threatened, endemic and/or conservation concern.



Interdunal cultivations, western part of CU10



Halophytic coastal vegetation



DIAGNOSIS OF PRESENT SITUATION

Current impacts and threats

The "Black Sands" area has been identified for future sand dune mining and this represents a major threat to this unique area. Other impacts include:

- Sand collection for construction.
- Removal of aquatic vegetation.
- Invasive species.
- Fishing and aquaculture.
- Agriculture and land reclamation.
- Use of pesticides.
- Grazing of domestic animals.
- Commercial exploitation of wildlife.

Coastal unit status

Biodiversity:

- Extension of natural habitats: High.
- Loss of natural habitats: High.
- Existence of protected areas: No.
- Extension of protected areas: NA.
- Number of endemic/threatened species: High.
- Number of protected species: High.

Natural resources:

- Inland fisheries stocks: NA.
- Species with potential use: High.

Natural water bodies:

- Pollution and contaminants: High.

DIAGNOSIS OF LONG-TERM SITUATION

Proposed protected areas: No

SOCIOECONOMIC SYSTEM

The unit hosted 1,421,961 inhabitants in 2006, of which a total of 78.4% lived in rural areas. The major town near to the coast is Baltim with 40,199 inhabitants in 2006.

- Economic activities: agriculture and fishing, whole sale and retail trade, building & construction, industry & manufacture.
- Cultural and heritage: there are 18 sites, such as Tell El kom El Kabier, Tell El Tien, Tell El Ghawett.
- Social groups and ethnicities: rural and urban residents.

DIAGNOSIS OF PRESENT SITUATION

- Fair educational facilities: 1183 schools and sections, 9927 classrooms, and 1 teacher per 20.3 students in 2010. High illiteracy rate: 35%
- Fair health care facilities: 7 public hospitals, 13 private hospitals, 1452 physicians, and 39 ambulances in 2010.
- Unemployment rate: 9.7%
- About 21.2% of the population was classified as poor in 2013.
- There is lack of infrastructure services, for instance, there is not sanitary wastewater treatment plant.
- Fishing port at Borg El-Buullus.
- Location of sugar beet plant at Elhamol and a sugar plant complex at Kalabsho, Markaz Balkas (300 acres).
- Industrial area at Baltim (114 acres) and Gamas (1170 acres).
- Poor infrastructure and poor quality serviced at rural clusters.

DIAGNOSIS OF LONG-TERM SITUATION

- A new fishing port at El Burullus area.
- An eco-touristic center is being stablished at Burullus Lake .
- The sugar plant at Elhamol will be extended and a new beet sugar plant will be located in Bulkas.
- Industrial development through the establishment of new industrial cities. There is a project of industrial free zone preparation in the south of Gamassa.
- Proposed project of integrated touristic center and marina at Gamassa.
- Constructing bridges to increase the connectivity (Bogas Burullus Bridge).
- A redistribution of the population by utilizing overpopulation of coastal Delta sectors for urban development of under populated sectors and new cities.
- Improving efficiency of roads connecting rural clusters.
- Coastal zone management project to address the pollution of water resources and preserve the fisheries' resources of Alexandria.
- Development of infrastructure services to abate the pollution of the water resources of Alexandria.

PLANS AND PROJECTS

EXISTING STUDIES

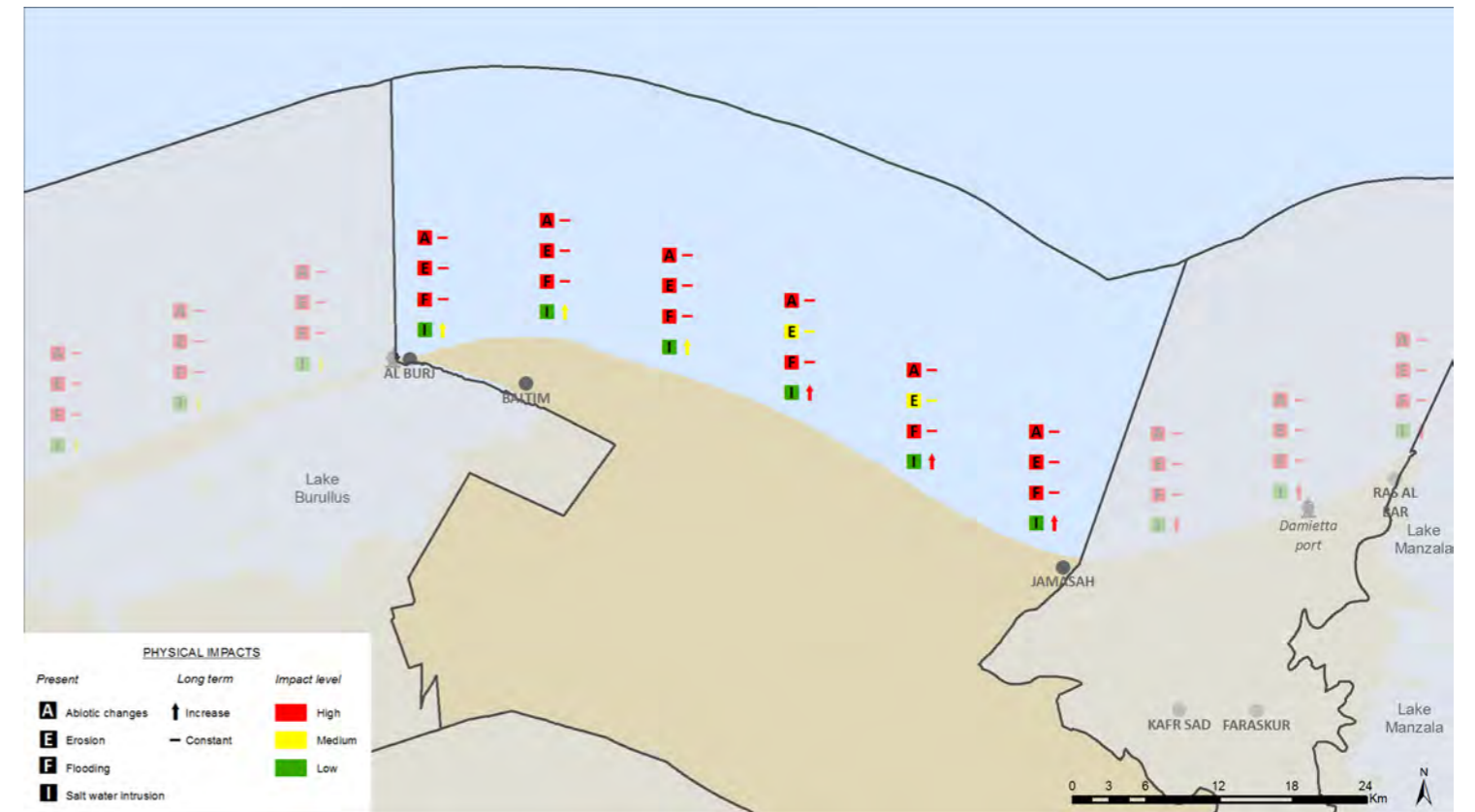
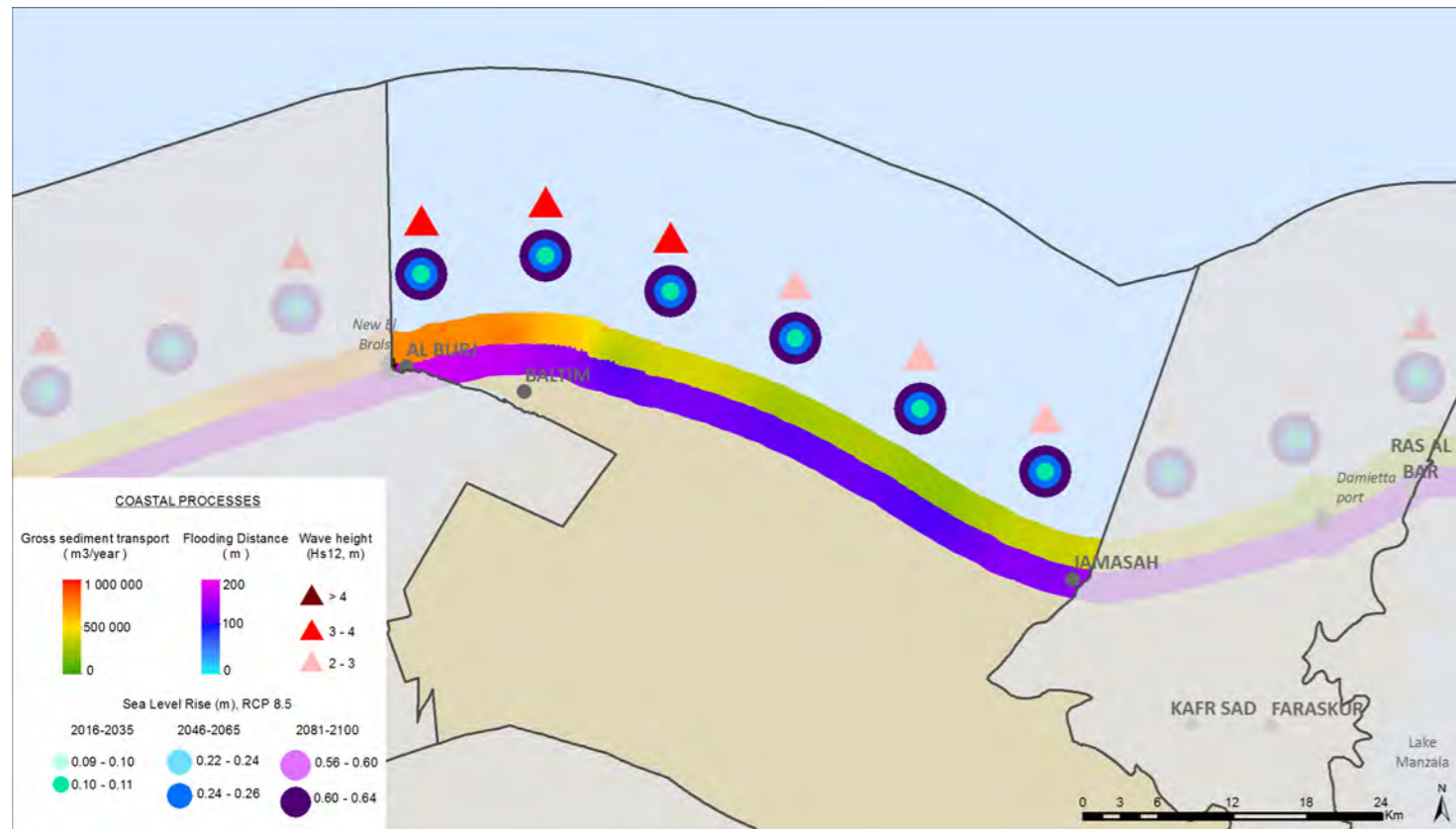
- The Burullus and Baltim sand dune system and surrounding areas, Kafr el Sheikh Governoratte, Nile Delta (MWTI, 2013)
- Study the erosion problem east of Kitchinar drain, Mediterranean Sea (CORI, 2006)
- Study the Sedimentation of Lake Outlets and Coastal Openings (CORI, 2002)
- Protection of Baltem shores (stag 1,2,3,4) (SAP)

LONG-TERM DEVELOPMENT PLANS

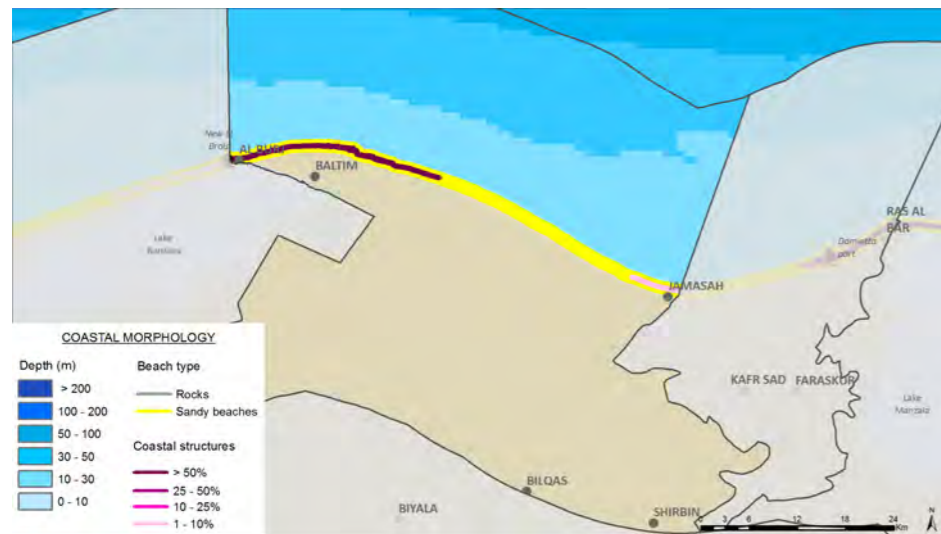
- Strategic Plan for the Northern Coast (GOPP, 2010): urban and tourism development on the coast of Kafr El Sheikh.
- Strategic Plan for the Governorate of Kafr El-Sheikh (GOPP, 2015)
- Strategic Development Plan for Dakahlia Governorate (GOPP, 2008)
- Stakeholders identified the following planned developments: i) black sands extraction in Burullus area, ii) the new Mansora city, iii) tourism development in Gamassa and iv) the Kitchener project for wastewater in Burullus.

LOCAL STAKEHOLDERS

Name	Type	Website	Name	Type	Website
Kafr el Sheikh Governorate	Authority	www.kafrelsheikh.gov.eg/default.aspx	Agriculture Cooperatives	Private sector (farms)	
Dakahlia Governorate	Authority		Reclamation Farms Near New Mansora City	Private sector (agriculture)	
EEAA Middle Delta regio, Tanta RBO	Authority		Fish Farms near Baltim City	Private sector (aquaculture)	
Shore Protection Authority– Kafr el Sheikh Administration	Authority	http://www.mwri.gov.eg/ShoreProtectionflowchart.aspx	Fish Farms near Burullus	Private sector (aquaculture)	
GAFRD Central Delta	Authority	http://www.gafrd.org/	Fish Farms near Mansora	Private sector (aquaculture)	
Gezzert Al Waards	Private Sector		Gamassa Industrial Zone	Private sector (industry)	



PHYSICAL SYSTEM



General description:

The coastal unit extends from Burullus inlet (Bourg El Burullus) to Gamassa drain. A major sand dune system with height from 4 m to 20 m lies from El Burullus up to Gamassa, with maximum heights observed in the N part of El Burullus promontory. 2 main drainage channels: Kitchener drain and Gamassa drain.

Beaches:

Beaches are long open sandy single-barred beaches with fine deltaic sediment over the entire unit (except at Rosetta channel entrance).

Coastal structures:

Coastal structures covering the entire N part of Burullus promontory. From W to E: (1) jetties at Bourg El Burullus W, (2) Burullus concrete sea wall, (3) Groin and detached breakwaters at Bourg El Burullus E, (4) detached breakwaters at Baltim and (5) sea groin system W and E Kitchener drain.

DIAGNOSIS OF PRESENT SITUATION

Erosion:

Erosion is high in the N part (Burullus town and Baltim beaches) due to strong sediment transport associated with high vulnerable deltaic sandy coast, strong past shoreline retreat and concentrated coastal protections which can cause side effects (e.g. E of Kitchener drain). Erosion is generally medium in the E part as sediment transport decreases eastward and the coastline is preserved from coastal protections (except at Gamassa where the sea groin partially retains sediment, causing erosion in next unit). The coastal groins protecting the drainage channels are partial barriers for the sediment transport. They cause sand deposition/erosion in the eastward/westward beaches. Notice that they do not impede siltation in the channels.

Flooding:

Flooding is high all along the unit because of high flooding level associated with gentle slopes topographies. Possible adverse effects nearby coastal structures (Burullus sea wall). Coastal dunes, when present, will however act as protection for flooding.

Saltwater intrusion:

Low saltwater intrusion within the whole unit with the exception of the W boundary, in which the degree of the impact is medium.

Abiotic stress:

High degree of abiotic stress due to the physical conditions given within the unit, which leads to the absence of neither *Posidonia oceanica* nor any other seagrass meadows.

Siltation:

Medium siltation obtained at Kitchener and Gamassa drain because of the medium longshore sediment transport in the area. However, because of the limited length of the protecting groins and the gentle slope bathymetry the inlets are highly dynamical and require a frequent dredging. The recent extension of Gamassa drain protections will reduce the frequency of dredging. Small drainage channels between Kitchener and Gamassa drains also affected by siltation.

DIAGNOSIS OF LONG-TERM SITUATION

Erosion:

Although erosion issues will increase in all the scenarios, principally due to shoreline retreat due to sea level rise, they are expected to remain high in the N part and near Gamassa and medium elsewhere.

Flooding:

The presently observed high flooding will increase in all the scenarios.

Saltwater intrusion:

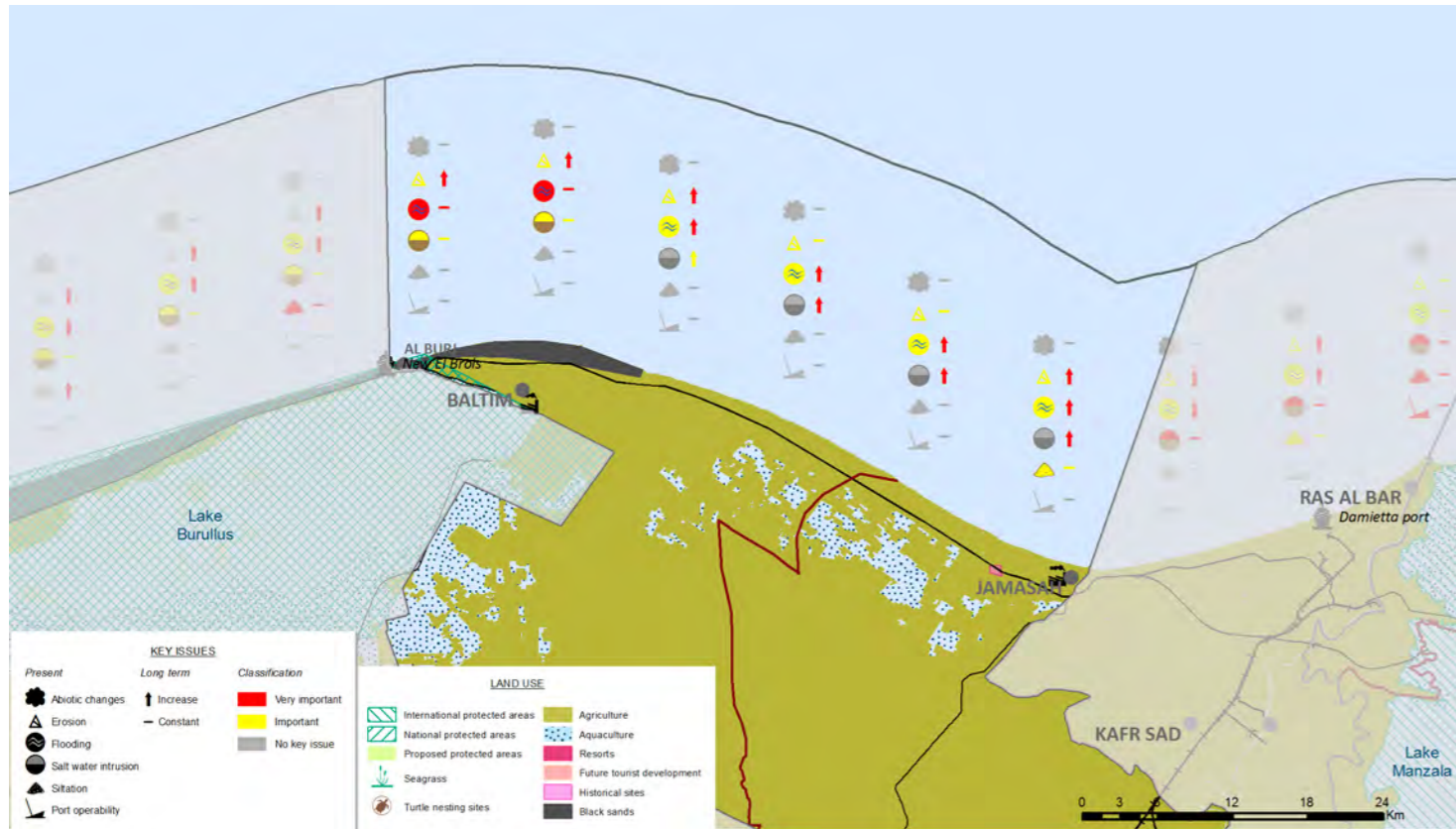
Mainly due to expected sea-level rise, the degree of saltwater intrusion will change into medium in the near term. Then, in the long-term, it will remain medium halfway towards W boundary and it will worsen to high within the rest of the unit.

Abiotic stress:

Increases in mean sea surface temperature will even exacerbate physical conditions, hence impeding the development and growing of seagrass meadows neither in near nor in long-term.

Siltation:

No changes are expected (siltation issues remain medium) if no action are performed as changes in longshore sediment transport are less than 2% in the different channels.



SWOT ANALYSIS

STRENGTHS

- Large extension of natural habitats.
- Fishing port.
- Industrial area.
- “Black Sands” area has been identified for future sand dune mining.

WEAKNESSES

- Lack of infrastructure services, sanitary wastewater treatment plant.
- Poor infrastructures and poor quality of services at rural clusters.
- High population density.
- Weak economic activities in the area of Gamassa.

OPPORTUNITIES

- Sustainable tourism development.
- Sustainable fishing development.
- Development of Burullus fishing port.

THREATS

- Coastal retreat.
- Change in the limits of the protected areas.
- Loss of coastal dunes.
- Loss of biodiversity interest due to pollution.
- Irreversible environmental impact from black sands.
- New activities can positively affect economy, but they should consider traditional activities and ways of life to not affect the coastal life.

KEY ISSUES FOR COASTAL MANAGEMENT

PRESENT KEY ISSUES

The most significant concerns of this unit are related to the high level of erosion and flooding along the Coastal Unit. Key issues are:

- High erosion level along the CU. Stakeholders indicated that coastline moves about 35 m/year backward.
- High flooding level along CU 10.
- High erosion level affecting urban areas in Al Burj (small urban centre) and Gamassa (large urban centre).
- Medium flooding level affecting urban areas in Al Burj (small urban centre) and Gamassa (large urban centre).
- The International Coastal Road can be affected by erosion and flooding.
- Flooding on agricultural areas.
- Medium siltation level in Kitchener and Gamassa inlets.
- Environmental impacts due to black sand extraction.
- Developments on low lying areas.

LONG-TERM KEY ISSUES

Long-term development in CU 10 is mainly related to urban and tourism sprawl. Erosion and flooding will maintain high level that will impact on these sector. Therefore, the following long-term Key Issues will be added to the present ones:

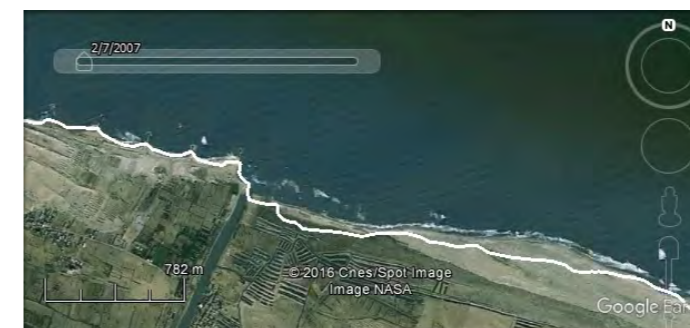
- High erosion level on urban and tourist developments along the whole coastal from, including new developments northwest to Al Burj (small urban centre) and New Mansora city (large urban centre).
- High flooding level on urban and tourist developments along the whole coastal from, including new developments northwest to Al Burj (small urban centre) and New Mansora city (large urban centre).
- Increased salt water intrusion in long-term.
- Destruction of the sand dunes of the apex.
- Environmental impacts due to black sand extraction.
- Increased (high) level of salt water intrusion.



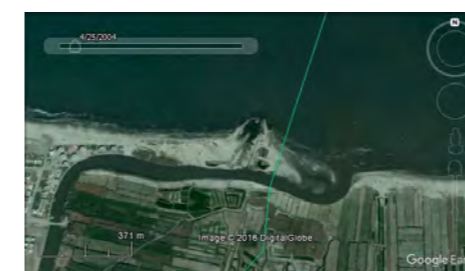
Coastal protection works on the coastal front in the Delta apex.



Erosion eastward the Bourg El Burullus detached breakwaters.

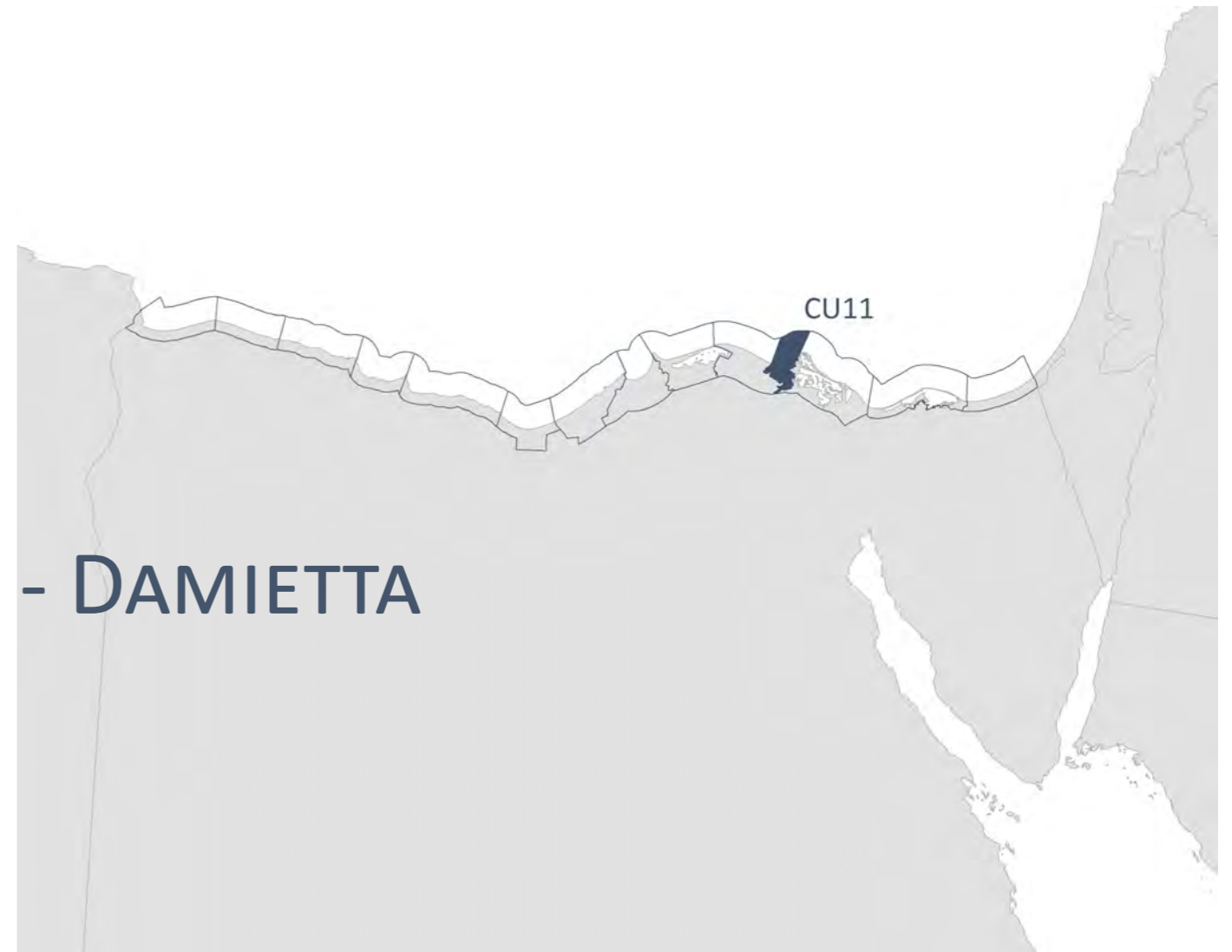


Eastern sea groins of Baltim and Kitchener drain. Siltation issues in Kitchener drain and erosion eastward. Left: 2007, right: 2016.



Rigidification of the highly dynamical Gamassa inlet. Siltation issues. From left to right: 2004, 2007, 2016

COASTAL UNIT 11 - DAMIETTA



GENERAL DESCRIPTION OF THE COASTAL UNIT

Damietta Coastal Unit correspond to Damietta Governorate in the Eastern Delta. It includes the city of Damietta and New Damietta. One of the most significant features is the presence of Damietta harbour .

- Coastal Length: 35 Km.
- Governorate: Damietta.
- Markaz: Damietta, Damietta first and second, Damietta Port, El Zarka, Farskor, Kafr Saad, New Damietta city, Ras El Bar.

ECOLOGICAL SYSTEM

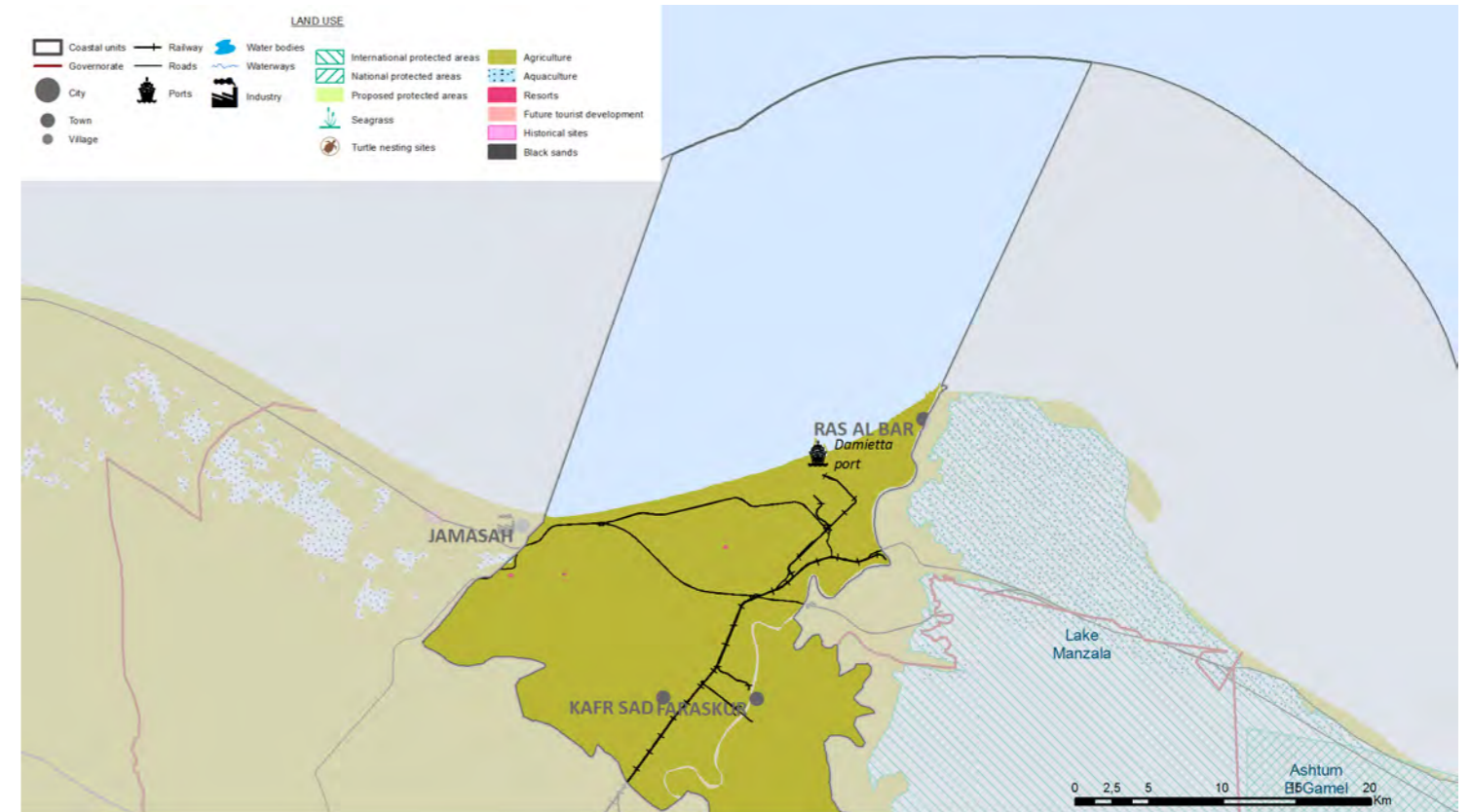
This sector is mostly developed and includes Ras El Barr, Damietta Port, New Damietta and Gamassa. In the few undeveloped areas (halfway between New Damietta and Gamassa), the seashore is sandy with few shells and scattered algae; while shells and shell fragments increase landwards. Southwards, the landscape is characterized by the presence of numerous vegetated small sand dunes and sand mounds. Recorded birds included Little Tern (*Sterna albifrons*), Spur-winged Plover (*Vanellus spinosus*) and White Wagtail (*Motacilla alba*). Shellfish collectors are active in this zone. Drain No. 1 (called by locals Nile Gamassa) at 31°26'31.7"N – 31°33'47.1"E intersect Izbet Gamassa, splits it into Izbet Gamassa Al-Gharbya (westwards) and Izbet Gamassa Al-Sharqya (eastwards) and discharges into the sea. Several fishing boats moor in the drain.

Nile River:

It empties into the Mediterranean Sea at Ras El Barr. The amount of fresh water and silt discharged into the sea has been significantly reduced since the building of the Aswan High Dam. There is a considerable amount of urbanization along the Nile, where extensive stretches of banks have been sealed with concrete and limestone or sandstone blocks to protect them from erosion.



Fishing boats at Drain No.1, Izbet Gamassa



DIAGNOSIS OF PRESENT SITUATION

Current impacts and threats

- Impacts on irrigation canals and drains.
- Removal of aquatic vegetation.
- Invasive species.
- Fishing and aquaculture.
- Agriculture and land reclamation.
- Use of pesticides.
- Grazing of domestic animals.
- Commercial exploitation of wildlife.

Coastal unit status

Biodiversity:

- Extension of natural habitats: Low.
- Loss of natural habitats: High.
- Existence of protected areas: No.
- Existence of IBAs: No.
- Existence of Ramsar Sites: No.
- Number of endemic/threatened species: Low.
- Number of protected species: Low.

Natural resources:

- Inland fisheries stock: Low .
- Species with potential use: Low.

Natural water bodies:

- Pollution and contaminants: High.

DIAGNOSIS OF LONG-TERM SITUATION

Proposed protected areas: No

SOCIOECONOMIC SYSTEM

Damietta Coastal Unit unit hosted 730,597 inhabitants in 2006, of which a total of 74.8% lives in rural areas. Health risks associated with the local industries (mainly furniture) causes high mortality rates among males. The unit is an important farming and fishing spot. In addition, Damietta is a famous industrial area for furniture and exports to the rest of Egyptian Governorates and other Arab countries. It is also famous for sweets and dairy products.

- Economic activities: agriculture and fishing, whole sale and retail trade, building & construction, industry & manufacture.
- Cultural and heritage: There are 6 sites, such as, Kom al-Ahmar, Tell el Balamown etc.
- Social groups and ethnicities: Rural and urban residents and visitors from all over Egypt during the summer in Ras El Barr City



Wood storage for furniture workshops in Damietta.

DIAGNOSIS OF PRESENT SITUATION

- Fair educational facilities: 638 schools and sections, 5541 classrooms, and 1 teacher per 12.0 students in 2010. Illiteracy rate: 15.7% .
- Fair health care facilities: 7 public hospitals, 12 private hospitals, 684 physicians, and 29 ambulances in 2010. Stakeholders identified the need of upgrading medical infrastructures such as private clinics and ambulance.
- Unemployment rate: 11.3%
- About 15.3% of the population was classified as poor in 2013.
- Tourism in Damietta depends on local tourism, 20% of local summer residences are here
- International coastal road and a road and railway track (Talkha- Damietta)
- The governorate of Damietta is connected in terms of maritime through the seaport of Damietta
- Allocation of services to rural and urban areas is disproportionate, with poor quality services and infrastructures at rural clusters.

DIAGNOSIS OF LONG-TERM SITUATION

- Industrial development through the establishment of new industrial cities. Stakeholders noted the proposed furniture industrial city, opening in June 2017.
- Redistribution of the population through establishing new cities.
- Coastal zone management project to address the pollution of water resources and preserve the fisheries’ resources of Alexandria.
- Development of infrastructure services to abate the pollution of the water resources of Alexandria.

PLANS AND PROJECTS

EXISTING STUDIES

- Adaptation to climate change in the Nile Delta through ICZM (CORI –SPA, 2009-2016).
- Compatibility Analysis of Dredged Sediments from Routine Pathways and Maintenance of Harbor’s Channels for Reuse in Nearshore Nourishment in the Nile Delta, Egypt (CoRI, 2016).
- Adaptation to the impact of the sea level rise in the Nile Delta coastal zone from Gamassa to Ras El Bar, Egypt with IDRC (CoRI, 2009-2012).
- Studying the wave climate at Damietta area (CoRI, 2001-2003).
- Base map study to develop Damietta harbor (CORI, 2001).
- Protection of Ras-El-bar shores (stag 1,2,3) (SAP).

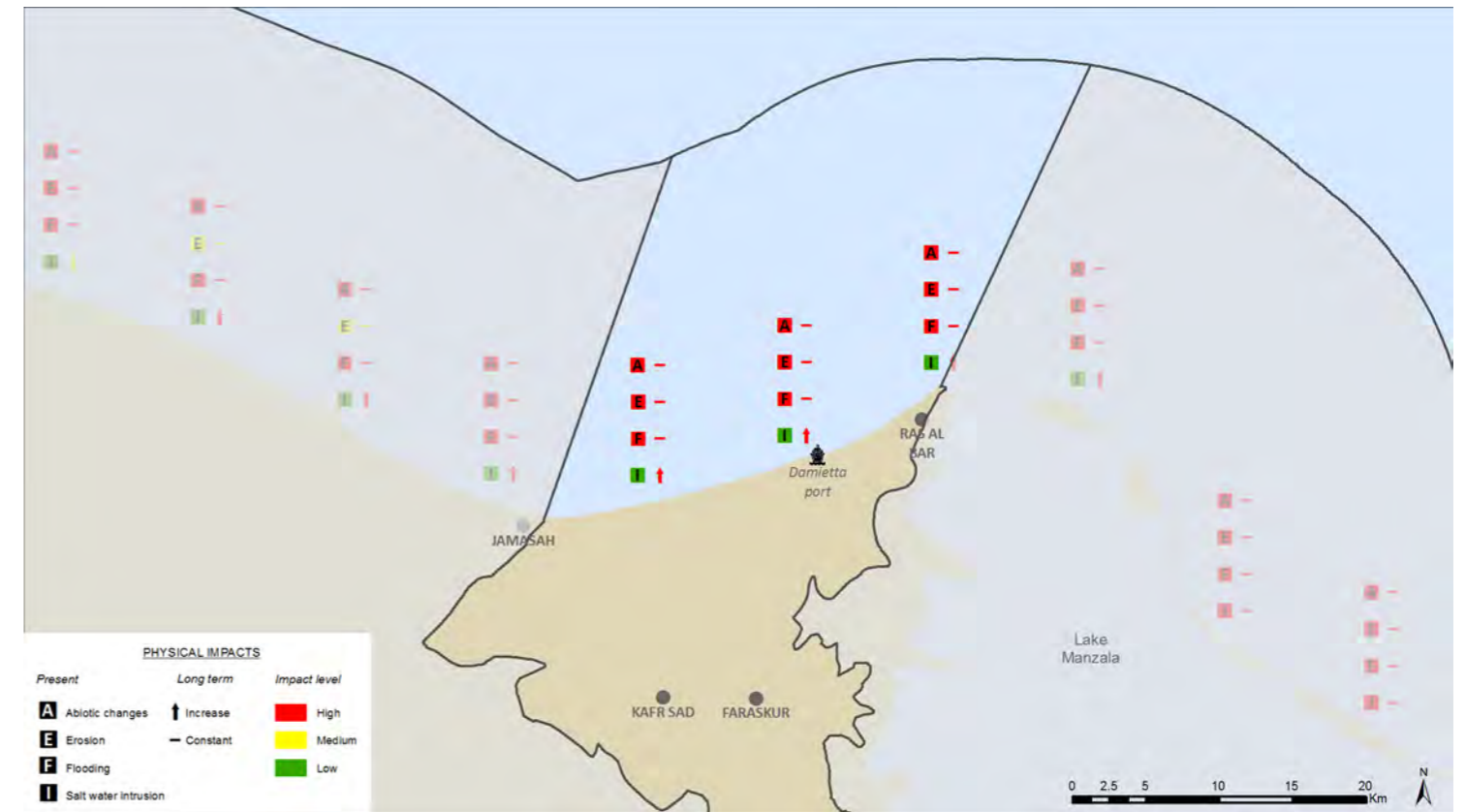
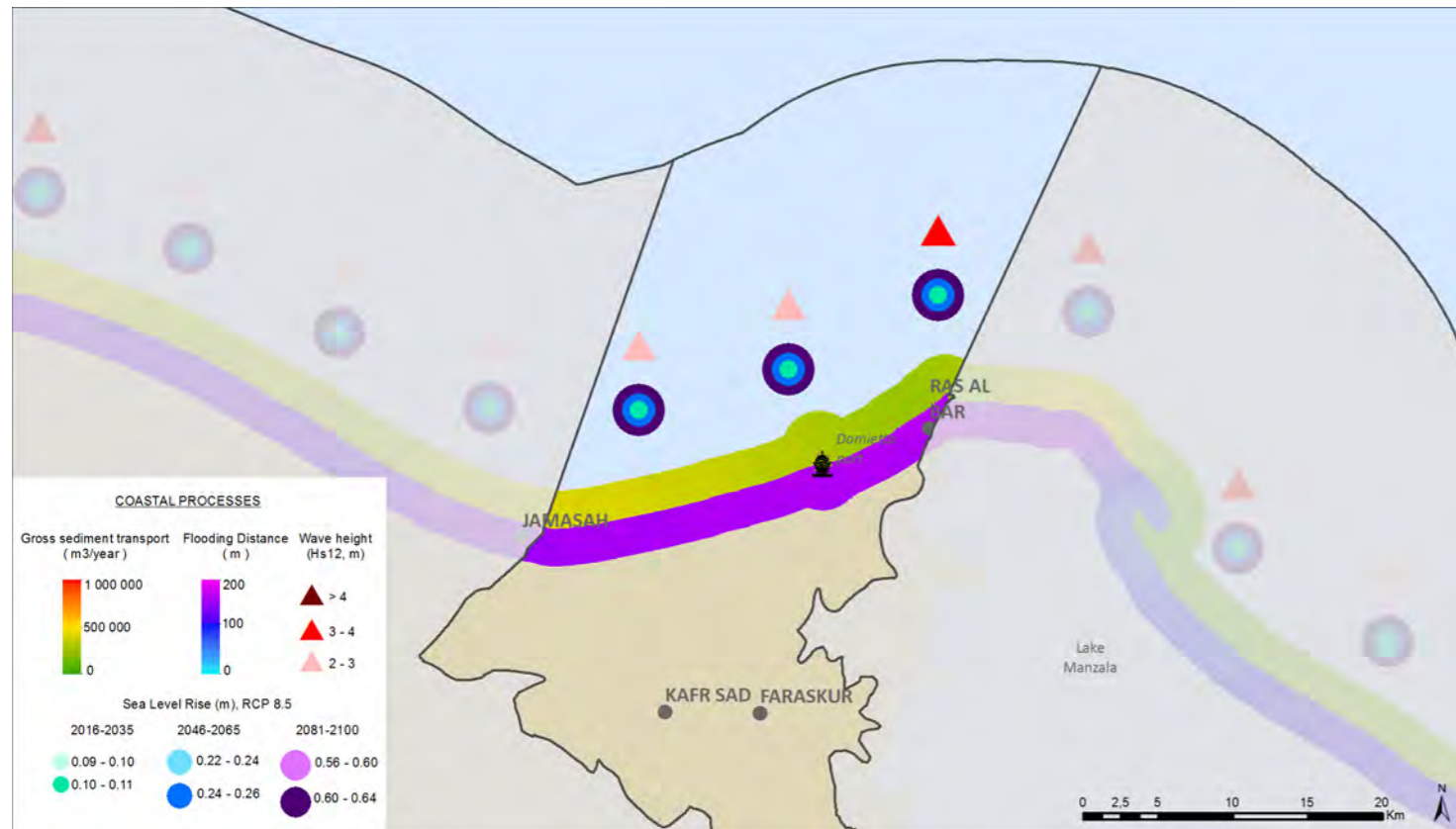
LONG-TERM DEVELOPMENT PLANS

- Strategic Development Plan for Damietta Governorate (GOPP, 2008).
- Strategic Plan for the Governorate of Dakahlia, 2032 (GOPP, 2008).
- Stakeholders identified the following planned developments: i) tourism development in eastern Gamassa, ii) industrial development for logistic zone near Damietta commercial port , iii) new power plant in Gamassa and iv) navigation project in the Damietta branch.

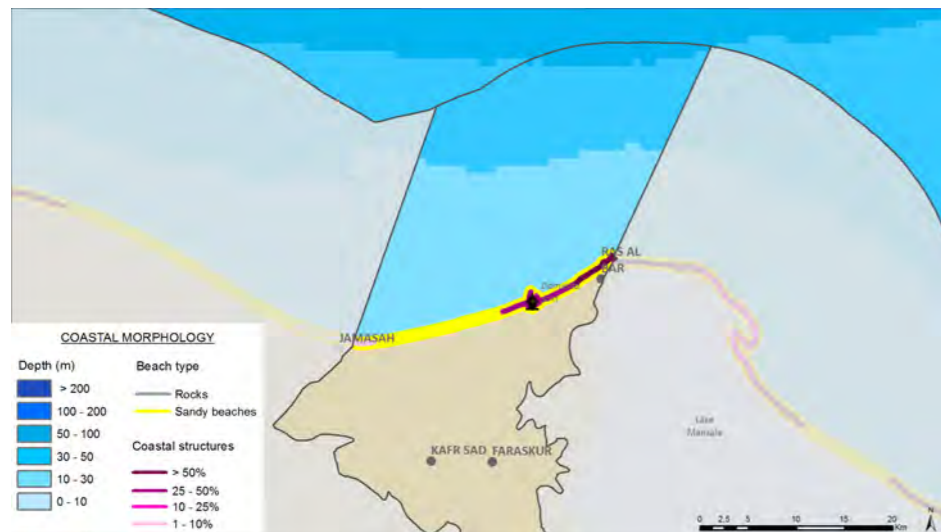
LOCAL STAKEHOLDERS

Name	Type	Website
Damietta Governorate	Authority	http://www.domyat.gov.eg/
EEAA East Delta Regional	Authority	
Shore Protection Authority-Port Said Administration	Authority	http://www.mwri.gov.eg/ShoreProtectionflowchart.aspx
GAFRD Damietta Area	Authority	

Name	Type	Website
Damietta Port Authority	Authority	http://www.mts.gov.eg/en/content/29-Damietta-Port-Authorities http://www.dpa.gov.eg/
Nuclear Materials Authority	Authority	nma.egypt@yahoo.es
Industrial Area in New Damietta	Private sector (industrial)	



PHYSICAL SYSTEM



General description:

The coastal unit extends from Gamassa drain up to Damietta channel entrance (Damietta promontory). It includes the well preserved coastline of New Damietta City, the New Damietta harbor and the coastline of Ras Al Bar. As the other Nile delta promontories the Damietta promontory suffered major erosion in the past and has been rigidified. This, associated to the new developments of the unit, have generated new erosion problems. Different drainage channels are present in the unit: a mobile (free) channel E of New Damietta port, a channel draining at New Damietta port, and the main Damietta channel entrance.

Beaches:

Beaches are long open sandy beaches with gentle slope and fine deltaic sediment along the entire unit (except at New Damietta port and Damietta channel entrance).

Coastal structures:

Coastal protection structures are located at (1) Gamassa drain (channel groins at the W boundary), (2) New Damietta harbor (W and E jetties), (3) Ras Al Bar (detached breakwaters) and (4) Damietta channel entrance (sea wall).

DIAGNOSIS OF PRESENT SITUATION

Erosion:

Erosion is globally high all along the unit although medium erosion has been obtained in the well preserved coastal stretches (beaches of New Damietta City with relatively large coastal setbacks). Both gross alongshore sediment transport and cross-shore sediment transport are medium all along the unit, and past shoreline retreat is strong. The most relevant problems occur nearby coastal protection structures that act as a barrier for longshore sediment transport (New Damietta port jetties, Ras Al Bar breakwaters and Damietta entrance sea wall), especially in the non-protected coastal stretches (W of Ras Al Bar).

Flooding:

Flooding is high in all the unit because of high flooding level associated with gentle slopes topographies. Whereas the Damietta sea wall has been designed for high flooding level, this coastal stretch is associated to high flooding for possible adverse effects on nearby stretches.

Saltwater intrusion: High saltwater intrusion within the entire unit.

Abiotic stress: High degree of abiotic stress due to the physical conditions given within the unit, which leads to the absence of neither *Posidonia oceanica* nor any other seagrass meadows.

Port downtime: The degree at which Damietta Port is inoperable due to overtopping on its main seawall is high. Currently overtopping rates over 0.1 m³/s/m are exceeded more than 300 hours per year.

Siltation: Medium siltation issues at New Damietta Port entrance and at the eastern Damietta drain because of the medium sediment transport in the area. Different kinds of problems are observed as the eastern Damietta drain has been kept free of coastal structures and is highly dynamical (it is not at a fixed position).

DIAGNOSIS OF LONG-TERM SITUATION

Erosion:

Erosion issues are expected to become high all along the unit at long-term (no significant changes a near term). This is mainly related to shoreline retreat due to sea level rise (expected shoreline retreat high at long-term and medium at near term, in all the unit). Weak expected changes in sediment transport (< 1% in the worst scenario).

Flooding:

The presently observed high flooding will increase in all the scenarios due to sea level rise.

Saltwater intrusion:

Due to the effect of sea-level rise, the current high degree of saltwater intrusion within the unit is expected to remain or even exacerbate if no action is taken.

Abiotic stress:

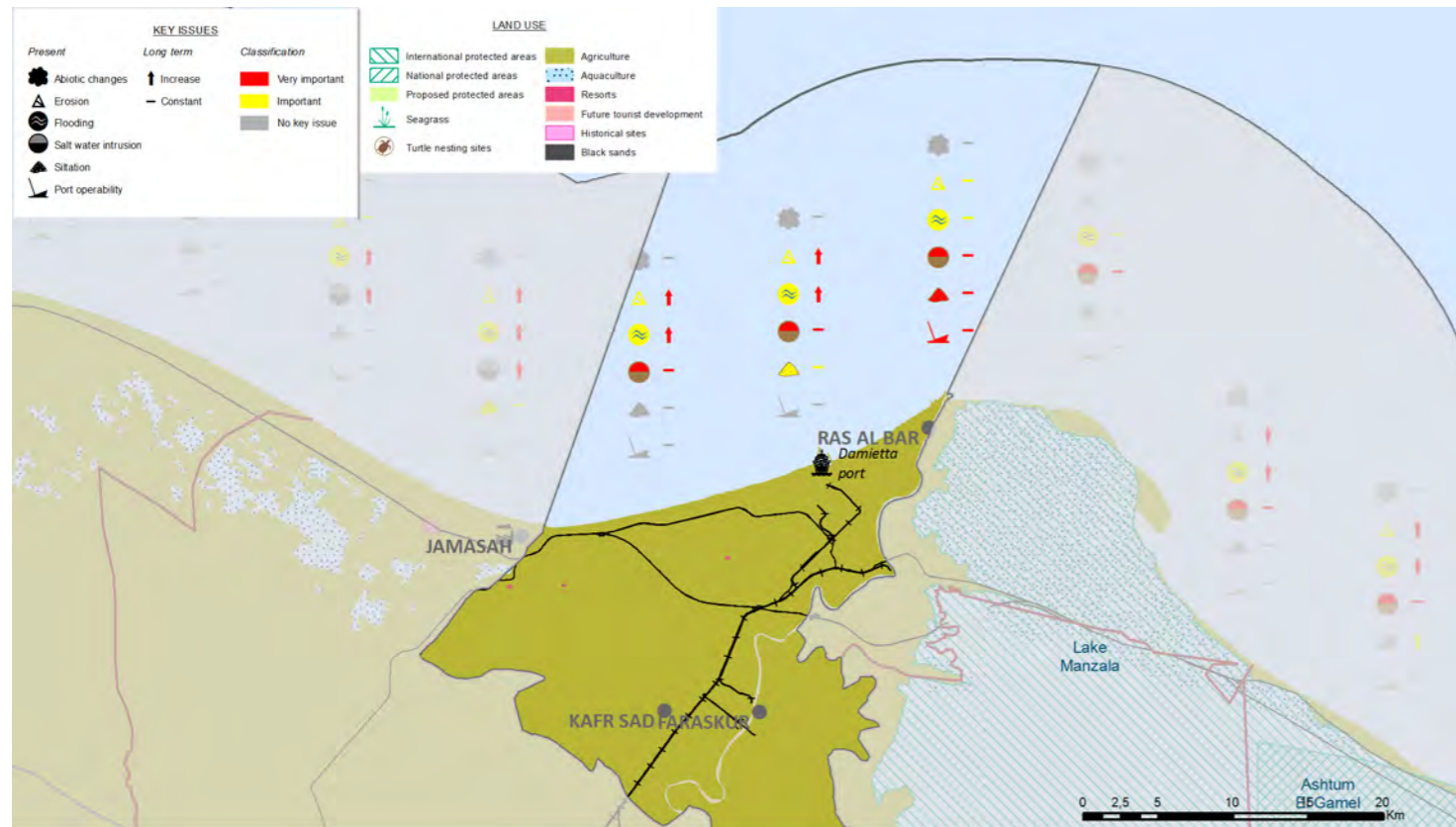
Increases in mean sea surface temperature will even exacerbate physical conditions, hence impeding the development and growing of seagrass meadows neither in near nor in long-term.

Port downtime:

The number of hours per year of port downtime in Damietta Port will far exceed 300 in both near and long-term, leading to interruptions of port operations.

Siltation:

No changes are expected as changes in longshore sediment transport are less than 1% in the different channels (medium at New Damietta harbor and high at Damietta main entrance).



SWOT ANALYSIS

STRENGTHS

- Famous industrial area related to furniture workshops.
- Important commercial port.
- Good transportation network.
- Important area for local tourism.

OPPORTUNITIES

- Sustainable sand nourishment and black sands extraction (continuing pilot project).

WEAKNESSES

- The amount of fresh water has been significantly reduced since the building of the Aswan High Dam.
- Highly polluted.
- Poor quality services and infrastructures at rural clusters.
- High population density.

THREATS

- Loss of coastal dunes.
- Loss of biodiversity interest due to pollution.
- Irreversible environmental impact from black sands.

KEY ISSUES FOR COASTAL MANAGEMENT

PRESENT KEY ISSUES

The Key Issues of CU 11 are:

- High erosion level along CU 11.
- High erosion level in large urban areas: New Damietta and Ras El Bar.
- High flooding level along CU 11.
- High flooding level in large urban areas: New Damietta and Ras El Bar.
- Flooding level on farmlands.
- Erosion and flooding level can affect the International Coastal Road.
- High level of port downtime in Damietta branch.
- High level of salt water intrusion.
- Medium siltation problems in Damietta commercial port inlet.
- High siltation problems in Damietta branch.
- Developments on low lying areas.

LONG-TERM KEY ISSUES

Long-term Key issues are related to the tourism and industrial development (additional to present Key Issues):

- High erosion problems in the planned resorts between Gamassa and New Damietta and in the power plant area.
- High flooding level in the planned resorts between Gamassa and New Damietta and in the power plant area.
- Increased salt-water intrusion.
- Need of data to assess the variation in coastal management activities and the impacts and relationships between human activities and effective stresses on local society.



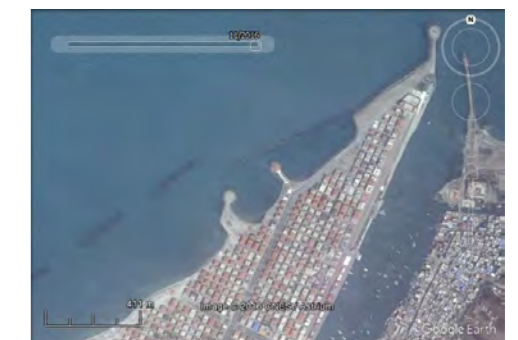
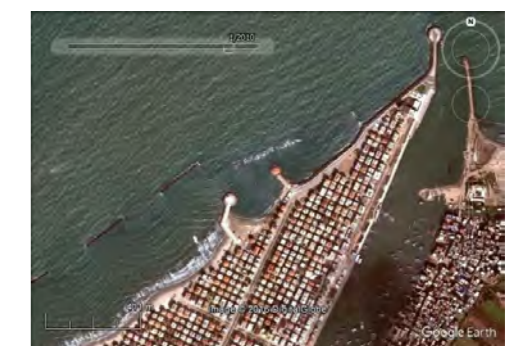
New Damietta.



ACCNDP pilot site.



Morphological evolution of the drainage channel east of New Damietta port currently free of coastal protection. A highly dynamical environment. From up to bottom: 2004, 2013, 2016.



Damietta entrance channel. Enlargement of E Damietta sea wall and saltation issues. Up: 2016, bottom: 2016.

COASTAL UNIT 12 - PORT SAID



GENERAL DESCRIPTION OF THE COASTAL UNIT

Port Said Unit is the largest unit of the Mediterranean coast, covering the Eastern Nile delta and Manzala Lake. The Suez Canal crosses along this unit. Port Said, the most populated city of the unit and closest areas as Port Fouad are famous tourist destinations.

- Coastal Length: 99Km.
- Governorate: Damietta, Port Said, Dakahlia and Sharkya
- Markaz: El Gamalia, El Manzala, El Matarya, Meet

ECOLOGICAL SYSTEM

This sector includes the Damietta promontory, which is a narrow barrier island extending to Port Said, separating the Mediterranean Sea from Lake Manzala on the south. The soil supports limited plant vegetation and is therefore highly prone to wind and water erosion, especially in the coastal zone. Main habitats include vegetated sand dunes, salt marshes and sabkha flats, cultivated farmlands and human settlements. Major plant communities recorded in the Port Said area: *Arthrocnemum macrostachyum*, *Halocnemum strobilaceum*, *Zygophyllum album*, *Inula crithmoides*, *Tamarix nilotica*, *Juncus rigidus* associated with *J. acutus*, and *Bassia indica*,

Nile River:

It empties into the Mediterranean Sea at Izbet El Borg. The amount of fresh water and silt discharged into the sea has been significantly reduced since the building of the Aswan High Dam. There is a considerable amount of urbanization along the Nile, where extensive stretches of banks have been sealed with concrete and limestone or sandstone blocks to protect them from erosion.

Lake Manzala:

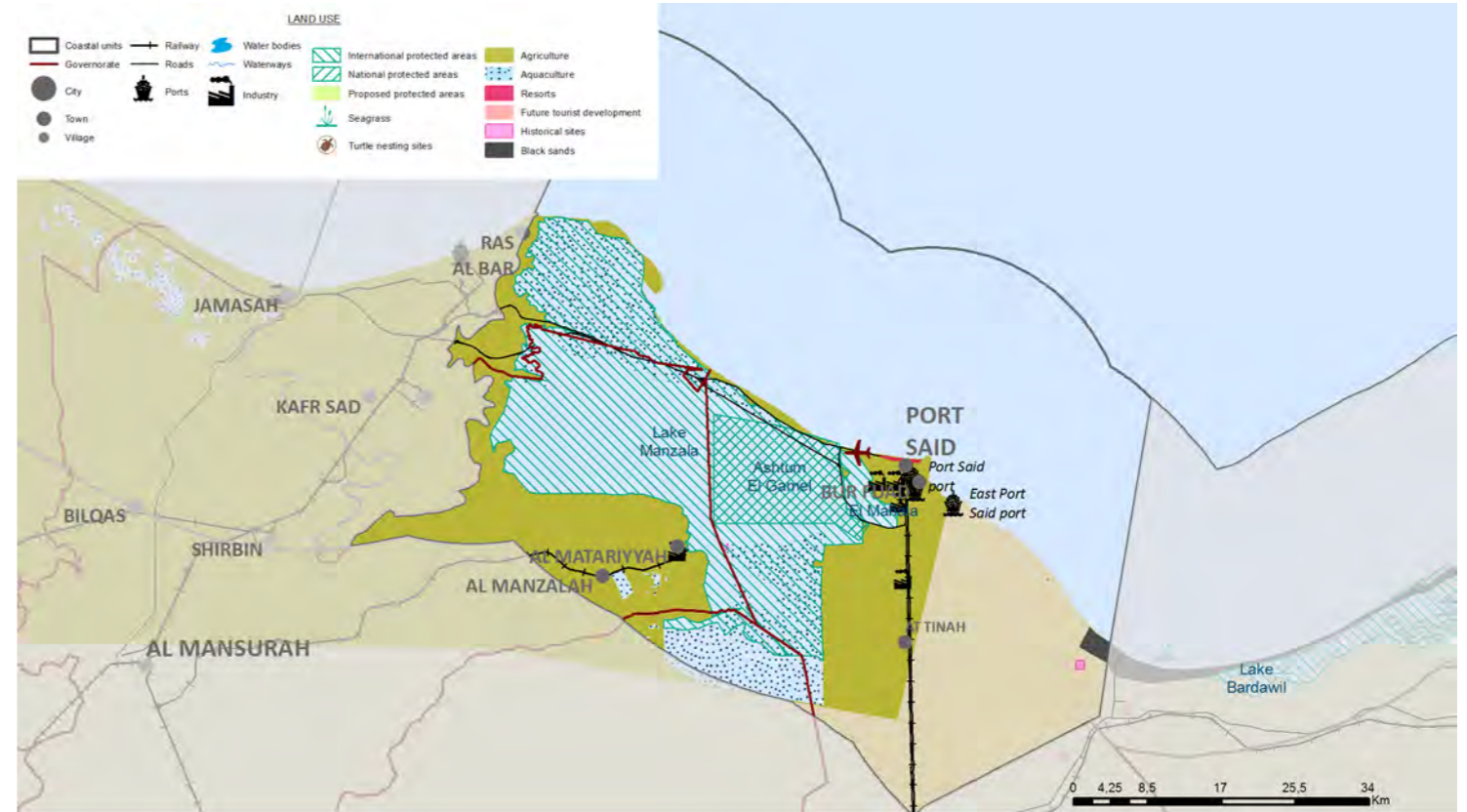
The largest of Egypt’s Mediterranean wetlands and the most productive for fisheries. It is a shallow, brackish coastal lagoon connected to the sea via three main boughazes (sea outlets). Fresh water input into the lake is comprised of drainage water primarily from five major drains. The lake is fresher in the south and more saline in the north. Large parts of the lake have been reclaimed, reducing the lake’s area by 40%. However, it continues to provide an important refuge for wildlife, though its importance as a wintering station for waterbirds has certainly diminished in recent years. The lake is considered to be an important nursery for Mediterranean fisheries and its northern part has been extensively modified for fish farming. However, the wetland is severely polluted as a result of untreated industrial, agricultural and domestic wastewater discharge. The lake is an IBA (IBA Criteria: A1, A4i, A4iii).

Astoum El Gamil and Tanis Island Protected Area:

Established according to Prime Minister Decree 459/1988 amended by Decree 2780/1998. It covers an area of about 180 km² and includes Ashtum El Gamil located along the sandbar at Boughaz El Gamil, as well as Tanis Island (8 km²). The protected area was originally created to protect gravid fish and fry during their passage in and out of Lake Manzala through the Boughaz. The actual extension aims at protecting also resident and migrant avian fauna, floral diversity and the archeological sites of Tanis Island.

El Mallaha IBA:

El Mallaha (IBA Criteria: A4i) was formerly the easternmost extension of Lake Manzala from which it was cut off when the Suez Canal was constructed. It is composed of two hyper-saline lagoons connected to the Mediterranean via Bughaz El Kala (eastern lagoon) and El Mallaha (western lagoon). Despite its small size, it is considered one of the most important wetlands in Egypt for waterbirds.



DIAGNOSIS OF PRESENT SITUATION

Current impacts and threats

Drastic ecological changes have taken place in the Nile Valley and Delta over the past one hundred years, as a direct result of intensive human interventions (such as the Aswan High Dam) and manipulation of the natural environment, as well as a growth in population and associated environmental deterioration. Main impacts include:

- Agriculture and land reclamation.
- Use of pesticides.
- Fishing and aquaculture.
- Feral animals.
- Grazing of domestic animals.
- Commercial exploitation of wildlife.
- Invasive species.
- Impacts on Lake Manzala.

Coastal unit status

Biodiversity

- Extension of natural habitats: Medium.
- Loss of natural habitats: High.
- Existence of protected areas: Yes.
- Extension of protected areas: Low.
- Existence of IBAs: Yes(2).
- Number of endemic/threatened species: Medium.
- Number of protected species: Medium.

Natural resources:

- Inland fisheries stock: High.
- Species with potential use: Medium.

Natural water bodies:

- Pollution and contaminants: High.

DIAGNOSIS OF LONG-TERM SITUATION

Proposed protected areas: No



Little Egret (*Egretta garzetta*), Lake Manzala

Lake Manzala

SOCIOECONOMIC SYSTEM

The unit hosted 1,540,965 inhabitants in 2006, of which a total of 68.5% lived in urban areas. Most of the people live in El Manzala, El Mataria, El Gamalia, Miat Salsabeel, Damietta city and Port Said city and Villages.

- Economic activities: agriculture and fishing, whole sale and retail trade, building and construction, industry and manufacture.
- Cultural and heritage: There are 10 sites, for instance, Tell AL Ahmar, Tell El Rokn and so on.
- Social groups and ethnicities: Rural and urban residents



Port Said. Source: Maritime Transport Sector

DIAGNOSIS OF PRESENT SITUATION

- Fair educational facilities: 1305 schools and sections, 12001 classrooms, and 1 teacher per 16.1 students in 2010. Illiteracy rate: 16 - 28% .
- Fair health care facilities: 12 public hospitals, 35 private hospitals, 2409 physicians, and 137 ambulances in 2010.
- Unemployment rate: 7 - 11% .
- About 17.2% of the population was classified as poor in 2013.
- Big percentage of fish production on national level.
- El-Manzala Lake links Port Said, Damietta, El Matareia cities through the internal water ways.
- There are two seaports, Port Said port and Sharq el Tafriaa.
- Stakeholders believe that there are low health insurance.
- Stakeholders propose to make Port Said a free zone city (tax free city) as it was previously.

DIAGNOSIS OF LONG-TERM SITUATION

- Supporting and developing the projects related to ports, shipyard, and shipbuilding activities, with development of free zones projects in the medium and long-term.
- Industrial development and redistribution of the population through the establishment of new industrial cities. The new eastern Port Said city is expected to have a population of 1.5 million in 2027. It is contains industrial zone, port, and free zone.
- Establishing hybrid solar energy stations for generating electricity and desalination.

PLANS AND PROJECTS

EXISTING STUDIES

- Adaptation to climate change in the Nile Delta through ICZM (CORI –SPA, 2009-2016).
- Basic physical data for Nile Delta Governorates (ACCNDP).
- Physical Parameters related to climate change along the Mediterranean coastal zone of Egypt (CORI, 2012).
- Coastal Protection works on Nile Delta, as seen on Google Earth (ACCNDP, 2010).
- Head Master Initiative for the Nile Delta Coastal Hydrodynamics, Sediment Transport, Erosion, and Defense Schemes in View of Climate Change and ICZM (CoRI, 2012).

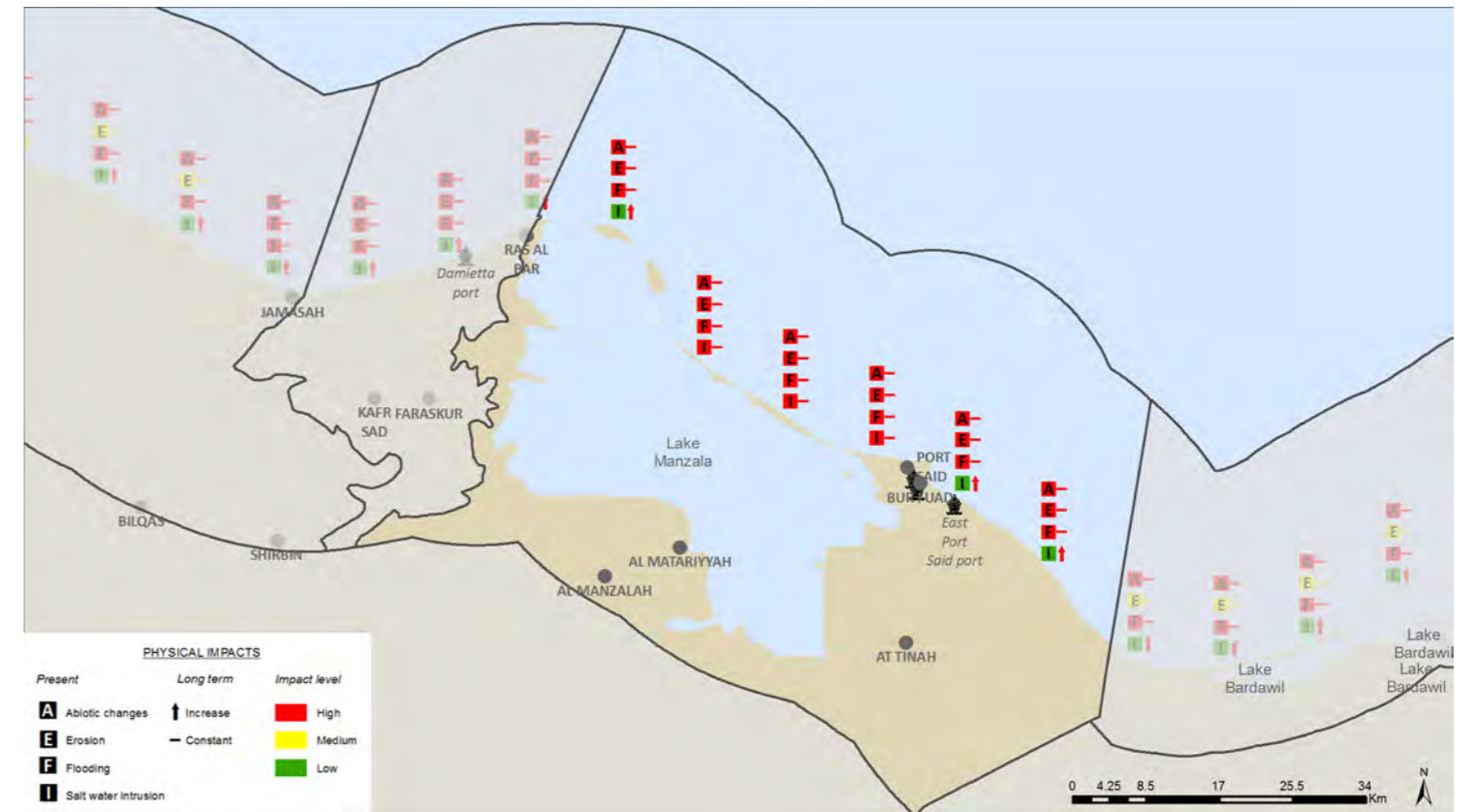
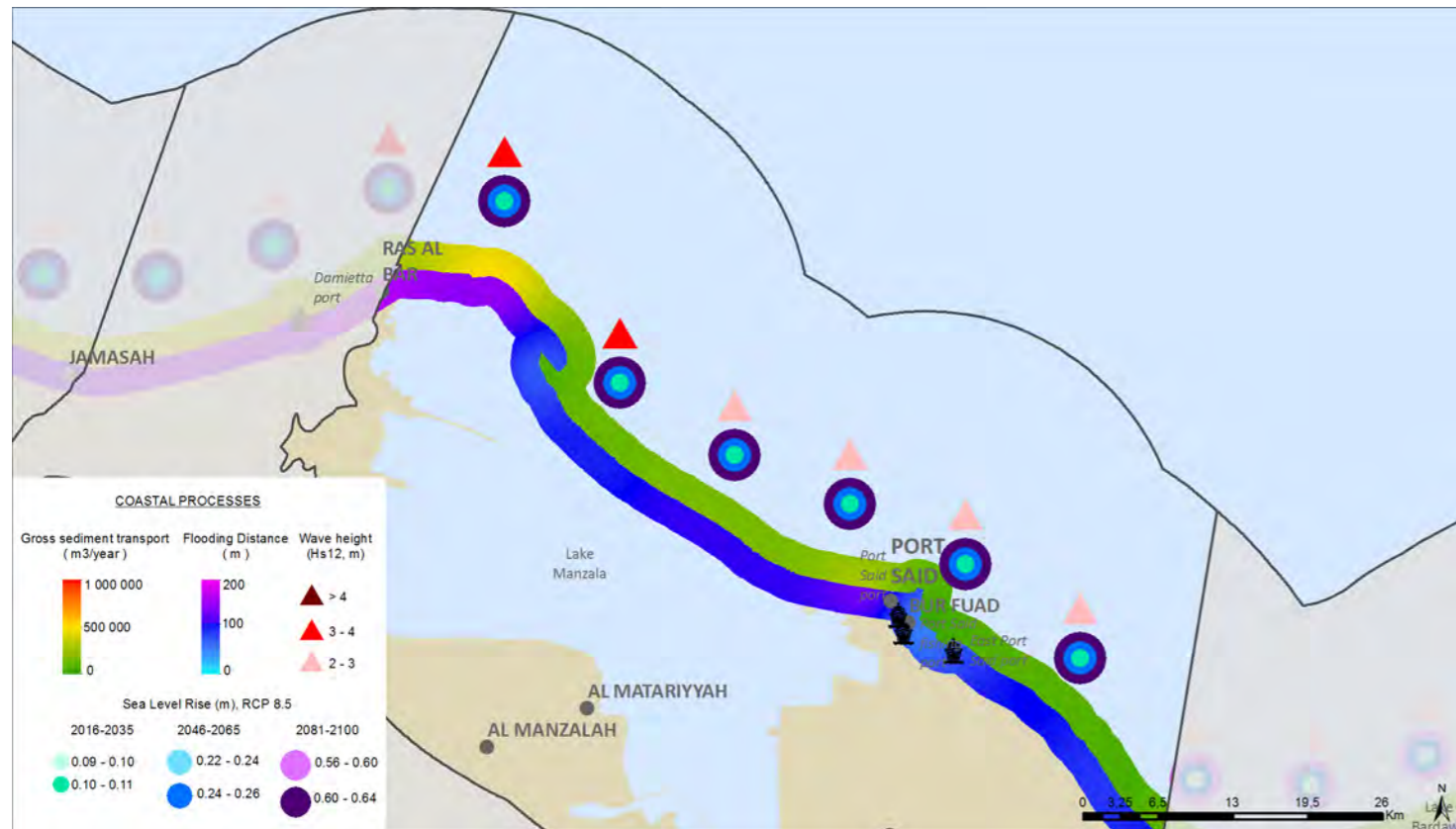
- Alexandria-Nile Delta coast Egypt update and future projection of relative sea-level rise (CoRI, unknown).
- Protection of Port Said and El-Arish shores (El Gameel - Cornish El Arish) (SPA).
- Protection of Azbet El Borg shores (stag 1,2,3) (SPA).
- Shore Protection Master Plan for the Nile Delta -1987 (SPA, 1987).
- Master Plan for Nile Delta -1984 (SPA, 1984).
- Policies for dealing with urban growth in Delta (GOPP).
- Support to the Egyptian Protected Areas Project (EEAA).

LONG-TERM DEVELOPMENT PLANS

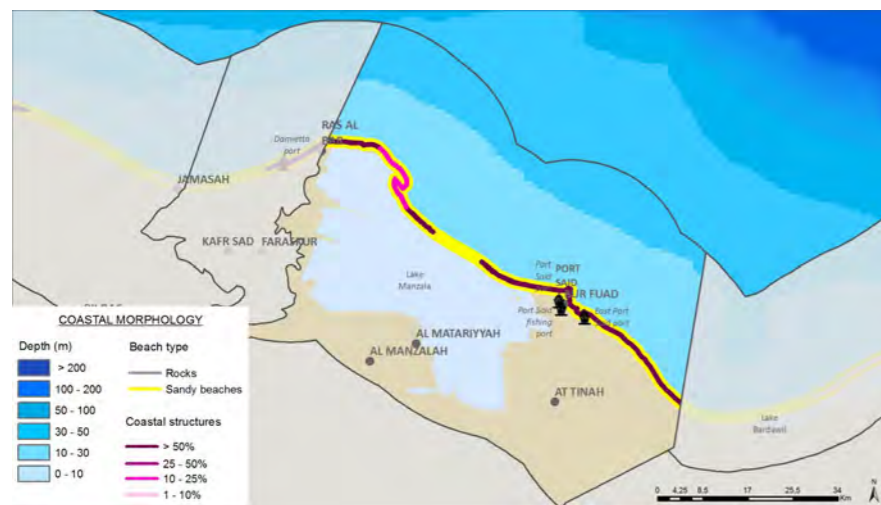
- National Strategic Plan for Urban Development (GOPP, 2015): urban development in East Port Said , in Fouad and in New Port and industrial development in Port Said and Mallaha and a fishing port in Port Said.
- Strategic Plan for the Governorate of Dakahlia, 2032 (GOPP, 2008).
- Strategic Development Plan for Port Said Governorate (GOPP, 2008).
- Stakeholders identified the following planned developments: i) tourism development in Mallaha and Manzala and ii) the creation of the new inlet in Port Said.

LOCAL STAKEHOLDERS

Name	Type	Website	Name	Type	Website	Name	Type
Dakahila Governorate	Authority	https://en.wikipedia.org/wiki/Beheira_Governorate https://www.facebook.com/pages/Behera/200148210031526	Ashtom Al Gamil Protectorate	Authority	www.eeaa.gov.eg	Reclamation Farms	Private sector(agriculture)
Port Said Governorate	Authority	http://www.portsaid.gov.eg/Default.aspx	Suez Canal Authority	Authority	http://www.suezcanal.gov.eg/	Ezbat El Borg Fishing Market	Private sector
Al Sharkia Governorate		http://www.sharkia.gov.eg/default.aspx	Port Said Fishing Sea Port	Authority		Morgan Resort in Port Foad and Port Said	Private sector (tourism)
EEAA East Delta regional	Authority		Port Said Port Authorities	Authority	http://www.mts.gov.eg/en/content/28/1-105-Port-Said-Port-Authority www.psd.gov.eg	Marhabah Resort in Port Foad and Port Said	Private sector (tourism)
EEAA Sharkia Regional Branch Office	Authority		GARFD	Authority	http://gafrd.org	Al-Batros resort in Port Foad and Port Said	Private sector (tourism)
Shore Protection Authority-Port Said Administration	Authority	http://www.mwri.gov.eg/ShoreProtectionflowchart.aspx				Al Radwan Resort in East Port Said New City	Private sector (tourism)
						Fish farms in Port Foad	Private sector (aquaculture)



PHYSICAL SYSTEM



General description:

The coastal unit of Port Said extends from the main Damietta channel entrance (Damietta promontory) to the E end of Sahl El Tina (Port Said governorate E boundary). It includes Manzala lagoon whose main drainage channel is located at El Gamail strait, and Sahl El Tina low-lands E of Port Said. From W to E the coastline is characterized by (1) Damietta entrance channel, (2) the free Damietta ridge system, (3) the sand barrier bounding Manzala lagoon interrupted by El Gamail strait, (4) Port Said port and (5) the sand barrier bounding Sahl El Tina (various drainage channels).

Beaches:

Beaches are long open sandy beaches with gentle slope and fine deltaic sediment along the entire unit (except at Port Said where beaches are almost inexistent). Beach width is limited all along the unit because of the rigidification of the different sand barriers where sea wall are built in the inner part of the barrier.

Coastal structures:

Coastal protection structures cover almost the entire coastline although Damietta ridges are free and naturally evolve. Most of the protection structures concern the intern part of the Manzala lagoon and Sahl El Tina sand barriers. The coastal protection structures facing the Mediterranean sea consist of (1) Damietta channel eastern wall, (2) El Gamail strait sea groins, (3) Port Said detaches breakwaters E of El Gamail strait and (4) the massive Port Said port wall and groin structures.

DIAGNOSIS OF PRESENT SITUATION

Erosion:

Erosion is globally high all along the unit although medium erosion issues have been obtained in the less protected areas (Damietta ridges, E of El Gamail strait). Potential sediment transport is high at the W boundary (Damietta entrance) and low-medium in the other part the unit. The strongest (apart Damietta) longshore sediment transport is obtained close to Port Said breakwaters. From past observations, the different coastal stretches expected strong shoreline retreat. Present day problems are mainly related to longshore sediment transport barriers caused by coastal structures, they cause erosion eastward.

Flooding:

Flooding is high in all the unit because of high flooding level associated with gentle slopes topographies. Flooding due to wave (setup, run-up) is relatively small in the unit. Flooding is mainly due to storm surges associated with (relatively) high astronomical tidal ranges. Less flooding issues in the protected Port Said port area.

Saltwater intrusion:

As stated by stakeholders, nowadays severe a high degree of saltwater intrusion affects the whole unit.

Abiotic stress:

High degree of abiotic stress due to the physical conditions given within the unit, which leads to the absence of neither *Posidonia oceanica* nor any other seagrass meadows.

Siltation:

Medium siltation issues at El Gamail strait and at Port Said port because of the medium alongshore sediment transport in the area. Small siltation issues in Sahl El Tina drainage channels (smaller gross alongshore transport), however, the outlets are highly dynamical and their positions are not fixed.

DIAGNOSIS OF LONG-TERM SITUATION

Erosion:

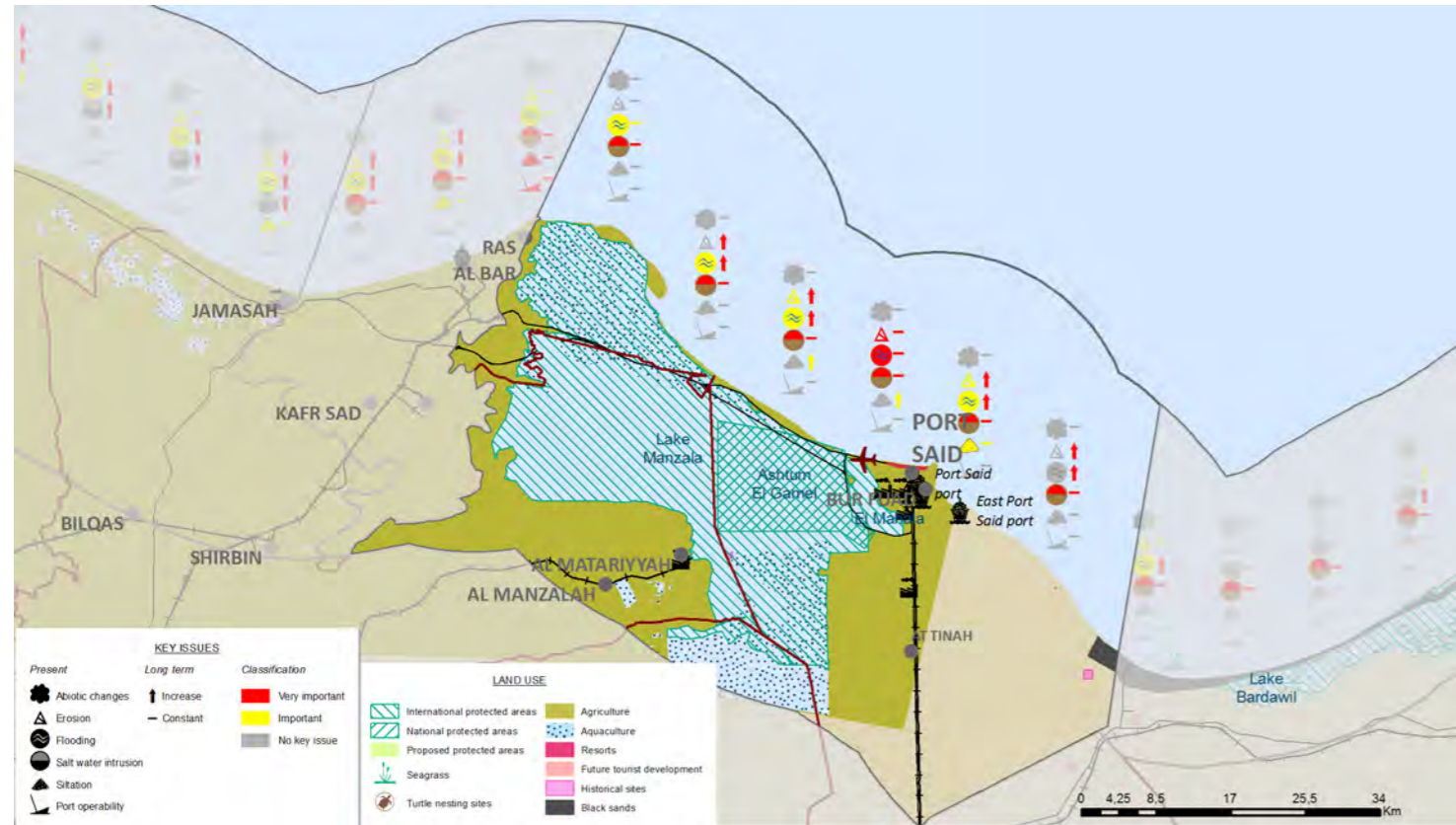
Erosion issues are expected to increase because of the strong shoreline retreat related to sea level rise in all the unit. It will remain globally high. At long-term, medium erosion will concern only the E part of El Gamail. Weak expected changes in sediment transport (< 1% in the worst scenario). The development of the new fishing port will affect the eastward coastal stretches.

Saltwater intrusion: The current high degree of saltwater intrusion will remain or even exacerbate in both near and long-term if adaptation is disregarded.

Abiotic stress: Increases in mean sea surface temperature will even exacerbate physical conditions, hence impeding the development and growing of seagrass meadows neither in near nor in long-term.

Flooding: The presently observed high flooding will increase in all the scenarios due to sea level rise. All shoreline stretches will expect a strong flooding even in the best near term scenario. Flooding issues can be locally exacerbated after the construction of the new fishing port.

Siltation: No changes are expected as changes in longshore sediment transport are less than 1% in the different channels (medium at El Gamail and at Port Said port and low at Sahl el Tina). Medium flooding expected at the new Port Said fishing port.



SWOT ANALYSIS

STRENGTHS

- Two seaports.
- Good communication through internal water ways.
- Lake Manzala, the largest of Egypt’s Mediterranean wetlands and the most productive for fisheries.
- Big percentage of fish production on national level.
- Lake Manzala and Mallaha are important refuge for wildlife.
- Three monitoring locations for the beach (EEAA).

WEAKNESSES

- Intensive human interventions.
- Extensive stretches of banks have been sealed with concrete.
- Considerable amount of urbanization along the Nile.
- The beach of Port Said does not have sanitary drainage nor industrial nor agricultural.
- High loss of natural habitats.
- Highly polluted area.
- Overfishing in Manzala.
- High population density.

OPPORTUNITIES

- Sustainable sand nourishment and black sands extraction (continuing pilot project).
- Sustainable economic activities in Mallaha area.
- More fish markets to improve fishing activity.

THREATS

- Loss of coastal dunes.
- Loss of biodiversity interest due to pollution.
- Irreversible environmental impact from black sands.
- Unsustainable fishing activity.

KEY ISSUES FOR COASTAL MANAGEMENT

PRESENT KEY ISSUES

The major concerns of CU12 are the following Key Issues:

- High erosion level along the unit. It can affect Port Said urban area (large urban centre) and tourist facilities, Port Fouad (small urban centre).
- High flooding level along the unit. It can affect Port Said urban and tourist facilities.
- Erosion and flooding can affect the International Coastal Road.
- Flooding can affect farmlands in CU12.
- Medium siltation level in Port Said ports.
- High production of fisheries in Manzala Lake.
- High level of saltwater intrusion.
- High interest for biodiversity conservation, especially for wetlands and birds.
- Degradation and pollution of Manzala Lake. Stakeholders also identified pollution in sea waters.
- Stakeholders stated that there is insufficient income from agriculture and fishing.
- Development on low lying areas.
- Stakeholders think that there is no clear plans for development in Mallaha area.

LONG-TERM KEY ISSUES

Long-term Key Issues of CU12:

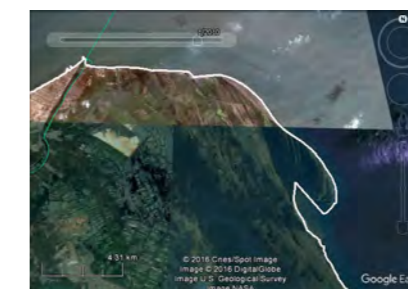
- High erosion and flooding impacts on very populated new urban area and resort in the narrow strip of Manzala Lake.
- Medium siltation level in Port Said new fishing port and new inlets.
- High erosion and flooding impacts in the new resorts and industries of Mallaha.
- Increased saltwater intrusion.



Sahl El Tina western drain (west of Port Said port) and internal wall of the sand barrier. Siltation issues. Top: 2011, bottom: 2016.



El Gamail strait: siltation issues and construction of new sea groins. Top: 2009, bottom: 2016.



Morphological evolution of Damietta ridges. From left to right: 1978, 2010, 2016. The white line corresponds to the 2010 coastline. The northern part is rigid (Damietta E wall), erosion eastward.

COASTAL UNIT 13 - BARDAWIL



GENERAL DESCRIPTION OF THE COASTAL UNIT

CU13 is located in North Sinai Governorate, between Port Said and El Arish. This Coastal Unit is mainly rural, being the major settlements the outer neighbourhoods of Bir El Abd. Lake Bardawil occupies the most are of the unit, having national and international environmental protection.

- Coastal Length: 118 Km.
- Governorate: North Sinai.
- Markaz: Romana, Bir El Abd.

ECOLOGICAL SYSTEM

This Coastal Unit includes Lake Bardawil and the sand formations located west of the lake.

Lake Bardawil:

The lake is an IBA (IBA criteria: A1, A4i, A4iii). It is bordered from the north by a convex sand barrier that separates it from the Sinai Mediterranean coast and from the south by the sand dune belt, which extends inland to the region of fold and anticlinal hills. The main water body of the lake lies towards the east with an area of 58,000 Feddan. Sea water enters the lagoon through two artificial tidal inlets (Boughaz) of 270 and 300 m wide and 4-7 m deep, maintained open by periodic dredging, and a natural eastern inlet at Zaranik which is occasionally closed by silting. Fish production of Bardawil Lagoon depends on the water exchange between the lagoon and sea, which regulates lagoon salinity. Common commercial fish include Gilthead Bream (*Sparus aurata*), mullets (*Mugilidae*), Sea Bass (*Dicentrarchus labrax*) and Common Sole (*Solea solea*). Six major habitat types are clearly distinguished in this lake: salt marshes, saline sand flats, sand hillocks, stabilized sand dunes, inter-dunes depressions, mobile sand dunes and mud flats. The salt marshes of Lake Bardawil, its islands and shores have vegetation types dominated by *Halocnemum strobilaceum*, *Arthrocnemum macrostachyum* and *Suaeda aegyptiaca*. On less moist saline areas *Nitraria retusa* abounds.

Zaranik Protected Area:

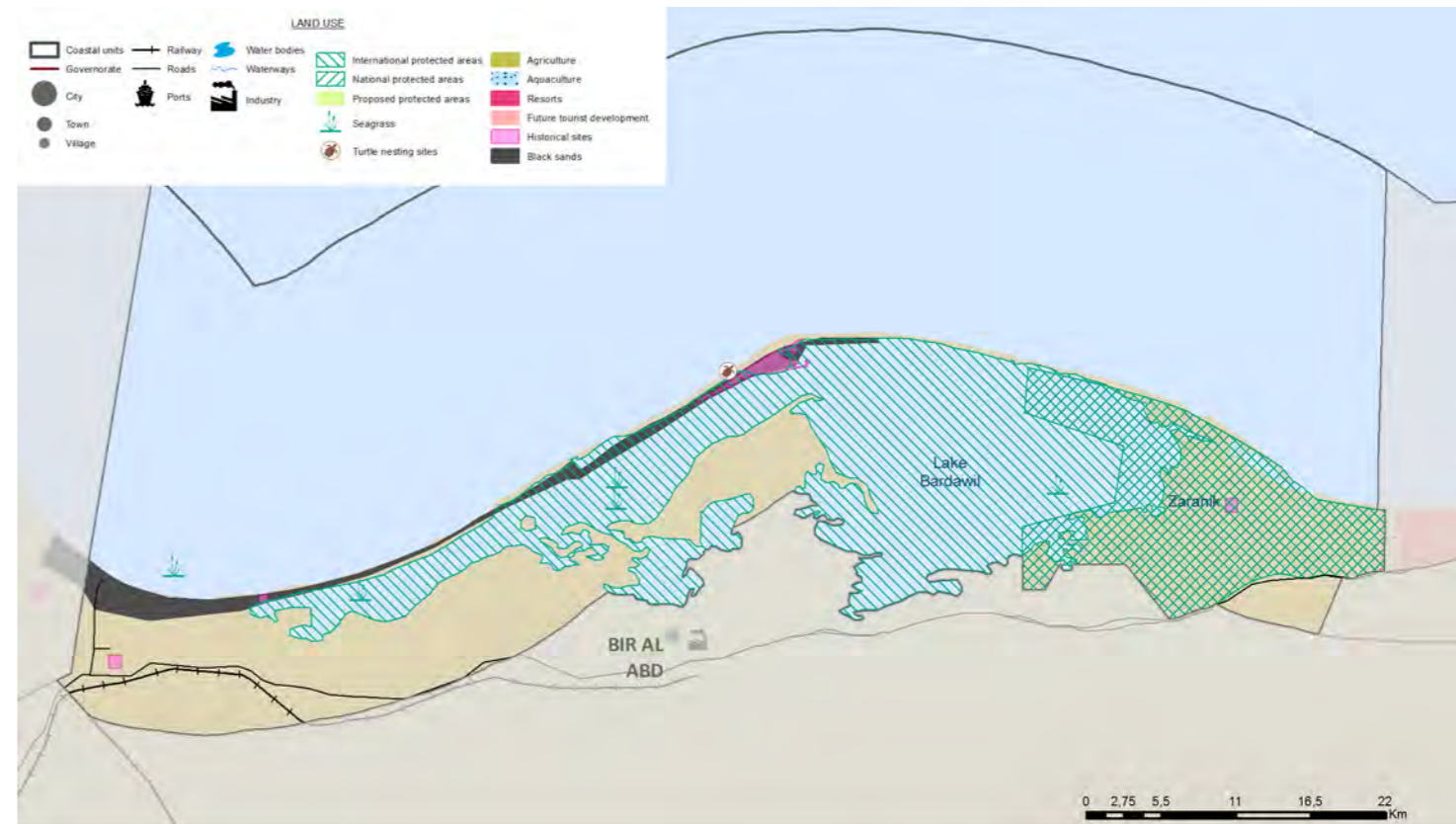
Established according to Prime Minister Decree 1429/1985 amended by Decree 3379/1996. Located at the eastern end of Lake Bardawil and encompasses an eastern extension of that lake: the Zaranik Lagoon. Area: 25,000 ha. Important Bird Area (IBA) according to BirdLife International (IBA criteria: A1, A4i) and a Ramsar Site. The lagoon is shallow, with numerous small islets scattered throughout it, most of which are covered with dense saltmarsh vegetation. Extensive mudflats and saltmarshes are found along the lagoon's shores, merging into sabkha and sand dunes further inland. A salt works was established at Zaranik prior to its declaration as a protected area.



Loggerhead turtle, lake Bardawil



Greater flamingos, Lake Bardawil



DIAGNOSIS OF PRESENT SITUATION

Current impacts and threats

Considerable ecological changes have occurred to Lake Bardawil due to the extension of salt extraction and the constant formation of sand bars (siltation), which close the channels connecting the lagoon with the sea. Moreover, a high sea turtle mortality rate has been noticed; the causes are unknown although some fishermen admitted to deliberately kill turtles profiting of poor law enforcement. Other impacts include:

- Rubbish and uncontrolled access to sea turtle nesting sites.
- Agriculture and land reclamation.
- Lake overfishing.
- Grazing of domestic animals.
- Hunting and commercial exploitation of wildlife.

Coastal unit status

Biodiversity:

- Extension of natural habitats: High.
- Loss of natural habitats: Low.
- Existence of protected areas: Yes.
- Extension of protected areas: Medium.
- Existence of IBAs: Yes (2).
- Existence of Ramsar Sites: Yes..
- Number of endemic/threatened species: High.
- Number of protected species: High.

Natural resources:

- Inland fisheries stocks: High.
- Species with potential use: High.

Natural water bodies:

- Pollution and contaminants: Low.

DIAGNOSIS OF LONG-TERM SITUATION

Proposed protected areas: No

SOCIOECONOMIC SYSTEM

Bir El Abd, the major settlement of this area hosted 63,333 inhabitants in 2006, of which a total of 77.2% lived in rural areas. Bir El Abd is famous for its fish production from Lake Bardawil. In addition, olives, figs, and dates are main agricultural products.

- Economic activities: 34.8% agriculture, grazing, and fishing, 18% education, 15.7% public administration & defense.
- Cultural and heritage: There are 9 sites, for example Tell el Farama, Tell el Kanayis.
- Social groups and ethnicities: rural and urban population.



Tell El Farama archeological site (www.touregypt.net)

DIAGNOSIS OF PRESENT SITUATION

- Lack of educational facilities: 124 schools and sections, 738 classrooms, and 1 teacher per 11.8 students in 2010. Illiteracy rate: 11-25%.
- Lack of health care facilities: 1 public hospital, 106 physicians, and 10 ambulances in 2010.
- Unemployment rate: 6-10%.
- About 44.8% of the population was classified as poor by CAPMAS in 2013.
- Unstable security situation in the area.
- The limited agriculture depends on groundwater and less on the surface water through Al Salam Canal.
- High quality fishery in Al Bardawil Lake.
- There is one industrial Zone in Bear Al Abd.
- There is poor connectivity between the sector and rest of western sectors in the delta, As Suez Canal represents a major barrier to extend roads, railways and other infrastructure.
- Poor infrastructure specially sanitation.
- Need of data to assess the variation in coastal management activities and the impacts and relationships between human activities and effective stresses on local society.

DIAGNOSIS OF LONG TERM SITUATION

- Exploiting the under construction tunnels under The Suez Canal Specially the three near Port Said (Two for roads and one for rail way).
- Providing public transportation means, regionally and locally.
- Repair of the train railway (East Qantara to Bir al-Abd).
- Utilization of rain and flashflood waters for agricultural reclamation.
- Touristic development of the sector, relying on existing attractions.
- Making more investments in the infrastructure sector and diversiform Energy production Sources.
- Improving and exploiting the Airport and the port in Al Arish for the development.
- Establishing transformative industries to raise the value of Mineral resources.
- Reconsideration of the current administrative division according to the economic activities and targeted projects, taking into account the main criteria for dividing the local units in terms of area, population and availability of infrastructure.

PLANS AND PROJECTS

EXISTING STUDIES

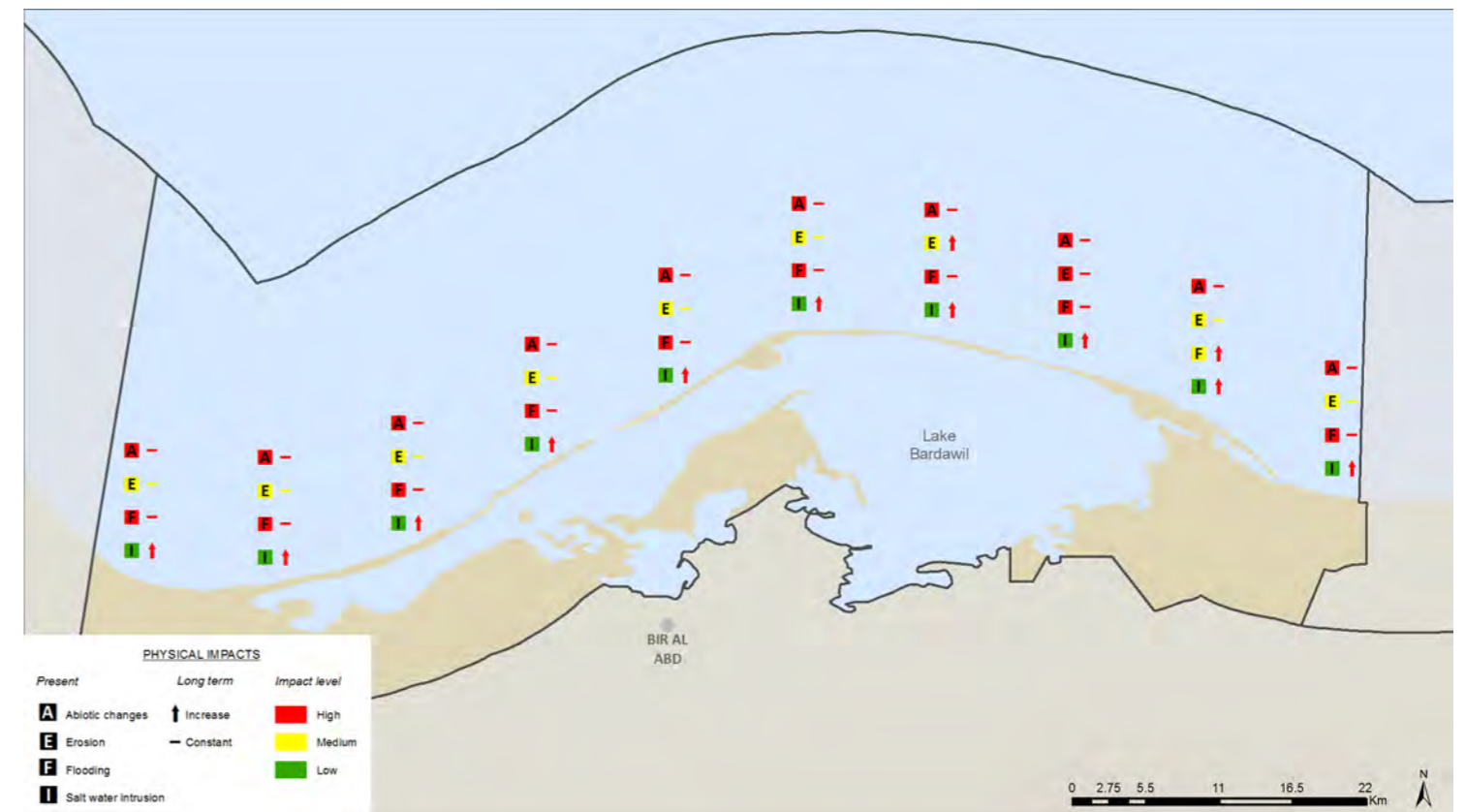
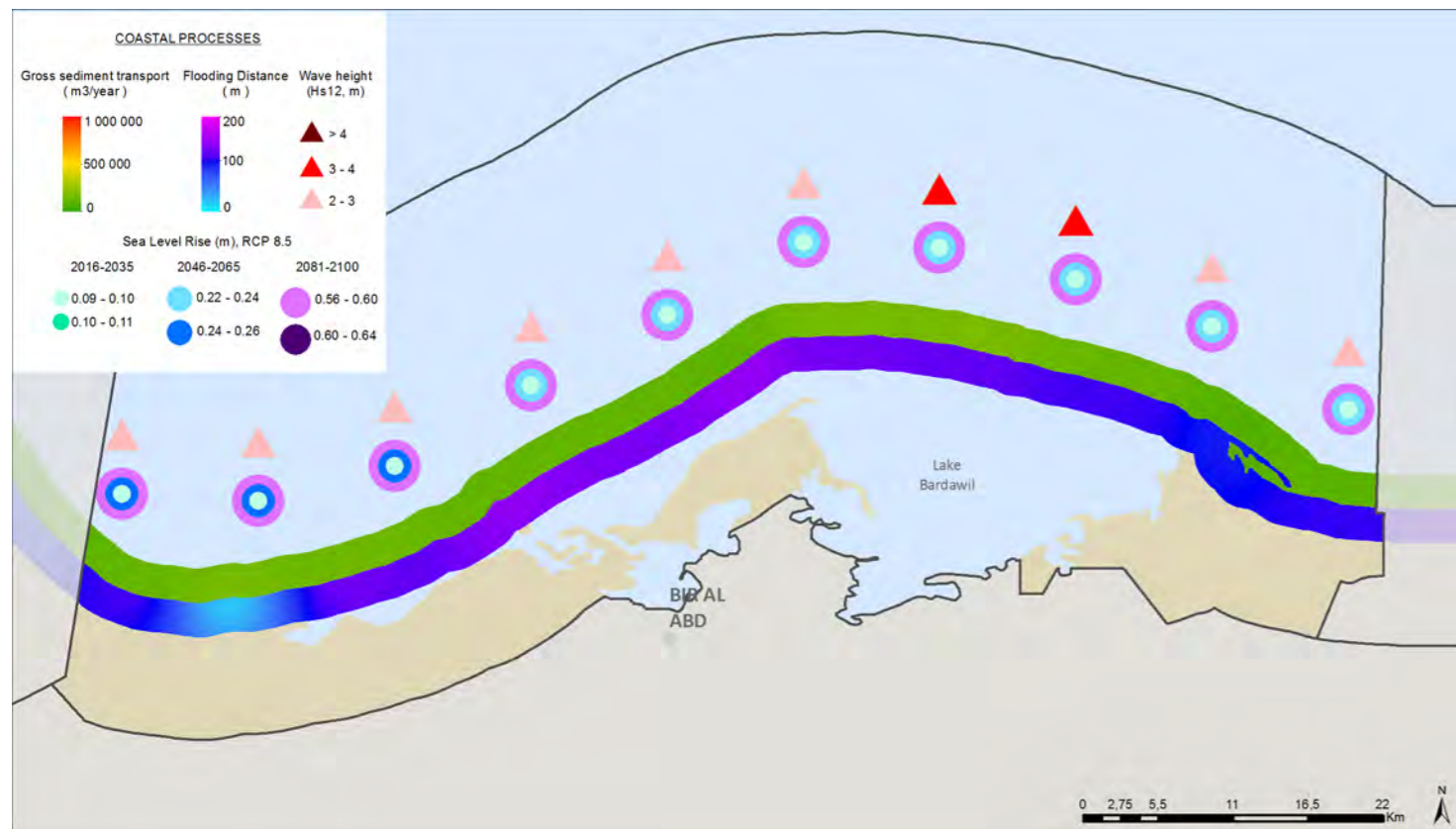
- Comprehensive plan for North Sinai Governotare (The Sinai Governorate, 2011).
- Studying and design of maintanance Works for outlet no.2 for El-Bardaweel Lake, Northeast coast of Egypt (CORI, 2004).
- Study of the Sedimentation of Lake Outlets and Coastal Openings (CORI, 2002).
- Strategic Development Plan for North Sinai Governorate (GOPP, 2008).
- Support to the Egyptcak Protected Area as Project (EEAA).
- National Strategic Plan for Urban development, 2015 (GOPP, 2015).
- Stakeholders identified the need of studies about stakeholder investment and crop pattern.

LONG TERM DEVELOPMENT PLANS

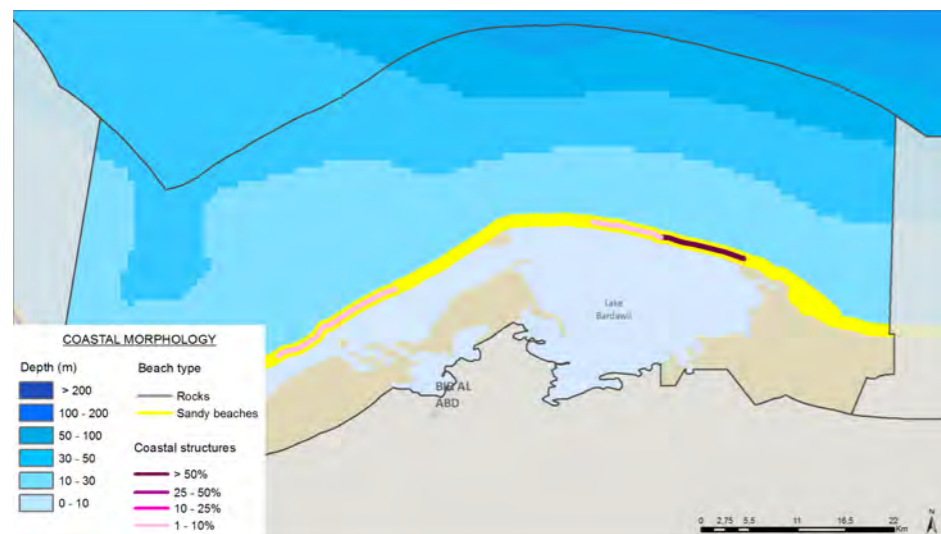
- National Strategic Plan for Urban Development (GOPP, 2015): planned urban development in Bir El Abd and tourism development in Mallaha.
- The stakeholders informed about: i) Agricultural development in Bardawill Lake, ii) Agricultural development in Bardawill, iii) Power plant in Romona.

LOCAL STAKEHOLDERS

Name	Type	Website
North Sinai Governorate	Authority	http://www.northsinai.gov.eg/home.aspx
Shore Protection Authority-Port Said Administration	Authority	http://www.mwri.gov.eg/ShoreProtectionflowchart.aspx
EEAA Suez Regional Branch Office	Authority	
Zaranik Protectorate	Authority	www.eeaa.gov.eg
Port Said Industrial Zone	Private Sector (industry)	
Salt Lakes in Al Bardawil	Private sector (industry)	
Neighbour countries	International	



PHYSICAL SYSTEM



General description:

The coastal unit extends from Sahl El Tina E limit (North Sinai western boundary) to the E end of Bardawil lagoon. It contains the Bardawil lagoon draining from two inlets (Bardawil W inlet, and Bardawil E inlet).

The E part of the coastline (from Sahl El Tina to the beginning of Bardawil lagoon) consists of a beach / dune / sabkha system. The W part of the coastline (major part) is a thin (minimum width of 50 m) sand barrier bounding northward the Bardawil lagoon. Bardawil lagoon is bounded southward by a vast sand dune system.

Beaches:

Beaches are long open sandy beaches with gentle slope and fine sediment along the entire unit. Beach width is somewhere limited at the thin sand barrier.

Coastal structures:

Coastal protection structures are located in the two lagoon inlets (E and W inlets). They consist of sea groins in both sides of the inlets that have been built because of siltation issues. Furthermore a riprap wall has been built eastward of the E inlet.

DIAGNOSIS OF PRESENT SITUATION

Erosion:

Medium erosion in the major part of the unit, and strong erosion in the Bardawil E inlet. Alongshore sediment transport is relatively low along the entire coastline, maximum values are obtained in the W part. Past shoreline retreats are medium along the coastline, except at the W boundary (high).

Main issues are observed eastward of the two inlets that act as barriers for the longshore sediment transport (directed eastward in the area). Strong erosions are observed locally, most problems occurring at the E inlet leading to the construction of the riprap wall. The sea wall, in turn, affects the nearby eastward coastal stretch.

These erosion problems occur because of the rigidification of the inlet that altered the natural dynamics of the barrier / lagoon system as the inlet cannot naturally evolve.

Flooding:

Flooding is high in the major part of the unit because of the low-lying topographies. Flooding issues are low in the areas protected by sand dunes (W part), and medium at the E end of Bardawil lagoon. This unit is characterized by relatively high astronomical tidal ranges.

Saltwater intrusion: According to stakeholders remarks, problems of saltwater intrusion currently exist within this unit.

Abiotic stress: High degree of abiotic stress due to the physical conditions given within the unit, which leads to the absence of neither *Posidonia oceanica* nor any other seagrass meadows.

Siltation: Low siltation issues detected at the two Bardawil inlets because of the relatively low longshore sediment transport in the area. However, the rigidification of the inlets affects the natural dynamics of the system and impede the natural migration of the inlet. This exacerbate siltation issues.

DIAGNOSIS OF LONG TERM SITUATION

Erosion:

Erosion issues are expected to increase because of the strong shoreline retreat related to sea level rise in all the unit. It will remain globally medium, but a larger stretch of coastline around Bardawil E inlet will expect high erosion issues at long term. The construction of the new Romana port at the extreme W boundary will increase erosion issues in the eastern coastal stretches.

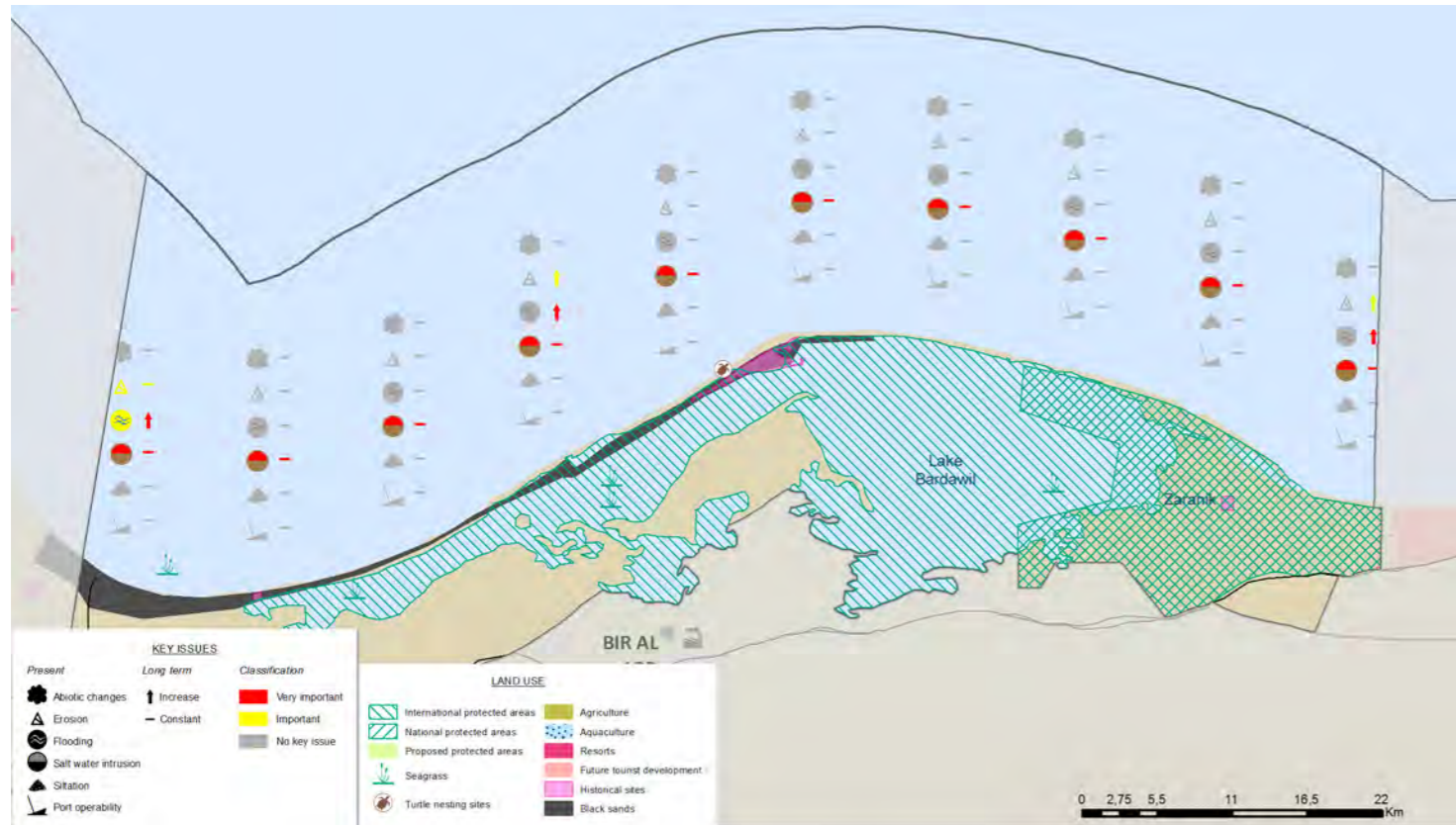
Flooding:

Flooding issues will increase because of the sea level rise. It is expected to be high in all the unit including from the best near term scenario, except in area protected by sand dunes (medium flooding SW of the unit at long term).

Saltwater intrusion: Sea level-rise will do nothing but exacerbate current problems of saltwater intrusion if no adaptation measures are taken.

Abiotic stress: Increases in mean sea surface temperature will even exacerbate physical conditions, hence impeding the development and growing of seagrass meadows neither in near nor in long term.

Siltation: No changes are expected at near term as changes in longshore sediment transport are less than 2% in the two inlets. At long term, the new Romana port will be built in an area of relatively small longshore transport. Siltation issues will depend on the port design. Dredging can be necessary because of the gentle slope bathymetry.



SWOT ANALYSIS

STRENGTHS

- Pristine area with valuable ecosystem services.
- High value for biodiversity conservation.

WEAKNESSES

- Lack of infrastructures and investment.
- Lack of fishing port.
- Lack of economic activities for local communities.
- Human security.
- Poor infrastructure specially sanitation.
- Poor connectivity to other sectors due to the canal.
- Salt extraction.
- Lack of data related to gas extraction and its effect on coastal processes, as subsidence, and on other activities.

OPPORTUNITIES

- Potential for eco-tourism.
- High quality fishery.

THREATS

- Erosion of the sand barriers protecting Bardawil lake.
- Flooding risks.
- Potential impacts of industrial development in the eastern border of North Sinai Governorate.
- Overfishing in lake Bardawil.

KEY ISSUES FOR COASTAL MANAGEMENT

PRESENT KEY ISSUES

The Key Issues of Bardawil Coast Unit are:

- High erosion level in the area of the eastern inlet of Lake Bardawil.
- Medium erosion level affecting the urban area located at the western border of North Sinai Governorate.
- High flooding level along the Coastal Unit.
- Medium flooding level affecting the urban area located at the western border of North Sinai Governorate.
- Saltwater intrusion affecting groundwater.
- High ecological value; important conservation area for bird and reptile species.
- Conflicts between fisheries and conservation of declining species, mainly tortoises.
- Human security problems.

LONG TERM KEY ISSUES

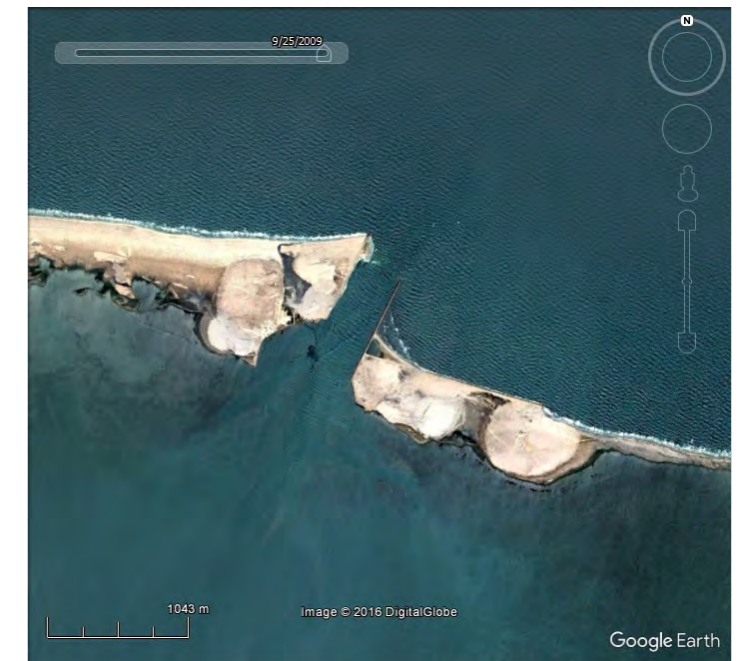
Stakeholder participation allowed the identification of potential developments in this Coastal Unit, as the planned power plant and commercial port in the western limit of North Sinai Governorate and the industrial development in Bir El Adb. Also, tourism developments are planned for the western and eastern limits of CU13.

Considering these developments, the long term Key Issues are:

- Medium erosion level would affect new resorts and new industrial developments in the western border of North Sinai Governorate.
- High flooding level affecting the urban area located at the western border of North Sinai Governorate.
- High flooding level could affect new industries around Bir El Abd.
- Potential impact of new industries on water quality and biodiversity conservation.
- High level of saltwater intrusion could affect the limited agriculture activity.



Bardawil western inlet. Sand deposition westward and sand deficit eastward. The sea groin broke the continuity of the sand barrier and impede the free behavior of the system.



Bardawil eastern inlet. Sand deficit eastward and a sea wall was built for this issue. Sediment bypass can be seen because of the limited length of the eastern groin: siltation issues.



Lake Bardawil, its thin sand barrier fully exposed to the Mediterranean sea (active surf zone), and the major sand dune system.

COASTAL UNIT 14 - ARISH



GENERAL DESCRIPTION OF THE COASTAL UNIT

CU 14 is located on the Egyptian - Palestinian border, in North Sinai Governorate. The major urban centres are El Arish, through which flows wadi El Arish, and Rafah.

- Coastal Length: 70 Km.
- Governorate: North Sinai.
- Markaz: El Arish first, El Arish second, El Arish fourth, El Sheikh Zweid, Rafh.

ECOLOGICAL SYSTEM

The Mediterranean Coastal Desert of Sinai consists of wide, sand-covered plains, gradually sloping northward. The northward-flowing Wadi El Arish, a very large wadi with numerous tributaries drains extensive areas of the Central Sinai highlands and is one of the major geomorphologic features of the region.

Habitats:

The coastal belt of North Sinai includes: sandy shoreline with date palm beaches in the El Arish area, bodies of coastal dunes in the eastern part and series of inland sand dunes with lows in between. The delta of Wadi El Arish, a drainage system with an extensive catchment area, crosses this belt east of the city of El Arish.

Flora:

Plant growth in the sand dunes shows an in-landward sequence dominated by *Zygophyllum album*, *Artemisia monosperma*, *Thymelaea hirsuta* and *Stipagrostis scoparia*.

Fauna:

Herpetofauna of this region includes 24 species and is dominated by those specially adapted to sandy substrates. At least 27 bird species are known to breed in the Mediterranean Coastal Desert of Sinai. Mammals include a total of 20 species.

El Ahrash Reserve

Established according to Prime Minister Decree 1429/1985 amended by Decree 3379/1996. It is located at north-easternmost borders of Egypt and covers an area of 8 km². It is an area of marshes characterized by sand dunes, of approximately 60 m height above sea level. Plants include a high density of Acacia trees, *Tamarix* trees, camphor trees, bushes, grass, pastoral and fodder plants. The area includes important resources for pasture and timber and constitutes a shelter for wildlife. Vegetation helps in sand dunes stabilization.



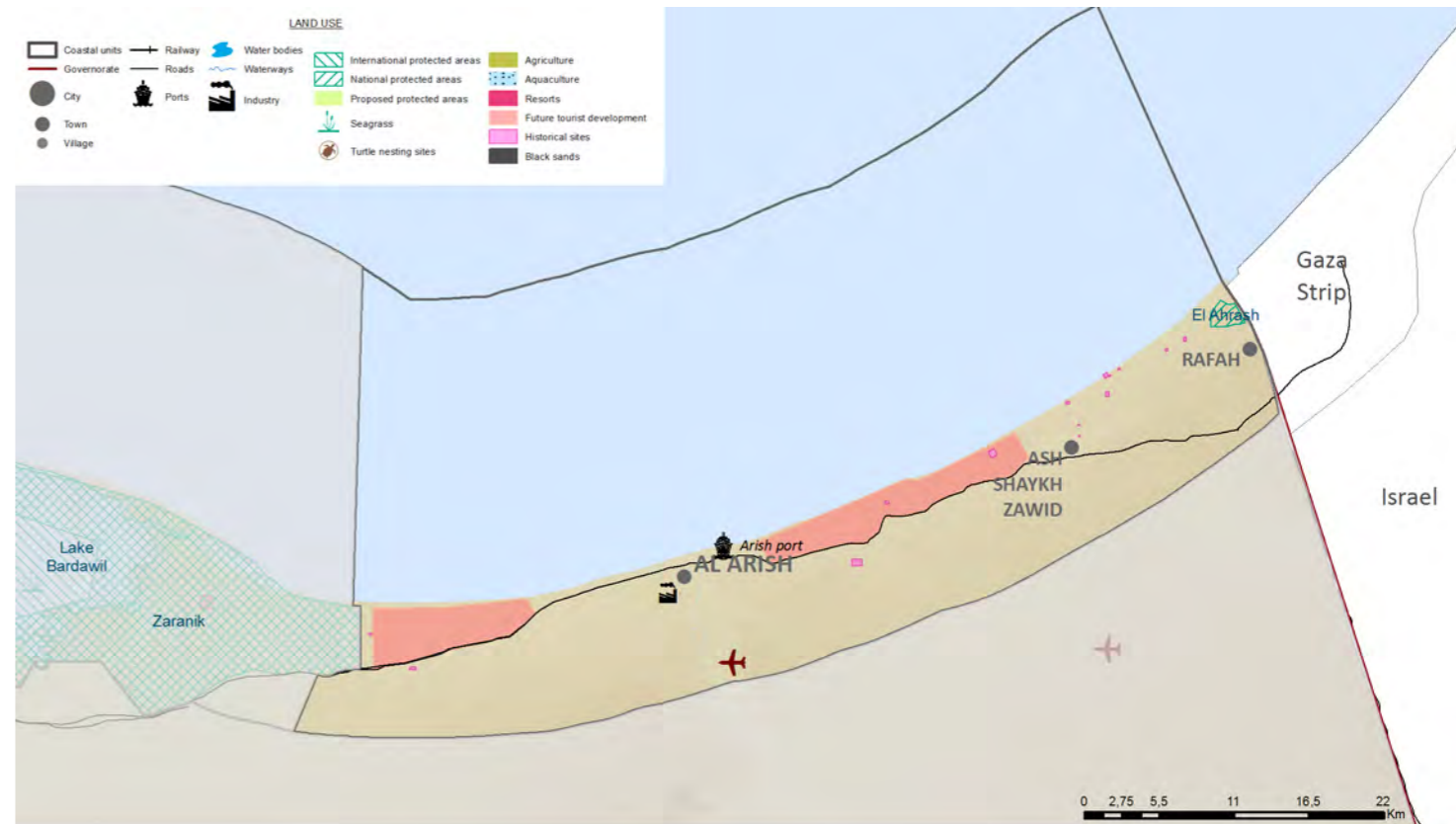
El Ahrash Reserve



Inland sand dunes, El Arish



Palm beach, El Arish



DIAGNOSIS OF PRESENT SITUATION

Current impacts and threats

The main impacts and threats include:

- Agriculture and land reclamation.
- Excessive withdrawal of groundwater and increased salinity.
- Decrease of numbers of palm trees.
- Collection of medicinal plants by locals.
- Grazing of domestic animals.
- Invasive species, as water hyacinth.
- Hunting and commercial exploitation of wildlife, as bird trapping, rain-fed agriculture and economic uses, pasturing,

Coastal unit status

Biodiversity:

- Extension of natural habitats: High.
- Loss of natural habitats: Low.
- Existence of protected areas: Yes.
- Extension of protected areas: Low.
- Existence of IBAs: No.
- Existence of Ramsar Sites: No.
- Number of endemic/threatened species: High.
- Number of protected species: High.

Natural resources:

- Inland fisheries stocks: NA.
- Species with potential use: High

Natural water bodies:

- Pollution and contaminants: NA.

DIAGNOSIS OF LONG-TERM SITUATION

Proposed protected areas: No

SOCIOECONOMIC SYSTEM

The major city in this unit is El Arish, where lived almost 140,000 inhabitants in 2006. Rafah and Ash Shaykh Zawid towns host about 50,000 inhabitants. The main crops include peaches, olives, citrus, apples, dates, and grapes. The Rafah crossing links Egypt to the Palestinian land. Many people sneak to the Egyptian land, while goods are smuggled to the Palestinian land. Currently, many terrorist attacks take place in this area.

- Economic activities: agriculture, grazing, and fishing, education, whole sale and retail trade
- Cultural and heritage: There are 11 archeological tell, such as Tell el Sheikh Zweid, Tell el Kharruba, Tell el Basta,
- Social groups and ethnicities: Bedouins from El Malaleha, El Tiaha, Sawarka, Mezena, and Tarabeen tribes. In addition to the sons of the valley who migrated after the peace agreement with Israel.

DIAGNOSIS OF PRESENT SITUATION

- Fair educational facilities: 391 schools and sections, 2,704 classrooms, and 1 teacher per 11.5 students in 2010. Illiteracy rate: 24.7% .
- Fair health care facilities: 1 public hospital, 2 specialized hospitals, 5 private hospitals, 411 physicians, and 33 ambulances in 2010.
- Unemployment rate: 5.7%.
- About 24.8% of the population was classified as poor in 2013.
- Unstable security situation in the area.
- The sector's limited agriculture depends on groundwater and less on the surface water through Al Salam Canal.
- There are two industrial Zones within the sector in Al Arish, Al Sheikh Zuid and one Free zone in Rafah.
- There is poor connectivity between the sector and rest of western sectors in the delta, As Suez Canal represents a major barrier to extend roads, railways and other infrastructure.
- The sector connected with South Sinai through the roads
- The sector acquires a Port in Al Arish for various activities such as trading and transportation, in addition to Al Arish international Airport.
- The eastern side of the sector is an international border area. People sneak across the border.

DIAGNOSIS OF LONG TERM SITUATION

- Extension of El-Salam Canal to feed lands targeted for reclamation.
- Exploiting the under construction tunnels under The Suez Canal Specially the three near Port Said (Two for roads and one for rail way).
- Providing public transportation means, regionally and locally.
- Repair of the train railway (East Qantara to Bir El Abd), and extending it to Rafah.
- Utilization of rain and flashflood waters for agricultural reclamation.
- Touristic development of the sector, relying on existing attractions.
- Establishing Rafah industrial zone and Al Masaed industrial crafts zone.
- Making more investments in the infrastructure sector and diversiform Energy production Sources.
- Proposed water desalination plant in Al Arish.
- Improving and exploiting the Airport and the port in Al Arish for the development.
- Reconsideration of the current administrative division according to the economic activities and targeted projects, taking into account the main criteria for dividing the local units in terms of area, population and availability of infrastructure.

PLANS AND PROJECTS

EXISTING STUDIES

- Study the erosion problems within El Arish coastal area, Northeast coast of Egypt (CORI, 2006).
- Protection of Port Said and El-Arish shores (El Gameel– Cornish El Arish) (SAP).

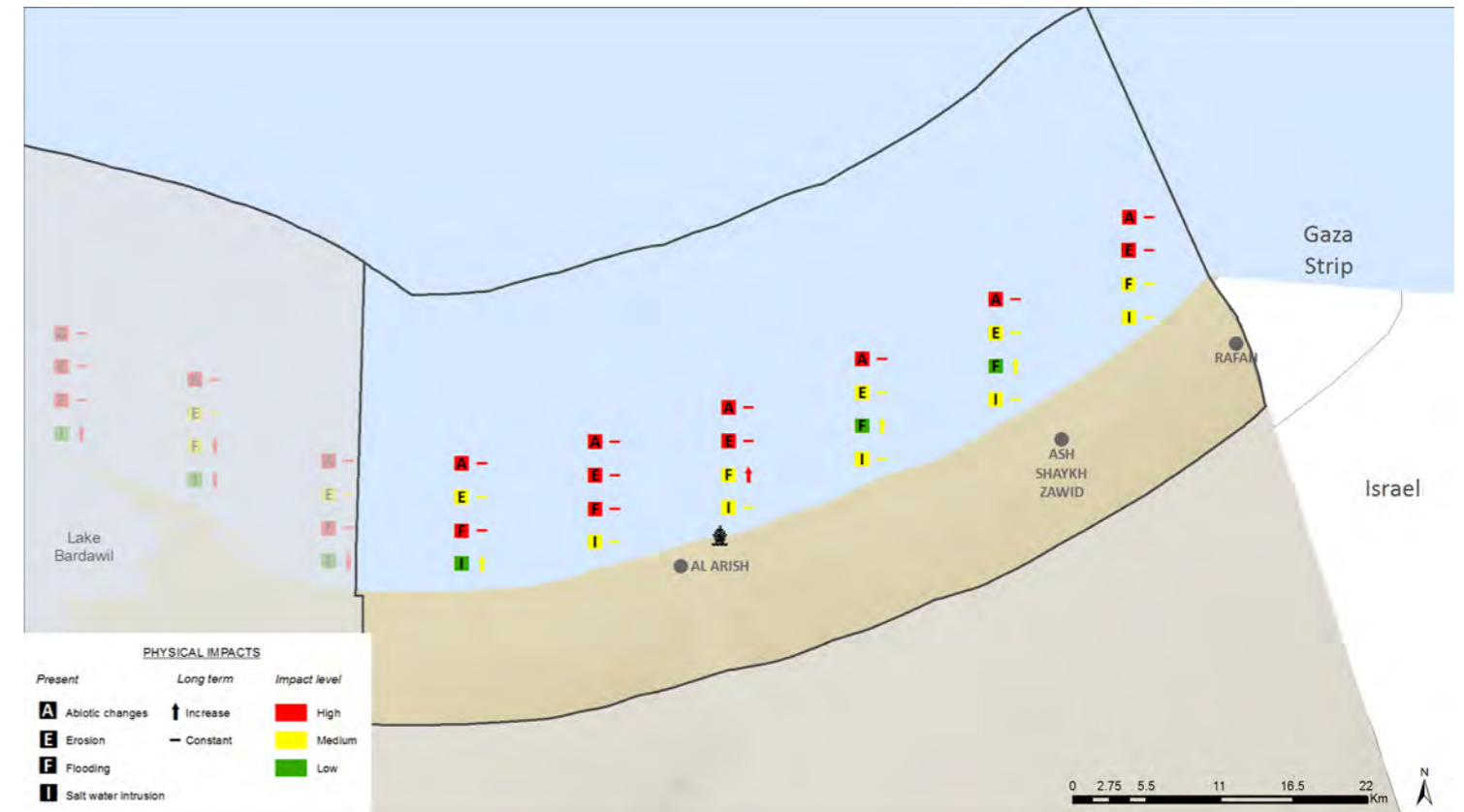
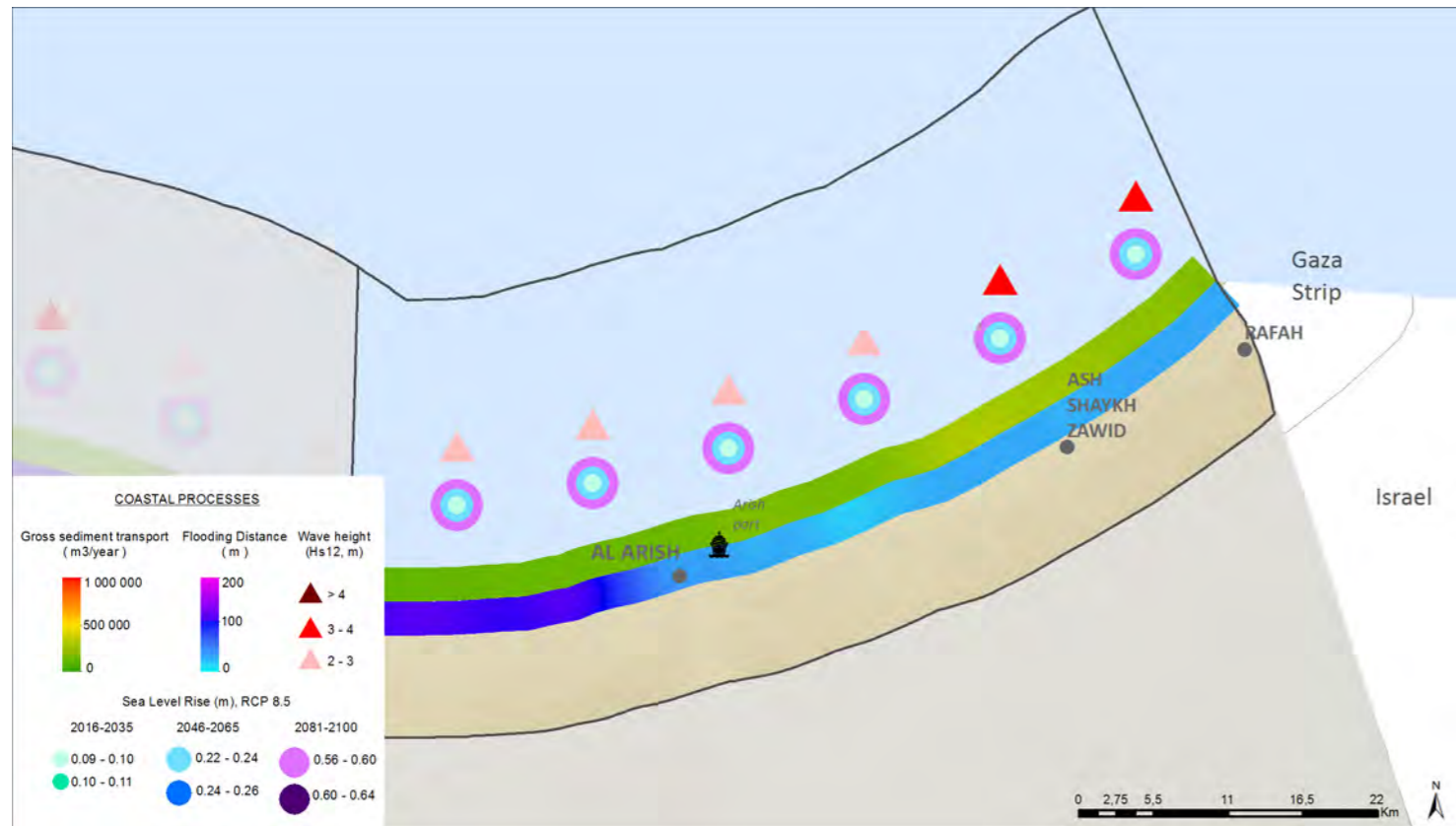
LONG TERM DEVELOPMENT PLANS

- National Strategic Plan for Urban Development (GOPP, 2015): planned urban development in Arish, Ash Shaykh Zawid and Rafah.
- Comprehensive plan for North Sinai Governorate (The Sinai Governorate, 2011).
- Strategic Development Plan for North Sinai Governorate (GOPP, 2008).
- Some stakeholders informed us about the enlargement of El Arish port and the tourism development in the area between El Arish –Rafah; but there is no consensus on this.
- Stakeholders note that long term plans will increase existing problems.

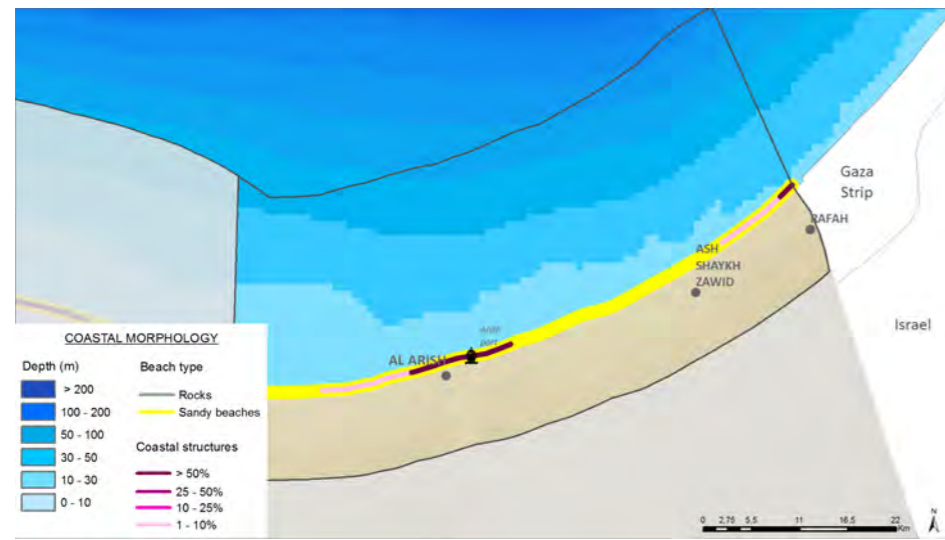
LOCAL STAKEHOLDERS

Name	Type	Website
North Sinai Governorate	Authority	http://www.northsinai.gov.eg/home.aspx
Shore Protection Authority-Port Said Administration	Authority	http://www.mwri.gov.eg/ShoreProtectionflowchart.aspx
EEAA Suez Regional Branch Office	Authority	
Port Said Port Authorities	Authority	http://www.mts.gov.eg/en/content/28/1-105-Port-Said-Port-Authority www.psd.gov.eg

Name	Type	Website
Zaranik Protectorate	Authority (environmental protection)	www.eeaa.gov.eg
Reclamation Farms in Raffah	Private Sector (agriculture)	
Reclamation Farms in Al Shekh Zuwaid	Private sector (agriculture)	



PHYSICAL SYSTEM



General description:

The coastal unit extends from the E end of Bardawil lagoon up to the Northern Egyptian coast E boundary (Rafah). The coastline is almost straight all along the unit and expects a smooth gradual change in orientation from a N orientation (W boundary) to a NW orientation (Rafah). Different sand dune systems extend all along the unit. The few interruptions of the coastline is seen at Arish (Arish port), and at different low protruding headland E of Arish.

Beaches:

Beaches are long open sandy beaches with relatively gentle slope and relatively fine sediment along the entire unit. Beach width is large all along the unit except eastward of coastal structures, or of the natural low protruding headlands. Nearshore bars are present all along the unit.

Coastal structures:

Most of the coastal structures are located W of Arish and at the E unit boundary (Rafah). They consist of (1) a small port 15 km W of Arish port, (2) a sea groin system W of Arish port, (3) the massive Arish port, (4) a sea groin system E of Arish port and (5) coastal protection structures of Rafah (shore connected parallel breakwater and sea wall at the extreme E).

DIAGNOSIS OF PRESENT SITUATION

Erosion:

Medium erosion has been identified in those area preserved from coastal structures (W boundary, E part of the unit except Rafah). Strong erosion eastward of the coastal structures, this mainly concerns Arish beach, Arish port and Rafah coastal structures. Erosion issues at Arish beach occur because of the low coastal setbacks, the construction of sea groins led to a chain reaction problems. The massive Arish port blocks the eastward directed net longshore transport and affect the E side of the harbor. Sea groins were constructed but they affect, in turn, the eastward coastal stretches. Strong erosion issues are observed at Rafah that have been partially solved with the construction of the seawall from the shore-connected breakwater up to the Egyptian border line. Erosion issues are thus transferred at the other side of the border.

Flooding:

Flooding is medium in Arish and Rafah because of the possible side effects induced by the coastal structures. Low flooding issues between Arish and Rafah. High flooding levels are the lowest in this area. Relatively high astronomical tidal ranges all along the unit.

Saltwater intrusion: Low degree of saltwater intrusion within the entire unit.

Abiotic stress: High degree of abiotic stress due to the physical conditions given within the unit, which leads to the absence of neither *Posidonia oceanica* nor any other seagrass meadows.

Siltation: Low siltation issues detected at Arish port because of the relatively low gross longshore sediment transport in the area.

DIAGNOSIS OF LONG TERM SITUATION

Erosion:

No significant changes in erosion issues are expected along the coastal unit. Shoreline retreat is expected to be small in the E part even in the worst long term scenario. Major (strong) shoreline retreat is expected to occur at Arish for the different long term scenarios. This will exacerbate the strong erosion issues. Low / medium shoreline retreat expected at the W part at near / long term, respectively.

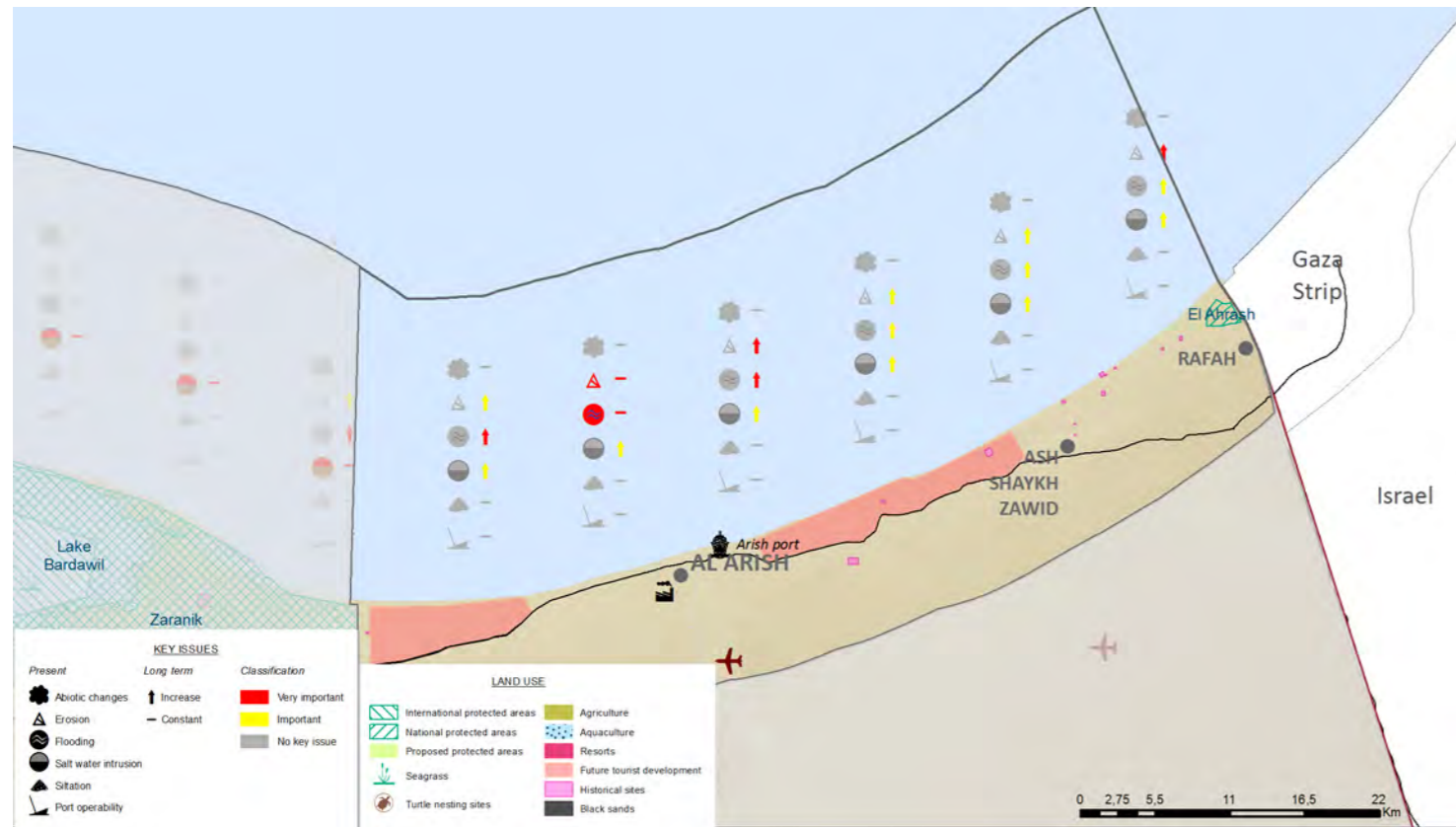
Saltwater intrusion: The current low degree of saltwater intrusion will be remain in the near term. In the long term, however, sea-level rise will worsen the situation leading to medium level.

Abiotic stress: Increases in mean sea surface temperature will even exacerbate physical conditions, hence impeding the development and growing of seagrass meadows neither in near nor in long term.

Flooding:

Flooding issues will increase because of the sea level rise. They are expected to be high in the entire W part (Bardawil - Arish) and medium in the entire E part (Arish - Rafah). The E part of Arish get strong flooding in the worst long term scenario only (medium flooding issues in the other scenarios).

Siltation: No changes are expected at near and long term as changes in longshore sediment transport are less than 1% in the area of Arish port (low siltation issues).



SWOT ANALYSIS

STRENGTHS

- Existence of dunes to protect the coast.
- Tourism attracting resources.
- Potential for agricultural activities.

WEAKNESSES

- Lack of basic services and infrastructures, and investment.
- Lack of fishing ports and lack of agreement on this weakness among stakeholders.
- Education is marginal and high rate of illiteracy.
- Lack of economic activities for local communities.
- Human security.
- Poor connectivity to other sectors due to the canal.
- Poor infrastructure specially sanitation.
- Build on the flood prone areas of the wadi.

OPPORTUNITIES

- Potential for eco-tourism.
- Enlargement of El Arish port.
- Protection works studied in an integrated manner.

THREATS

- Salt water intrusion and lack of fresh water.
- Potential impacts to biodiversity and landscape due to tourism development.
- Increased erosion and flooding in the long term.
- It is necessary to assess the effect of new projects on marine life.

KEY ISSUES FOR COASTAL MANAGEMENT

PRESENT KEY ISSUES

Key Issues of Arish Coast Unit are:

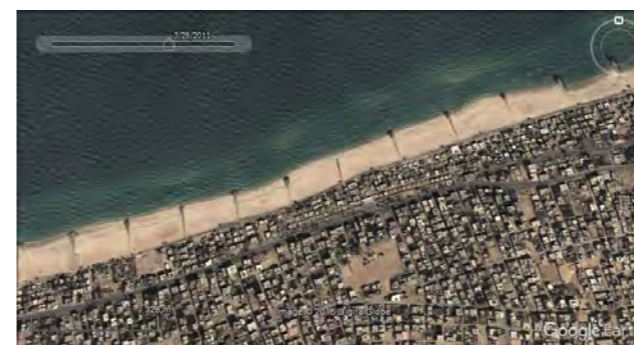
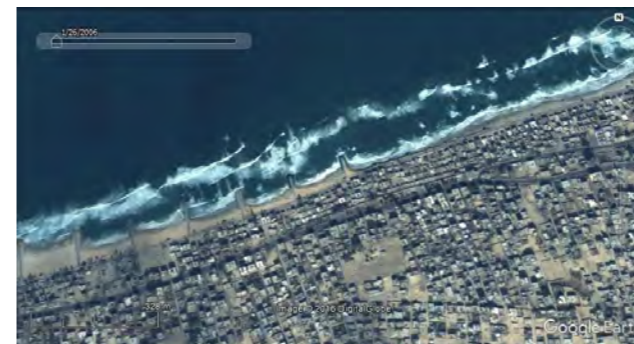
- High erosion level in El Arish coastal area affecting urban facilities.
- High erosion level in the area of El Arish port and the Palestinian border.
- High flooding level in El Arish coastal area affecting urban facilities.
- High flooding level in the western part of the unit.
- Flash floods in wadi El Arish.
- Human security and terrorism problems.
- Stakeholders identified sewage and groundwater problems in Rafah.

LONG TERM KEY ISSUES

The National Strategic Plan for Urban Development (GOPP, 2015) expects the increase of the urban centres of this unit: El Arish, Rafah and El Sheikh Zweid . Besides, there are planned tourism developments on the coastal front, both western and eastern of El Arish, even the security challenges in this area.

The future Key Issues of CU14 are:

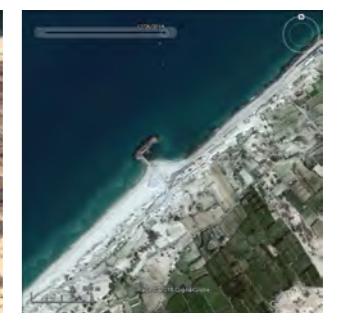
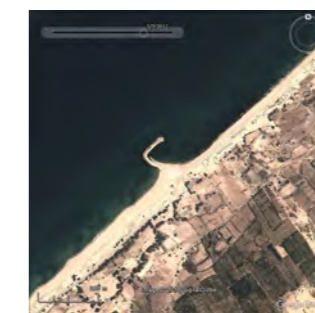
- Medium erosion level in the areas with planned tourism development.
- High erosion level in El Arish urban area.
- High flooding level in the areas with planned tourism development and El Arish urban area.
- Security and terrorism impede tourism development.



The Arish beach sea groin system protruding in a very active surf zone. The initial (2009 image) structures do not impede erosion and have been extended (2011 image). The problem is partially (locally) solved, it is transferred eastward.



Arish port. Coastal groins eastward to stop erosion. Erosion issues transferred eastward of the groin system.



Rafah beach. Various tentative to stop erosion. Erosion eastward of the breakwater. A wall has been built. This will cause issues eastward.

LEGAL AND INSTITUTIONAL ASSESSMENT

Background

Effective development and protection of natural assets necessitates the adoption of integrated approaches. Integrated approaches can be successful only when the overall development aims and particular roles are clearly defined and understood by all those involved at the institutional, collective and individual levels. Such clarity and commitment is even more critical for coastal zone development and management given the sensitivities, dynamics and uncertainties.

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 expansion and increase of economic activities, urbanization, and resource depletion, as well as population growth, have continuously amplified the vulnerability of coastal zones.

Aim of the assessment

The aim of the assessment is to provide a baseline and a high level assessment concerning the main legal and institutional opportunities and constraints for the development of ICZM in Egypt. The spatial scale of this analysis is the entire North Coast, since most of regulations and institutions are common for all the coastline management. However, the assessment is also extended to identify potential legal and institutional differences between the governorates, if any. This assessment is part of a larger scoping study and is thus considered as a precursor document guiding further activities, including detailed research, toward the establishment and subsequent implementation of ICZM in the northern coast of Egypt.

Regulatory Framework

Several regulation instruments have been activated addressing the ICZM aspects in order to effectively engage essential partners on both the regional and national scale. Egypt has both moved towards formulating its own regulatory framework, and joined regional and international agreements related to the north coast of Egypt as outlined below order of ratification in reverse chronological order:

A. Regional and International Levels

- The conservation of Small Cetaceans of the Black Sea, Mediterranean Sea and Contiguous Atlantic area (ACCOBAMS), 1996
- The London convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter, 1972
- International Convention on Oil Pollution Preparedness, Response and Co-operation (OPRC), 1989
- Stockholm Convention on Persistent Organic Pollutants (POPs), 2000
- The Conservation of African-Eurasian Migratory Water birds (AEWA), 1995
- The United Nations Framework Convention on Climate Change (UNFCCC) 1992
- Global Convention on the Protection of Biological Diversity, 1992
- The Basel Convention, 1989
- International Convention Relating to Intervention on the High Seas in Cases of Oil Pollution Casualties, 1969
- The International Convention on Civil Liability for Oil Pollution Damage, 1969
- RAMSAR Convention on Wetlands of International Importance Especially as Waterfowl Habitat, 1971
- International Convention for the Prevention of Pollution from Ships, 1973
- The Law of the Sea, 1982
- The Bonn Convention on the Conservation of Migratory Species of Wild Animals, 1979
- Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), 1973
- World Heritage Convention, 1972
- The Rotterdam Convention, 1998
- Bern Convention on the Conservation of European Wildlife and Natural Habitats, 1979

B. National Level

- Law No. 4/1994 on Environment amended by Law No. 9/2009
- Law No. 12/1984 on Water Drainage and Irrigation
- Law No. 102 of 1983 on Natural Protectorates
- Law No. 48/1982 on Protection of the Nile River and Waterways from Pollution
- Law No. 124/1983 on Fishing, Aquaculture and Regulate Fish Farms

- Prime Ministerial Decree No. 1095/2011, amending some provisions of the Executive Regulation of Law 4, issued by the prime ministerial decree no. 338/1995
- Ministerial Decree No. 758/1972, promulgating the Executive Regulations of Law No. 66/1953 concerning mines and quarries (petroleum resources), issued by the Minister of Commerce and Industry
- Ministerial Decree No. 447/1988, regulating the establishment of tourism projects in the north coast region of Egypt
- Minister of new urban communities Decree no. 24/1993, regarding the Licensing Requirements and Procedures for construction at the northwest costal region
- Prime Ministerial Decree no. 1599/2006, regarding the protection of Egyptian seashores
- Decree of the Minister of Housing, Utilities and Urban Development no. 144/2009, regarding the executive regulation of Unified Building Law issued by the law no. 119/2008
- Presidential Decree No. 108/2000, on State-owned lands which lie within the Nile Valley and Delta, as a designated area for the establishment of new urban communities
- Prime ministerial decree no. 206/1997, on the area in Gamsa city, south of the coastal international highway in Dakahliya, as an industrial zone in accordance with the provisions of the Investment Guarantees and Incentives law
- Prime Ministerial Decree no. 250/1999, Establishes a public free zone for warehouse projects in Damietta

C. Frameworks, Plans and Strategies

A number of guiding documents was developed for the coastal zone activities. However, none of these documents seem to be institutionalized as providing the unquestionable reference to others.

- Sustainable development strategy 2030 (prepared by the ministry of planning in 2014)
- National strategy for adaptation to climate change and Disaster risk reduction (prepared by Egypt's Cabinet Information and Decision Support Centre and the UNDP in 2011)
- ICZM Strategy (prepared by EEAA in 2009)
- Urban Strategic plans (prepared by GOPP in 2009)
- National Environmental Action Plan 2002-2017 (prepared by EEAA in 2001)
- ICZM Framework (prepared by NCICZM in 1996)

Key Institutional Stakeholders

The institutional map of ICZM has several stakeholders to which the responsibility preserving the coastal natural resources is assigned each according to its competent authority. The key entities engaged in the ICZM institutional map include the following;

- Ministry Of State for Environmental Affairs, Egyptian Environmental Affairs Agency (EEAA)
- Ministry of Water Resources and Irrigation , Shore Protection Authority (SPA) and Coastal Research Institute (CORI)
- Ministry of Transportation , Egyptian Authority for Maritime Safety (EAMS) and Marine Transportation Sector (MTS)
- Ministry of Tourism, Tourism Developing Agency (TDA)
- Ministry of Agriculture, General Authority for Fish Resources Development (GAFRD)
- Ministry of Defense, Coastal Guard Department and the Naval Forces
- Ministry of Scientific Research and Technology, National Institute for Oceanography and Fisheries (NIOF)
- Ministry of Housing , General Organization for Physical Planning (GOPP) and The Central Agency for Reconstruction
- Council of Ministers, National Center for Planning State Land Uses (NCPSLU)
- Coastal Governorates, Matrouh, Alexandria, Beheira, Kafr El-Sheikh, Dakahlia, Damietta, Port Said, and North Sinai

Key Issues

The review of the previous regulatory framework and the key institutional stakeholders complemented by the knowledge acquired through interviews with key stakeholders, has delineated the institutional and legal system relevant to ICZM in Egypt. This section not only provides an understanding of the causes for stalled progress in the ICZM agenda, but also identifies points on which future progress could be based. The summary below of the main points distilled from the analysis and interviews indicates a possible path to progress,

1) Limited Knowledge

Interviews have revealed the need to increase awareness of the definition of the coastal zone. Although the latest amendments of the Environment Law provide a clear definition, it did not trickle down to practical applications, and thus is not in the scope of the interviewees direct interest.

The limited knowledge extends to what this general definition really mean for the specific governorate. It was noted in both Port Said and Damietta that according to this definition, the whole, or at least most of, the respective governorates are within the coastal zone. This definition needs to be reflected on the ground, and be refined/revised as needed.

2) The critical need for coordination

The multiplicity of actors affects the potential achievement of coordinated actions in the coastal zone, especially as related to the multiple land jurisdictions (governorate, Military, agriculture reform, TDA, EEAA, etc.). A large number of administrative and decision making entities which mandates extend to the coastal zones seems not to be avoidable. However, having these entities acting based on different objectives and different regulatory instruments is a substantive cause of conflicts. The issue of inter-organizational conflicts was highlighted by interviewees, on both a horizontal level, between organizations of different scopes, and on a vertical level, between central and local organizations. It was generally agreed that proper coordination, clear planning and determining the roles for each entity, is a must for integrated management, without which bureaucracy and the long governmental procedures within each entity are real challenges facing both ICZM, investors and communities.

3) The strengthening of the NCICZM

None of the interviewees has considered the centralization of functions in a single agency as a proposed approach of choice in Egypt. Centralization has been historically adopted in Egypt in organizations implementing national projects. Given the wide geographic area it covers, it will run against the current interests of multiple and well established institutions with specialized scopes working under much different legislations, as confirmed by interviewees. This will entail time and effort needed to overcome the resulting organizational resistance, as well as the investments needed to build organizational capacity, as not a single would have the full scope of knowledge and expertise which needed in this respect.

4) Prerequisite to activate the NCICZM

Some interviewees consider the need to revise membership and organizational level. However, some perceived the issue in a more strategic way which seems to suggest the building blocks available, including the NCICZM, lack the main integrator between them namely a whole-of-government vision for the coastal zone. According to this view, an initial consensus among different stakeholders on the coastal zone management strategy and the coordinating rules as well as their respective roles, and responsibilities must be clear for a committee to operate. It is unproductive to bring conflicts to the table without ensuring a common reference shared among the parties

5) Reflecting the specificity of the Coastal zone on laws and procedures

In order to make a real difference on the ground, policy and planning documents obviously need to be clearly reflected on the day-to-day work of executives agencies and communities. Several tools and means to transpose principles to actions were proposed by interviewees.

6) Regional Planning

Regional plans are the pertinent vehicles to streamline ICZM principles. The previous practice of having both a regional development plan and an ICZM plan for the same region should be discontinued. It is more effective to have a single development plan, the one produced by GOPP, in which the ICZM criteria are integrated.

7) Stakeholder engagement

Stakeholder engagement was not thoroughly considered by the interviewees as the focus was on getting ICZM coordinated and streamlined among governmental stakeholders as a first priority. Nevertheless, the critical role played by the local communities

still figured in the discussion. In Damietta, for example, where the fishermen community is important, it was proposed to prepare programs focused on building capacities of local communities as a critical and core part of ICZM.

SWOT Analysis

This analysis is to identify strengths and weaknesses of the existing institutional and legal framework as well as the opportunities and threats it faces as shown below:

Strength

- Although not specifically referring to the coastal zone, the constitution mandates the protection of the seas and the shores
- The ICZM geographic extent, and concept, are legally defined
- A number of Laws to protect the shore and marine water exist
- The agency responsible for physical protection of the shore is specified as the SPA
- The Agency responsible for ICZM coordination is identified as the EEAA
- Vehicles for cooperation and coordination at multiple levels are established, including a national committee for ICZM
- An ICZM strategy is drafted, and could represent a good basis for an updated document
- ICZM plans were recently produced for specific regions (Alexandria and Matruh-Sallum), which give an opportunity for appreciation - of how ICZM-based plans compare to standard regional plans.
- The accumulated experience in raising ICZM on the national agenda, although hardly a success provides important lessons to guide future actions in this respect.

Weakness

- The primacy of sustainable development, as stated by the constitution, is not clearly reflected in laws
- Regulatory focus is on controlling individual projects, while public projects, usually of a larger scale and thus more prominent impact, are not similarly controlled
- The legal definition of the coastal zone is not adopted by the applicable laws, as most of those were issued prior to this definition.
- The responsibility of coordination is not symmetrical, as it is expected from EEAA but not formally imposed on other governmental agencies. Actions on the ground therefore reflect the relative power of each
- The main vehicle of coordination, the NCICZM, is inactive
- Vehicles for coordination mainly revolve around governmental actors with no effective involvement of communities directly affected by actions on the ground. The regulated consultation related to the EIA process is limited to large individual projects rather than plans and policies which have a larger, although delayed, impacts
- Multiple development and protection oriented strategies, but which are not adequately cross referenced
- The ICZM strategy is not adopted, and thus a common vision/approach to development in the coastal zone across the multiple actors is lacking.
- Without a common base, a programmatic plan to which all parties contribute, each according to its role and responsibility, is currently unachievable, and multiple plans devised according to each organization's objective and mandate is sure to result in conflicts hardly resolvable at the level of implementation.

Opportunities

- Interest in Climate Change impacts has grown higher during the last few years to the highest administration level; witness the involvement of the President in the Climate Change conferences.
- The officially adopted sustainable development strategy clearly pointing at the challenges faced by the coastal zones
- The revision of laws based on constitution, especially capitalizing on its focus on sustainability.
- The obligations related to international conventions. However, the clearest reference in the ICZM protocol of the Barcelona convention is not applicable since Egypt did not sign it

Threats

- Pressure on resources due to demographic and economic growth would stall regulatory and institutional actions
- The delayed ratification of several protocols seems to reflect less interest in international cooperation

CHAPTER 5: CONCLUSIONS AND FUTURE STEPS TO IMPLEMENT ICZM



Credits: M.Nada-Medasset

CHAPTER 5. CONCLUSIONS AND FUTURE STEPS TO IMPLEMENT ICZM

This Chapter presents a summary of the major outputs of the study that will lead future ICZM stages in the Northern Coast. To this end, this Chapter is structured into four sections:

- The first section “*Existing initiatives along the Northern Coast*” aims at describing the ICZM framework in which future ICZM stages will take place.
- Then, section two “*Present Key Issues and Priority Areas*” and three “*Future Key Issues and Priority Areas*” summarize identified Key issues for the present and future situation, respectively. These sections emphasize the locations where Key Issues are more relevant (priority areas) and where high-resolution analyses should be developed.
- Finally, section four “*Future stages to establish ICZM in the Northern Coast*” lists the necessary steps to implement subsequent ICZM stages in the Northern Coast.

5.1. EXISTING ICZM INITIATIVES ALONG THE NORTHERN COAST

Since the 90’s, ICZM is a major concern for Egyptian institutions to deal with the great variety of coastal problems and the uncertain consequences of climate change. The National Committee for Integrated Coastal Zone Management (NCICZM) was established in 1994 and two years later the *Framework Programme for the Development of a National ICZM Plan for Egypt* set clear planning objectives.

In 2009, Egypt amended its Law for the Environment No 4/1994 to adapt it to the Protocol on ICZM in the Mediterranean Sea. The amended Environmental Law No 9/2009 defines the coastal zone of Egypt and confers the responsibility for ICZM at national level upon EEAA. Since then, EEAA has drafted the National Strategy for ICZM and has participated in the preparation of local ICZM plans.

In the Mediterranean coast, the first ICZM study was the “*Fuka – Matruh Project*” (UNEP/MAP, 2001), developed in the framework of the Mediterranean Action Plan - Coastal Area Management Project. Also in Matruh Governorate, the *ICZM Plan for the coastal area between Marsa Matruh - El Sallum* was funded by the Spanish Agency for International Development Cooperation. In Alexandria Governorate, *ALAMIM Project* (2009) represented the first effort to promote ICZM in Lake Mariut, and this area was also influenced by the *PEGASO Project* (2012). The most recent initiative in Alexandria is the *Mariut Lake and Valley ICZM Plan*, developed under the *Alexandria Coastal Zone Management Project*, already finalized and handed over to Alexandria Governorate for its implementation.

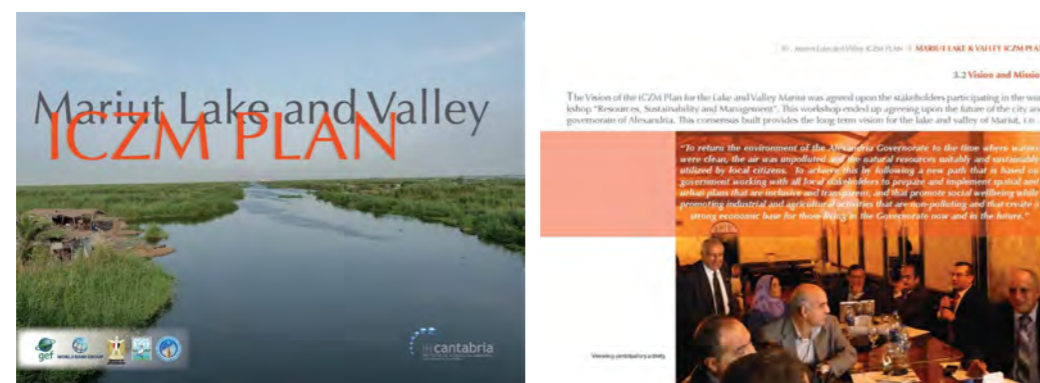


Figure 5.1. Mariut Lake and Valley ICZM Plan: Left: cover page. Right: visioning participatory activity.

In the delta, the most significant project towards an integrated management of the coastal area is the ACCNDP, led by UNDP and implemented by MWRI.

These initiatives, together with the proposal of setting ICZM Committees at Governorate level (EEAA, 2009) are establishing favourable conditions for ICZM to be effectively implemented in the Mediterranean Coast of Egypt.

5.2. PRESENT KEY ISSUES AND PRIORITY AREAS

Key Issues and their locations along the Northern Coast will lead management priorities and priority areas of action of ICZM plans. Present Key Issues refer to current coastal challenges that require short-term action. Key Issues and priority areas are divided into two groups:

1. Key Issues related to coastal risks.
2. Key Issues related to land-use and environmental conflicts.

5.2.1. Key Issues related to coastal risks.

These are Key Issues related to the negative consequences that physical impacts might cause on i) economic activities or infrastructures and ii) on the water environment:

- Negative consequences that erosion may cause on economic activities or infrastructures.
- Negative consequences that flooding may have on economic activities or infrastructures.
- Negative consequences that siltation may cause on economic activities or infrastructures.
- Negative consequences that overtopping may cause on port activity.
- Salt-water intrusion in coastal aquifers.
- Loss of marine habitats.

Negative consequences that erosion may cause on economic activities or infrastructures.

The impact of erosion in the Northern Coast mainly affects economic activities and infrastructures. The presence of urban areas in the coast, the development of economic activities and the tourism development (resort development) has led to the construction of coastal structures, most of them to protect the coastline against flooding and erosion. They, in turn, affect the longshore sediment transport and cause side erosion problems in the neighbouring sandy beaches. These side effects are common problems in the entire Northern Coast and reflect the lack of global integrated perspective to solve a local problem.

The results of the erosion index along the Northern Coast obtained from the historical data indicate a significant difference in the erosion impact between the following areas: (1) the Northern-Western Coast from CU01 to CU06, (2) the Nile Delta Coast from CU07 to CU12, and (3) the North Sinai Coast, CU13 and CU14.

The **Northern-Western Coast** (CU01-CU06) is characterized by a low to medium erosion. Low erosion levels are obtained in the rocky cliffy areas. In sandy beach areas, medium erosion is generally observed associated to generally medium sediment transport. Most of the sandy beach areas are generally concerned by touristic activities (many resorts), or by urban areas (El Sallum and Marsa Matruh). Coastal protection structures increase the vulnerability of adjacent (eastward) beaches.

In the **Nile Delta Coast** (CU07-CU12), beaches are generally highly vulnerable long open sandy beaches with gentle slope and fine deltaic sediment. Erosion is dominantly high (with some areas of medium erosion). The maximum values of sediment transport have been obtained in this region, causing strong potential problems. While the net longshore sediment transport is directed eastward in the largest part of the Northern Coast, there is an area of sediment transport divergence in Rosetta promontory that can cause severe problems. Furthermore, strong past shoreline retreat has been observed in the entire area, the major retreat occurring near the two main inlets (Damietta and Rosetta) that suffered anthropogenic changes associated to the construction of the High Dam at Aswan which deprived the Nile Delta of its main source of sediment. This led to the construction of major hard coastal structures (sea wall, concentrated break waters) in the vicinity of the inlets that solved, locally, the erosion problems, but create side effects in the next coastal stretches.

The **North Sinai Coast** (CU13-CU14) is characterized by a medium to high erosion. The Bardawil lake coastline is very low anthropized (decreasing its vulnerability) but highly exposed to wave storms. This results in a medium erosion level. Coastal structures (sea groins) causing erosion side effects are only located in the two inlets.

The highest erosion problems occur in El Arish and Rafah in the areas of short coastal setbacks, they are mainly due to the side effects eastward of the coastal protection structures.



Figure 5.2. Erosion index.

Urban centres in areas with high or medium level of erosion:

CU01: medium erosion level in El Sallum urban area.

CU03: medium erosion level in Marsa Matruh beaches (inside the lagoon).

CU07: high erosion level in Alexandria corniche.

CU09: high erosion level in small urban areas surrounding Rashid.

CU10: high erosion level in Al Burj and Gamassa.

CU11: high erosion level in Ras El Bar.

CU12: high erosion level in Port Said Port Fouad.

CU14: high erosion level in El Arish and spared settlements near Rafah.

Resorts in areas with high or medium level of erosion:

CU03: medium erosion level in Ras Umm El Rakham dune area.

CU04: medium erosion level in Jarawlah zone.

CU04: medium erosion level in Jaz Oriental and Jaz Almaza resorts.

CU05: the whole unit present medium level of erosion affecting spared resorts.

CU06: El Alamein coastal area is completely covered by resorts, potentially affected by erosion (medium level).

CU07: the western part of Alexandria Governorate is dedicated to tourism activities where there is medium level of erosion.

Industries in areas with high or medium level of erosion:

CU07: SUMED industrial area (medium erosion level).

CU08: industries in Abu Qir bay (high erosion level).

Roads in areas with high or medium level of erosion:

CU01: medium erosion level could affect access roads to El Sallum.

CU03: medium erosion level could affect roads crossing coastal dunes along "long" Agiba beach.

CU06: medium erosion level could affect roads in El Alamein area.

CU09, CU10, CU11 and CU12: the international Road is close to the coastline and could be affected by high level of erosion.

CU14: high erosion level could affect access roads to El Arish and tracks in Rafah settlements.

High level of erosion affecting other areas:

High erosion levels between Abu Qir bay and Port Said.

High erosion level in the eastern inlet of Lake Bardawil.

Negative consequences that flooding may have on economic activities or infrastructures.

The impact of flooding in the Northern Coast mainly affects economic activities and infrastructures. The increasing development of tourism, economic activities, and, more generally, of coastal infrastructures is associated to the need of increasing the protection of the coastline against flooding and erosion. This has been done, in general, by adopting hard adaptive measures such that the construction of sea walls, sea groins or breakwaters. They, in turn, affect nearby coastal stretches where flooding issues are exacerbated. Furthermore, the anthropization of the coastline is generally characterized by short coastal setback areas showing that the initial coastal setbacks did not take into account the severe shoreline retreat rates already observed and their exacerbation due to sea level rise.

The level (degree) of flooding is closely related to the mean sea levels observed during stormy conditions and to the topographic characteristics of the area. The highest flooding will be registered in the low lying areas (e.g. Nile Delta areas or sabkhas) when high energetic waves and storm surges coincide leading to extreme values of sea levels. Furthermore it is linked to the erosion level and in particular to the shoreline retreat: a highly erosional coastline will get exacerbated flooding issues.

Similarly to the erosion index map, the flooding index along the Northern Coast shows significant differences between the following areas: (1) the Northern-Western Coast from CU01 to CU06, (2) the Nile Delta Coast from CU07 to CU12, and (3) the North Sinai Coast, CU13 and CU14.

The **Northern-Western Coast** (CU01-CU06) is characterized by a low to medium flooding from CU01 to CU05 (high flooding locally as in resort areas of Marsa Matruh) and by medium to high flooding in El Alamein (CU06, high flooding in the resort areas of El Alamein). Low flooding values are obtained in the rocky cliffy areas with high topographic slope (low vulnerable areas, and short flooding distance even for high sea levels). Most problems are localized in/nearby the sabkha areas and in touristic areas (resorts) with short coastal setbacks.

The **Nile Delta Coast** from CU08 to CU12 is characterized by a high flooding in all the coastal stretches because of the highly vulnerable sandy coastline and of the low lying areas in the Delta area. In Alexandria coastal unit (CU07), flooding is medium to high, with most problems in the resort areas.

The **North Sinai Coast** (CU13-CU14) is characterized by (1) medium to high flooding in the Bardawil lake where the low-lying sand barrier is highly vulnerable to flooding and (2) high to medium flooding in El Arish and Rafah (highest values nearby coastal protection structures / infrastructures). The other stretches of CU14 have low flooding values.



Figure 5.3. Flooding index.

Urban centres in areas with high or medium level of flooding:

- CU01: medium flooding level in El Sallum town.
- CU03: medium flooding level in Marsa Matruh.
- CU07: Alexandria city has high level of flooding.
- CU09: high flooding level could affect surrounding urbanized areas of Rashid.
- CU10: medium level of flooding in Al Burj and Gamassa.
- CU11: high flooding level in Ras El Bar.
- CU12: Port Said and Port Fouad urban areas present high level of flooding.
- CU14: El Arish urban centre present high level of flooding.

Resorts in areas with high or medium level of flooding:

- CU03: high flooding level in resorts near Ras Umm El Rakham.
- CU04: medium flooding level could affect resorts near Jarawlah.
- CU05: high flooding level in the eastern part of the CU, near Marassi resort.
- CU06: this unit is completely covered by resorts and there are medium and high level of flooding along the coastal front.
- CU07: western part of Alexandria Governorate is occupied by resorts, where there are medium level of flooding.

Agricultural areas with high or medium level of flooding:

Although medium flooding level could affect small crops in the North-Western Coast, the priority areas are located in the Nile Delta, especially in low-lying areas. In this regard, the most significant areas are:

- CU07: agricultural lands around Lake Mariut.
- CU08: Abu Qir bay and around Lake Idku.
- CU09: crops around Lake Burullus.
- CU10: crops in Baltim area.
- CU11: crops in Damietta Governorate.
- CU12: crops in the narrow strip of Manzala Lake.

Industries in areas with high or medium level of flooding:

- CU07: high flooding level could affect SUMED industry and industries around Lake Mariut in low-lying areas.
- CU08: high flooding level could affect industries in the coastal front of Abu Qir bay.

Roads in areas with high or medium level of flooding:

- CU01: access roads to El Sallum.
- CU06: roads in El Alamein.
- CU09, CU10, CU11 and CU12: the international Road.
- CU14: access roads to El Arish.

High level of flooding affecting other areas:

- CU03: West part of Marsa Matruh lagoon.
- CU05 and CU06: coastal stretch between Marassi and El Alamein lagoon.
- CU08 to CU13: the whole coastal area between Abu Qir bay and Bardawil lake.

Negative consequences that siltation may cause on economic activities or infrastructures.

A channel siltation indicator has been computed in the area where an inlet (or channel drainage) or a port has been identified, the major key issues identified are therefore related to infrastructures or economic activities.

The level of siltation is based on the gross sediment transport computed in the corresponding coastal stretch and in its closest neighbouring stretches. It is important to notice that this indicator do not take into account the shape of coastal structures that have been built to reduce siltation issues. Concerning these protection works, two kinds of problems have been observed.

- (1) They never completely impede sediment deposit in the channel, and periodic dredging is performed, especially in the areas with gentle slopping bathymetries.
- (2) They have led to the rigidification of the entrance channels and they impede its natural migration. The natural dynamics of the system is therefore altered and siltation problems, but also erosion or flooding problems can be exacerbated.

The gross alongshore sediment transport is a good indicator to identify the potential issues and to identify those areas where adaptation measures are the most difficult to apply (that are the coastal stretches where sediment transport is strong). The analysis of the sediment transport patterns along the Northern Coast suggests to divide the analysis within three areas (this coincides with the analysis of erosion and flooding).

The **Northern-Western Coast** (CU01-CU06) is characterized by, globally, medium values of alongshore sediment transport. Low values are obtained in the coastal stretches protected by natural headlands (just eastward the headland) while high values are generally obtained just westward the headland, often characterized by long open sandy beaches. Siltation issues are medium (medium sediment transport) in the channels of interest (Marsa Matruh inlets, CU03, Alamein, CU06).

The **Nile Delta Coast** (CU07-CU12) is the area showing the strongest values of longshore sediment transport. Medium to high values in the entire area, except in the southwest of Alexandria coastal unit and close to the North Sinai boundary (low values). In agreement with these results, the highest levels of siltation are observed in Rosetta, Damietta and Burullus channels, and in Alexandria city and Al Maadia outlet (Abu Qir bay).

The **North Sinai Coast** (CU13-CU14) is characterized by a globally low alongshore sediment transport in comparison with the rest of the Northern Coast. Medium longshore sediment transport has been obtained in areas without channels. Siltation issues are thus small in the channels of the North Sinai coast, however, it should be stated that the natural dynamics of the Bardawil inlets (rigidification with coastal structure) has been altered, this can exacerbate siltation issues.

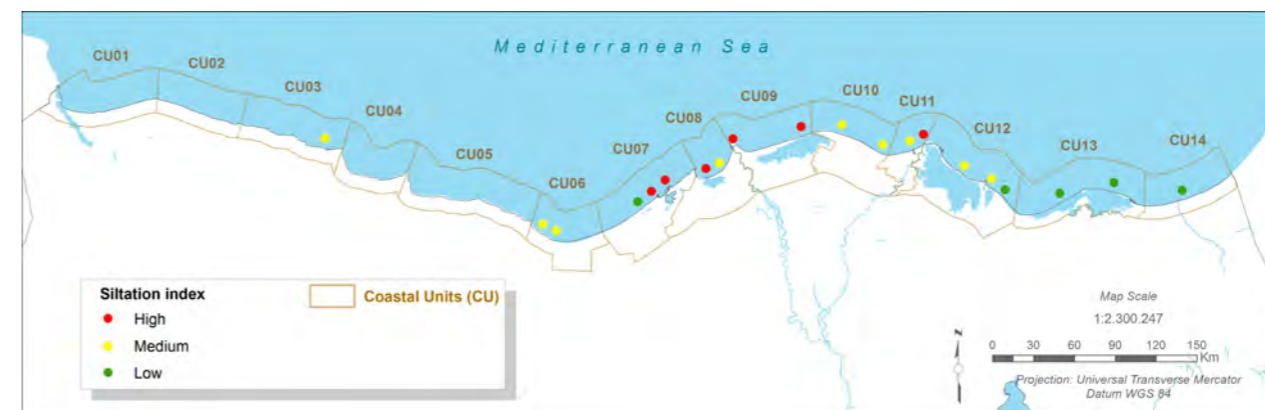


Figure 5.4. Siltation index.

Inlets with high or medium level of siltation:

CU03: medium siltation level in the inlet of Marsa Matruh lagoon.

CU06: medium siltation level in the inlet of El Alamein lagoon.

CU09: high siltation levels in Rosetta and Burullus inlet.

CU10: medium siltation level in Kitchener and Gamasa inlets.

CU11: high siltation level in Damietta inlet.

CU12: medium siltation level in El Gamil inlet.

Ports with high or medium level of siltation:

CU06: medium siltation level in El Hamra Petroleum port.

CU07: high siltation level in EL Dekheila and Alexandria ports.

CU08: high siltation level in El Maadiya Petroleum port and El Maadiya Strait Fishing port. Medium siltation level in ELNG Petroleum port.

CU09: high siltation level in Burullus Fishing port.

CU11: medium siltation level in Damietta Commercial Port.

CU12: medium siltation level in Port Said Commercial ports.

Negative consequences that overtopping may cause on port activity.

Impacts on the main Egyptian ports have been analysed through the loss of operability due to agitation and due to overtopping. Based on historical analysis of the wave climate there is low degree of downtime due to agitation in all ports considered except than for the Alexandria Port, in which the degree is medium since the number of hours per year that agitation exceeds 2.5 m is higher than 200. Regarding to overtopping, all ports have a high degree of downtime due to the fact they exceed 0.1 m³/s/m more than 300 hours per year, except El Hamra and El Maadiya ports (medium degree).

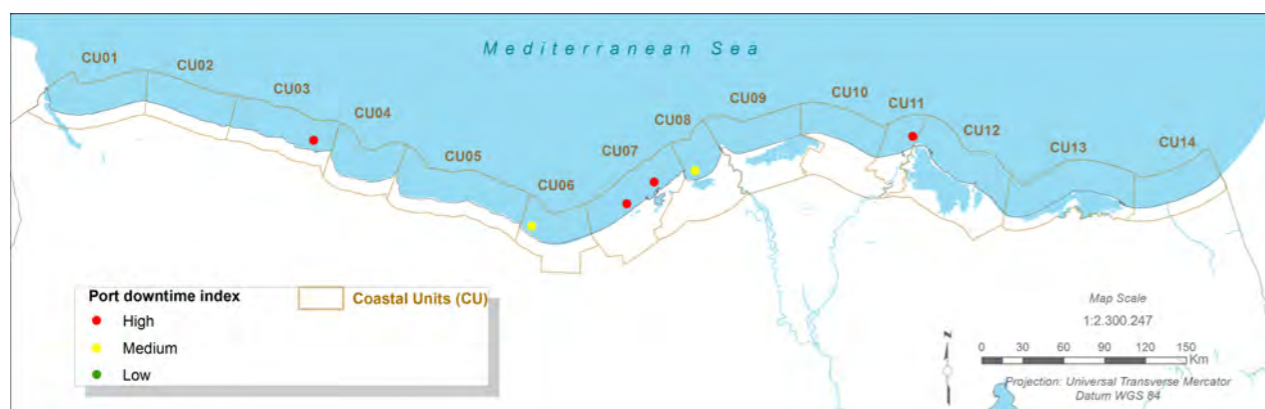


Figure 5.5. Port downtime index.

Ports with high or medium level of overtopping:

CU03: high level of overtopping in Marsa Matruh lagoon inlet.

CU06: medium overtopping level in El Hamra Petroleum port.

CU07: high overtopping levels in SUMED and Alexandria commercial ports.

CU08: medium overtopping level affecting El Maadiya Petroleum and fishing ports.

CU11: high overtopping level in Damietta port.

Salt-water intrusion:

Based on historical characterization of climate data and on the spatial distribution of aquifers and water bodies, high degree of saltwater intrusion affects the Egyptian region located between west Damietta and North Sinai, and medium degree threats the areas between Sidi Barrani and the border of Libya, and between east El Alamein and Baltim. This level will be exacerbated in the future due to sea level rise.

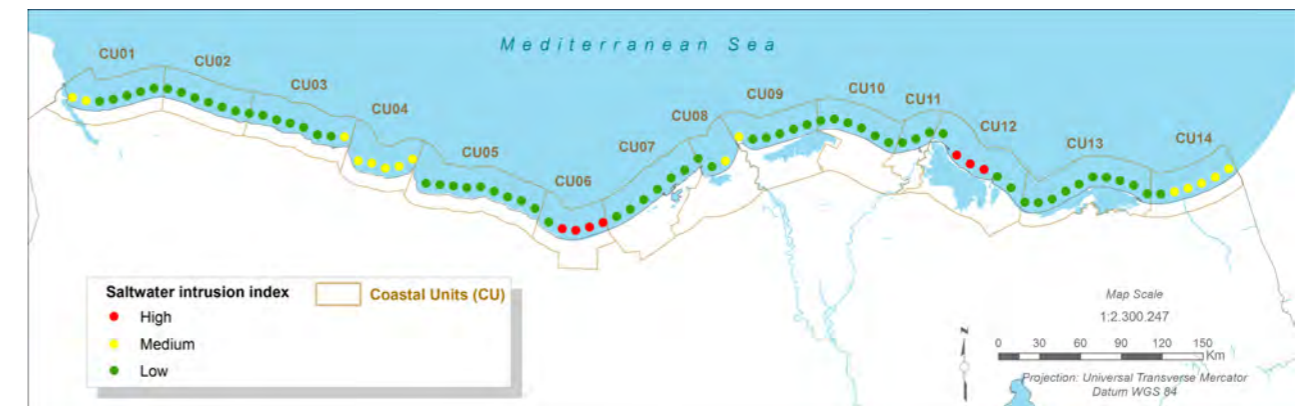


Figure 5.6. Saltwater intrusion index.

Areas with high or medium level of salt-water intrusion:

CU01: medium level of salt-water intrusion in the coastal aquifer of El Sallum

CU03: medium level of salt-water intrusion in the coastal aquifer eastwards to Marsa Matruh.

CU04: medium salt-water intrusion along the coastal unit.

CU06: high salt-water intrusion in El Alamein coastal unit.

CU08 and CU09: medium level of salt-water intrusion around Rosetta spit.

CU12: high level of salt-water intrusion in the area of Lake Manzala.

CU14: medium level of salt-water intrusion in the eastern part of the unit.

Loss of marine habitats:

The degree of abiotic stress for the present situation has been analysed across the Egyptian coast. Results show that there is low abiotic stress that will allow the development of different species of seagrasses such as *Posidonia oceanica* within the coastal stretch between the border of Libya and Zawya. There is medium degree of abiotic stress located between Zawya and west Alexandria and, within the rest of the coast, the degree is high, in which there is neither development nor growth of seagrass meadows.

Areas with high probability of *Posidonia oceanica* occurrence:

CU01 to CU05: the western part of the Mediterranean Egyptian coast has a high probability of occurrence of *Posidonia oceanica*, between El Sallum and Fuka.

5.2.2 Key Issues related to land-use and environmental conflicts.

These are Key Issues related to the conflicts on land-use policies that create competitive demands for the use of the territory, causing negative impacts on other uses or on the coastal environment. In the present situation, these Key Issues are limited to the negative impacts of future developments on coastal ecosystems:

Negative impacts of current developments on coastal ecosystems.

Urban or tourism developments on coastal ecosystems or protected areas:

CU03 to CU07: resorts in the North-Western area are mainly built on beaches, affecting the coastal processes and occupying sensitive habitats as coastal dunes and sabkhas.

CU06: high density of resorts built within the limits of El Omayed protected area and El Alamein lagoon.

Polluted water bodies due to industrial, agricultural or aquaculture activities:

CU07: Lake Mariut is highly polluted due to intense industrial and agricultural activities on its shore.

CU08: Lake Idku is polluted due to industrial, agriculture and aquaculture activities.

CU09: Lake Burullus (included in Burullus protected area) is polluted due to industrial, agriculture and aquaculture activities.

CU12: Lake Manzala (partly included in Ashtum El Gamal protected area) is polluted due to agriculture and aquaculture activities.

Areas potentially affected by extraction of black sands:

CU09, CU10, CU12 and CU13: extraction of black sand can cause severe negative impacts on the coastal biodiversity and environment quality. These units include three protected areas: El Burullus, Ashtum El Gamal and Zaranik.

5.3. FUTURE KEY ISSUES AND PRIORITY AREAS

Future Key Issues reveal long-term challenges and concerns arising during upcoming years due to the effects of climate change and the planned human development on the Northern Coast. The coastal management plans should address future Key Issues to prevent the consequences of climate change and to enhance coastal resilience.

Future Key Issues and priority areas are presented into two groups:

1. Future Key Issues related to coastal risks.
2. Future Key Issues related to land-use and environmental conflicts.

5.3.1. Future Key Issues related to coastal risks.

These future Key Issues are related to the negative consequences that physical impacts might cause on i) economic activities or infrastructures and ii) on the water environment in the long-term. This section is structured as follows:

- Future negative consequences that erosion may cause on economic activities or infrastructures.
- Future negative consequences that flooding may have on economic activities or infrastructures.
- Future negative consequences that siltation may cause on economic activities or infrastructures.
- Future negative consequences that overtopping may cause on port activity.
- Future salt-water intrusion in coastal aquifers.
- Future loss of marine habitats.

Future Key Issues are obtained by analysing physical impacts in the long-term (2050-2070) under RCP 8.5. In this scenario, physical impacts always have similar or higher values than in the present situation. Therefore, future Key Issues are additional to the present Key Issues.

Future negative consequences that erosion may cause on economic activities or infrastructures.

The projections of the climate dynamics have led to a systematic increase in erosion problems in the future. All along the Northern Coast, the erosion index is increasing or is stable. The following conclusions can be drawn.

- The increase of erosion is mainly due to the expected shoreline retreat associated to sea level rise. Maximum values of shoreline retreat due to sea level rise are obtained in the Nile Delta. The values are larger than 40 m in the worst scenario (RCP8.5, 2050-2070). These values do not take into account the retreat of the Nile promontory due to local anthropic changes (or to the High Dam at Aswan depriving the Nile Delta of its main source of sediment) so that the future total shoreline retreat is expected to be higher. More generally, all along the Northern Coast, high values of shoreline retreat are obtained in areas of low-lying topographies, especially close to sabkha areas.
- Changes in sediment transport are weak even in the worst scenarios. The values of the gross sediment transport is expected to decrease all along the Northern Coast, except in El Sallum areas. Overall, the changes in gross longshore sediment transport are less than 2% with respect to the historical values, so that they will not have consequences on the future erosion impacts.
- Future erosion problems will probably be exacerbated if new (hard) coastal structures are built. As shown in the diagnosis of the present situation, coastal protection structures generally solve the erosion problems locally but cause side effects and displace the problems to the neighbouring coastal stretches.

- Sand dunes are natural protection elements of the Northern Coast and they provide a natural sand input to the beaches. Their maintenance is essential. A future increasing anthropization of sand dunes would result in a lower protected coastline and in further erosion problems in neighbouring beaches.

According to the present situation diagnosis, the changes in erosion issues for the Northern Coast is presented for the three following zones.

Along the **Northern-Western Coast** (CU01-CU06) the current low erosion issues are expected to become, generally, medium erosion issues in the worst scenario. Strong erosion issues are expected in El Alamein (currently medium erosion issues).

Along the **Nile Delta Coast** (CU07-CU12), the erosion map remains similar (generally high erosion in the Delta), except in the Alexandria coastal units, where strong erosion is expected in all the city area (currently medium erosion in some coastal points)

Along the **North Sinai Coast** (CU13-CU14) erosion issues remains medium to high. The only differences are obtained in the Bardawil lake east entrance (increasing erosion issues).

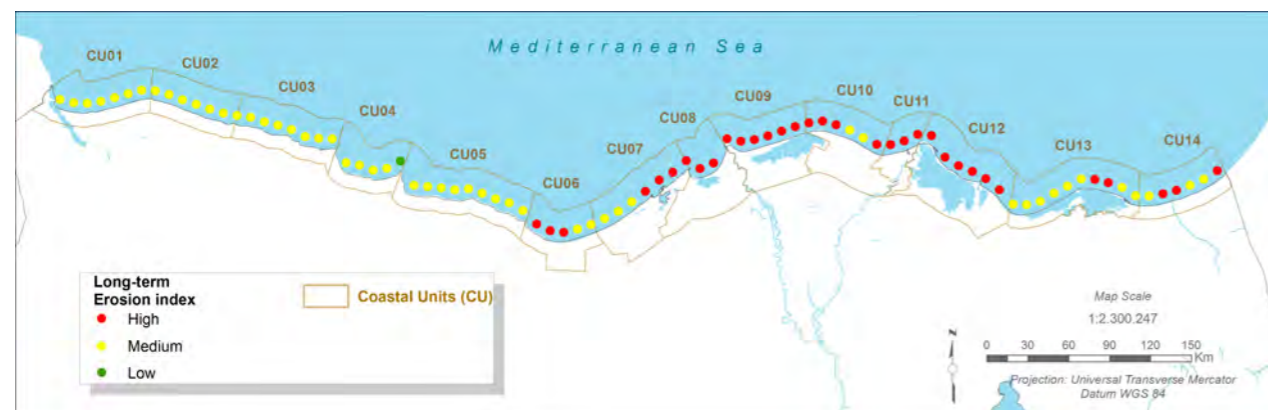


Figure 5.7. Long-term erosion index.

Future urban areas with high or medium levels of erosion:

CU05: medium erosion level in areas for new urban development around El Dabaa.

CU06: high future erosion level in the area of the new El Alamein eco-city.

CU07: increased erosion level in Abu Qir urban centre.

CU09: high erosion level in the area of urban development in Rosetta spit.

CU10: high erosion level in areas with planned urban developments on the coastal front, as Al Burj and New Mansora city.

CU12: planned resorts areas on the narrow strip of Lake Manzala, where high level of erosion.

Future tourism areas with high or medium levels of erosion:

CU01, CU02: medium level of erosion in the long term, that could be increased by the construction of resorts and other facilities on the coastal front.

CU03: the western part of the coastal unit, between Maaten El Neguila and Agiba pocket beach, will have medium erosion levels that could be increased by the construction of resorts on the coastal front.

CU04 and CU05: medium erosion level could be increased by the development of new tourism areas in Ras El Kanayis area.

CU06: increased erosion level in the western part of the unit, already occupied by resorts.

CU09: high erosion level along the unit, where planned tourism development.

CU10: high erosion levels in areas with planned tourism developments on the coastal front, as Al Burj and New Mansora city.

CU11: high erosion problems in new tourism developments between Gamassa and New Damietta.

CU12: planned urban development on the narrow strip of Lake Manzala, where high level of erosion.

CU12 and CU13: high erosion level in Mallaha, where planned tourism development.

CU14: foreseen medium erosion level in tourism development areas, both sides of El Arish.

Future industrial areas with high or medium levels of erosion:

CU09: high erosion level in areas with potential industrial development (Rosetta spit)

CU11: high erosion level in the area where planned the new Gamassa power plant.

CU12 and CU13: high erosion level in new industrial area in Mallaha.

High levels of erosion affecting other areas:

High erosion levels between Alexandria and Port Said.

Higher erosion level in the eastern inlet of Lake Bardawil.

Future negative consequences that flooding may have on economic activities or infrastructures.

The projections of the climate dynamics have led to a systematic increase in flooding problems in the future. All along the Northern Coast, the flooding index is increasing or is stable. The following conclusions can be drawn.

- The increase of flooding is mainly due to sea level rise. Although projected sea level rise is relatively uniform along the Northern Coast for the different scenarios studied (near term, long term, RCP4.5 and RCP8.5), the flooding problems will be further exacerbated in the low lying areas: in the Nile Delta coast and nearby the sabkha areas, where increase in flooding distance will be the highest. In the worst long-term scenario, the flooding level and distance is expected to duplicate the present values (obtained from historical characterization of the climate data).
- The expected changes in wave conditions have insignificant effects in the total future flooding levels (changes in mean wave heights less than 5% with respect to the historical data, in the worst scenario). The expected changes in storm surge levels are one order of magnitude lower than the expected changes of sea level rise.
- Future flooding problems can be exacerbated due to the development of new coastal infrastructures or coastal protection structures, they can cause side effects.
- Sabkha areas have to be maintained free of constructions as they are natural flooding zones. Anthropization of sabkha areas would perturb the natural dynamics and cause side effects.
- The future flooding issues will be exacerbated in area of strong erosions, especially in area of short coastal setbacks.

According to the present situation diagnosis, the changes in flooding issues for the Northern Coast is presented for the three following zones.

Along the **Northern-Western Coast** (CU01-CU06) the current low-medium flooding (CU01-CU05) is expected to change to medium-high flooding. Particularly, high flooding is obtained in El Sallum city and sabkha areas and in most of the touristic (resort) areas. In El Alamein coastal units (CU06), high flooding is systematically obtained, this concerns resort areas and the new El Alamein eco-city.

Along the **Nile Delta Coast** (CU07-CU12) the flooding remains / becomes high in the largest part of the coast. This includes most of the Alexandria coastal unit where medium flooding was obtained for the present situation.

Along the **North Sinai Coast** (CU13-CU14), the expected flooding level is globally high. It is medium in the area of currently low flooding, this includes the planned tourism areas around El Arish.



Figure 5.8. Long-term flooding index.

Future urban areas with high or medium levels of flooding:

- CU03: high flooding level in Marsa Matruh urban sprawl zones.
- CU06: high flooding level in the coastal front of the new El Alamein eco-city.
- CU09: high flooding level could affect new urban developments in Rosetta spit.
- CU09: high flooding level could affect new urban developments in Al Burj and New Mansora city.
- CU12: high flooding level in the narrow strip of Manzala Lake where planned new urban area.
- CU13: high flooding level could affect the new urban centre located in the border between Port Said and North Sinai governorates.
- CU14: high flooding level in El Arish urban sprawl area.

Future tourism areas with high or medium levels of flooding:

- CU01: high flooding level in tourism development areas along the unit.
- CU02: high flooding level in tourism development areas near Sidi Barrani.
- CU03: high flooding level in areas with future tourism development in Ras Unm el Rackham.
- CU04: Increased flooding level at Garawalah area where planned tourism development.
- CU05, CU06, CU07: increased flooding level could affect existing resorts.
- CU09, CU10: high flooding level could affect new tourism developments on the coastal front.
- CU11: high flooding level could affect planned resorts between Jamasa and New Damietta.
- CU12: high flooding level in the new tourism area in Mallaha.

CU14: medium flooding level in the areas with planned tourism areas around El Arish.

Future industrial areas with high or medium levels of flooding:

- CU10: high flooding level could affect new industrial areas in Rosetta spit.
- CU11: high flooding level could affect the area of the new power plant near Gamassa.
- CU12: high flooding level in the area of Mallaha, where new industrial area is planned.
- CU13: high flooding level could affect new industrial areas around Bir El Abd.

High levels of flooding affecting other areas:

Long-term flooding levels will increase in El Sallum, El Alamein and Alexandria coastal units.

Future negative consequences that siltation may cause on economic activities or infrastructures.

The level of siltation is based on the magnitude of the gross sediment transport. Changes in sediment transport are weak even in the worst scenarios. The values of the gross sediment transport is expected to decrease all along the Northern Coast, except in El Sallum areas. Overall, the changes in gross longshore sediment transport are less than 2% with respect to the historical values, so that they will not have consequences on the future siltation impacts.

Future changes in the level of siltation concerns the new development projects identified. Particularly, the new projects where medium siltation is obtained are the new port developments in Marsa Matruh (CU03) and at Port Said (CU12), and where high siltation is obtained are the new inlets of Lake Burullus (CU09). Although the other projects are in an area of relatively low sediment transport (low siltation level), a special attention has to be paid as rigidification of inlets, or new coastal structures will alter the natural dynamics of the system. Other problems (erosion and flooding) can therefore be exacerbated.



Figure 5.9. Long-term siltation index.

Inlets with high or medium levels of siltation:

CU09: new inlets in Burullus coastal area could be affected by high levels of siltation.

Ports with high or medium levels of siltation:

- CU03: new ports in Marsa Matruh could be affected by medium levels of siltation.
- CU12: new fishing port in Port Said could be affected by medium level of siltation.

Future negative consequences that overtopping may cause on port activity.

Impacts on the main Egyptian ports have been analysed through the loss of operability due to agitation and due to overtopping for the different projected scenarios. For all the scenarios and periods of analysis, there is low degree of inoperability due to agitation in all ports considered except than for the Alexandria Port, in which the degree is medium since the number of hours per year that agitation exceeds 2.5 m is higher than 200. Regarding to overtopping, all ports have and will have a high degree of inoperability for the different projected scenarios, under RCP4.5 and RCP8.5 and for all the periods considered, due to the fact they exceed 0.1 m³/s/m more than 300 hours per year, except than El Hamra and El Maadiya ports. El Hamra Port has currently a medium degree of inoperability and it is expected to remain in the future. However, El Maadiya Port will change its degree of inoperability from medium to high for any future conditions.

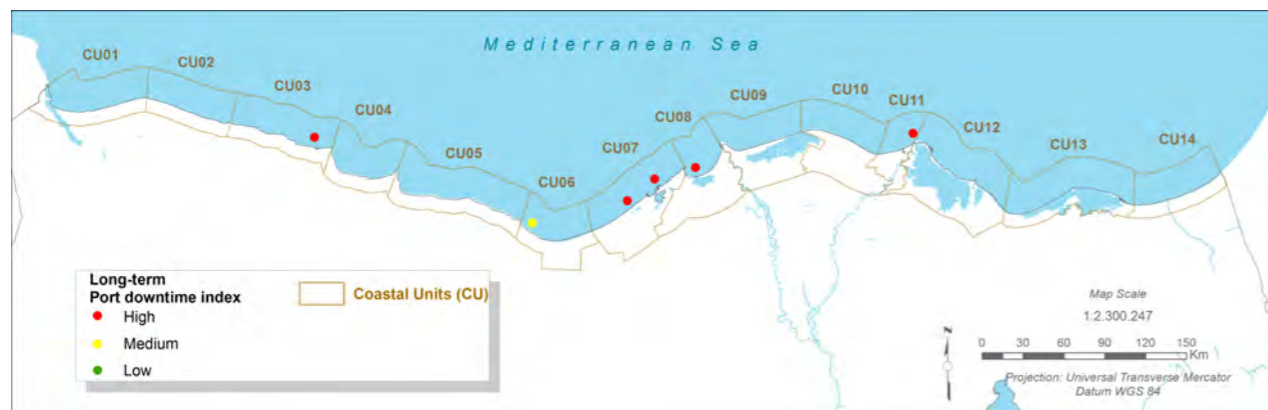


Figure 5.10. Long-term port down time index

Ports with future high or medium levels of overtopping:

In the long-term, port operability remain similar to the present situation. Overtopping level only increase to high level in El Maadiya port (CU08).

Future salt-water intrusion.

Under RCP4.5 and for the period 2016-2035 with respect to 1989-2015, no changes are expected, however, for the period 2046-2065 (also with respect to 1989-2015), regions in which saltwater intrusion is now low will reach a medium degree of the impact. Under RCP8.5, and for the near term, only the area between North Sinai and the eastern boundary will maintain low its degree of saltwater intrusion, the rest will change into a medium degree of the impact. Due to sea-level rise, for the period 2046-2065 with respect to 1989-2015, saltwater intrusion will highly affect the entire coast except than the regions located between east El Alamein and Baltim, and between North Sinai and the eastern boundary of Egypt, that both will suffer a medium degree of the impact.



Figure 5.11. Long-term saltwater intrusion index

Future areas with high or medium levels of salt-water intrusion:

CU01, CU02, CU03, CU05, CU06, CU10, CU11, CU12 and CU13: significant increase of salt-water intrusion into the coastal aquifer.

Future loss of marine habitats.

The degree of abiotic stress for future scenarios: under RCP4.5 and RCP8.5, for the periods 2040-2070 and 2070-2100 has been analysed across the Egyptian coast. Under RCP4.5, and for the period 2040-2070, the coastal stretch in which the abiotic stress is high will expand to El Alamein (from the east boundary of the country). Under that conditions, the impact will be low only in Sidi Barrani and Marsa Matrouh. These locations will change the degree of abiotic stress from low to medium, limiting the development seagrasses, for the period 2070-2100. Under RCP8.5, and for the period 2040-2070 the pattern will be very similar to RCP4.5 results in the long term. For the period 2070-2100, the entire coast will suffer from high abiotic stress except than Sidi Barrani, the area near Kafr Sabir and Marsa Matrouh, in which the impact will be medium.



Figure 5.12. Long-term abiotic changes index.

Areas in which the probability of *Posidonia oceanica* occurrence decrease severely:

CU01, CU02, CU03, CU04: severe decrease in the probability of occurrence of *Posidonia oceanica* due to the effects of climate changes on the abiotic niche. CU03 includes El Showela proposed protected area.

5.3.2. Future Key Issues related to land-use and environmental conflicts.

These are future Key Issues related to the conflicts on land-use policies that create competitive demands for the use of the territory, causing negative impacts on other uses or on the coastal environment. In the long-term, these Key Issues include:

- Future negative impacts of future developments on coastal ecosystems, and
- Future land-use conflicts.

Future negative impacts of future developments on coastal ecosystems.

Future urban or tourism areas on coastal ecosystems or protected areas:

CU01: most of the coastal front of Sallum Coastal Unit is under potential tourism development plans. This could cause negative impacts on El Sallum protected area, on coastal processes and on turtle nesting sites. TDA land also could affect the coastal lagoon.

CU02 and CU03: most of the coastal front of these coastal units is under potential tourism development plans that could affect the ecological value of the El Showela proposed protected area and existing turtle nesting sites.

CU04 and CU05: new resorts could affect Ras El Hekma proposed protected area.

CU06: new El Alamein city, planned for 1,000,000 inhabitants will be partially developed within El Omayed protected area and on the shores of El Alamein lagoon, causing very severe environmental impacts.

CU09: urban and tourism development on the coastal front would impact coastal dunes. These areas would partially overlap with El Burullus protected area.

CU10: urban and tourism development would have a negative impact on the coastal dunes of the delta apex.

CU12: urban and tourism development on the narrow strip of Manzala Lake could affect coastal processes and water quality in Manzala lake.

Polluted water bodies due to future industrial, agricultural or aquaculture activities:

CU04: new power plant in El Dabaa could cause negative environmental impacts.

CU07: new industries in Borg El Arab could cause negative environmental impacts on Mariut valley.

CU11: new power plant in Jamasa could cause negative environmental impacts.

CU12: new industrial area in Mallaha could cause negative environmental impacts.

CU12: new aquaculture areas could decrease water quality in Lake Manzala (partly included in Ashtum El Gamal protected area).

CU13: New power plant in Romona and industrial development in Bir El Abd could cause negative environmental impacts on Lake Bardawil.

Areas potentially affected by extraction of black sands:

CU09, CU10, CU12, CU13: extraction of black sand can cause severe negative impacts on the coastal biodiversity and environment quality. These units include three protected areas: El Burullus, Ashtum El Gamal and Zaranik.

Future land-use conflicts

Future urban, tourism or industrial development on agricultural areas:

CU01, CU02 and CU03: potential tourism development could displace small scale agricultural activities, performed by local communities.

CU07: urban and industrial development in Alexandria could displace intense farming activities.

CU10 and CU11: urban and industrial development in the delta coastal front could displace intense farming activities.

5.4. FUTURE STAGES TO ESTABLISH ICZM IN THE NORTHERN COAST

According to the ICZM policy cycle, the next stages to implement ICZM in the Northern Coast of Egypt are: i) the preparation of a management plan addressing identified Key Issues and ii) ensuring its formal adoption and funding.

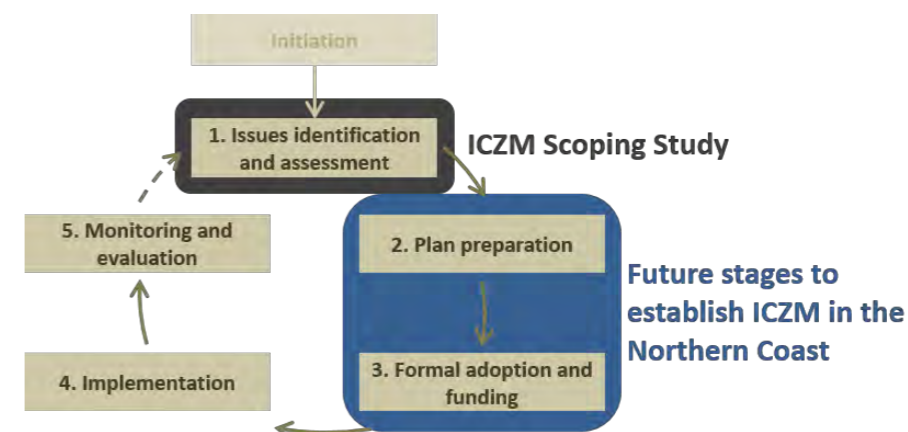


Figure 5.13. Future stages to establish ICZM.

This Chapter describes the steps to be followed in order to ensure the implementation of these two stages, gathered as follows:

1. Steps to develop a Coastal Management Plan for the Northern Coast.
2. Steps to establish a sustainable framework to develop ICZM in the Northern Coast.

5.4.1. Steps to develop a Coastal Management Plan for the Northern Coast

Once the major Key Issues for coastal management are identified, this planning stage aims at defining strategic and operational objectives and designing specific actions to address these Key Issues and achieve the sustainable management of the Northern Coast of Egypt.

The main output of this stage is a Coastal Management Plan developed under the principles of ICZM. That is, a master plan defining different types of shoreline management options for each Coastal Unit (local scale). These shoreline management options address current Key Issues and adaptation strategies to minimize the effect of climate change on the Northern Coast. The necessary activities necessary to prepare the Coastal Management Plan are summarized below, according to the following structure:

- High-resolution analysis of Key Issues
- Analysis and assessment of shoreline management options for each Coastal Unit
- Elaboration of a Coastal Management Plan for the Northern Coast
- Stakeholder participation strategy

High-resolution analysis of Key Issues

Once Key Issues are identified at Coastal Unit scale, the next step is to assess the different types of Key Issues and priority areas at high resolution. These assessments will lead the design of shoreline management options. The steps to conduct the high-resolution assessment of Key Issues will depend on the typology of Key Issues: (i) related to coastal risks, and (ii) related to land-use and environmental conflicts.

The steps to assess Key Issues related to coastal risks are:

- Establish homogenous databases and numerical tools to model shoreline dynamics and process at high resolution in priority areas.
- Conduct high resolution analysis of physical impacts for different timeframes, with emphasis into:
 - Erosion and shoreline retreat.
 - Sedimentation.
 - Flooding due to storm surge and sea level rise.
 - Salt water intrusion.
- Identify and assess non-climate threats to coastal areas as tsunami.
- Conduct high resolution analysis of coastal vulnerability (sensitivity and resilience), including i) human dimension, ii) infrastructures dimension, and iii) environmental dimension.
- Integrate these analyses into a high-resolution risk assessment study.

The steps to conduct the high-resolution assessment of Key Issues derived from land-use and environmental conflicts are:

- Identify specific land use conflicts and root causes.
- Carry out integrated carrying capacity assessment of each Coastal Unit.

Analysis and assessment of shoreline management options for each Coastal Unit

Shoreline management options are site-specific measures and strategies aimed at addressing Key Issues and reducing coastal risks at local scale (each Coastal Unit). The identification and assessment of the effectiveness of shoreline management options shall follow next steps:

- Review existing shoreline management options.
- Prepare a portfolio to identify and describe different types of shoreline management options.
- Identification and assessment of shoreline management options for priority areas in Coastal Units.
- Selection of preferred shoreline management options.

Elaboration of a Coastal Management Plan for the Northern Coast

The Coastal Management Plan will compile the preferred shoreline management options and integrate it into a planning stage to facilitate its implantation, following next steps:

- Integrate preferred shoreline management options into a planning scheme.
- Design an implementation strategy and monitoring system.

Stakeholder participation strategy

Stakeholder participation is the core of any ICZM initiative, and therefore should be carefully designed. The steps to integrate stakeholder participation into the Coastal Management Plan are:

- Design a stakeholder consultation strategy including public consultation for selection of shoreline management options.
- Design a stakeholder communication strategy.
- Maintain and update the website and GeoViewer of the *ICZM Scoping Study*.

5.4.2. Steps to establish a sustainable framework to develop ICZM

ICZM processes require a set of formal procedures and structures to run properly and allow developing governance practices. These procedures and structures refers to i) a comprehensive regulatory framework, ii) ICZM institutional structures and inter-institutional coordination mechanism and iii) a sustainable funding system; all engaged into the existing governance system for coastal management.

In this regard, the Government of Egypt has encouraged the development of a national ICZM framework by specific actions as the creation of the National ICZM Committee, the amendment of Law of Environment and drafting a National Strategy for ICZM in Egypt. However, the procedures and competences regarding ICZM planning at local level are still not clear.

The following sections describe the necessary steps to update the existing ICZM framework ensuring the enabling conditions for developing and implementing the Coastal Management Plan, as well as any other ICZM in the Northern Coast of Egypt. These are structured as follows:

- Legal and policy requirements to implement ICZM.
- Institutional requirements to implement ICZM.
- Funding requirements to implement ICZM.

Legal and policy requirements to implement ICZM

The existing regulatory system includes a large number of regulations regarding the management of the coastal area and its resources. But, even these laws and regulations have been updated recently to move towards ICZM principles, the regulatory framework needs to be updated to i) resolve existing gaps and overlaps, and ii) to address local ICZM processes. The future steps to update the regulatory framework are:

- Formal adoption of the national Strategy for ICZM in Egypt.
- Develop an action plan for ICZM implementation in consensus with key stakeholders.
- Identify prerequisites for ICZM in terms of capacity at different governance levels.
- Define administrative procedures for ICZM Plan development and implementation under regulatory system (laws, regulations, decrees, etc).
- Organize participatory activities with key stakeholders to debate about alternatives for improving the regulatory framework.

Institutional requirements to implement ICZM

Much of the challenge of implementing ICZM processes lies on encouraging collaborative management among key stakeholders. To achieve this, new procedures and structures at national, and especially at local level, need to be established. The Strategy for ICZM in Egypt focuses on the need of institutional structures for ICZM at Governorate level.

The steps required to improve the institutional framework are gathered into three groups: i) competences for ICZM, ii) inter-institutional coordination mechanisms, iii) data sharing and iv) capacity building.

i) Competences for ICZM:

- Organize participatory activities with key stakeholders to debate about the definition of roles and competences for ICZM, at national and local level.
- Define roles and competences of key stakeholders regarding ICZM implementation under the regulatory system.
- Establishment of local committees to support the development and implementation of the Coastal Management Plans. It requires the previous definition of the spatial scope of local committees to fit them to the Coastal Units scheme.

ii) Inter-institutional coordination mechanisms:

- Organize participatory activities with key stakeholders to debate about the improvement of inter-institutional coordination mechanisms for ICZM at national level.
- Organize participatory activities with key stakeholders to debate about the creation of inter-institutional coordination mechanisms for ICZM at local level.
- Establish realistic communication and coordination mechanisms to ensure the adoption of ICZM principles and climate change adaptation strategies under development plans (urban, tourism, industry, agriculture and aquaculture, etc.)

iii) Data sharing:

- Develop and implement a national strategy for sharing coastal data.

iv) Capacity building:

- Capacity building for key stakeholders and coastal management practitioners.

Funding requirements to implement ICZM.

ICZM is a dynamic and cyclical process, so it requires a supporting funding mechanism in the long-term. Guaranteeing a solid funding system will highly determine the feasibility of achieving a sustainable management of the Northern Coast of Egypt. The funding mechanism should include funds for launching and maintain ICZM processes in the Northern Coast, in.

The steps proposed to establish a funding mechanism are:

- Establish a shared strategy for funding ICZM between the Ministry of Water Resources and Irrigation and Ministry of Environment, including resources from international donors and national funding.
- Obtain international funding for launching the Coastal Management Plan of the Northern Coast.
- Defining a sustainable national funding system to ensure the sustainability of ICZM.

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SCIENTIFIC REPORTS

OPEN An holistic approach to beach erosion vulnerability assessment

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Abstract Beach erosion is a global problem that is increasing in intensity and extent. This study presents a holistic approach to beach erosion vulnerability assessment. The study is based on a review of the literature and a field study in Helwan, Egypt. The study identifies the different factors that contribute to beach erosion and develops a vulnerability index. The index is used to assess the vulnerability of beaches in Helwan and to identify the areas that are most at risk of erosion. The study also identifies the different factors that contribute to beach erosion and develops a vulnerability index. The index is used to assess the vulnerability of beaches in Helwan and to identify the areas that are most at risk of erosion.

ORIGINAL ARTICLE

Morphodynamic implications for shoreline management of the western-Mediterranean sector of Egypt

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Abstract Although the western-Mediterranean coast of Egypt between Sidi Barrani and Alexandria, ~150 km long, has experienced a considerable accretion throughout history, developments have built traditional protective structures in an effort to create artificial coastal beaches without taking into consideration the geomorphologic characteristics, coastal processes and their harmful impact on the coastal environment and human safety. The impact practices in this environmentally vulnerable region have indicated an immediate need 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 coastal protection or wave sheltering, the study shoreline can be categorized into four distinct morphological stretches: (1) high-energy wave-swept shores and the outer margin of the rocky beachline; (2) moderate to high wave-energy beaches along wave-swept embayments and large newly developed beachland bays and pocket beaches; and (3) calm wave-sheltered including wave fields for salt marshes, mangroves and recreation beaches. The results obtained will have practical applications for shoreline management initiatives regarding sustained and suitable for future beachline development such as safe retaining embankments, groin facilities, water intakes and diaphragm walls for coastal structures. Results revealed by the understanding of the morphodynamic processes would enhance our awareness of the significance of the role of various coastal geomorphologies in supporting sustainable development via shoreline management. As far as sustainability is concerned, the selection of appropriate sites would help providing or restoring the functions of the beach structures needed for creating safe recreation beaches. On a national scale, coastal beaches 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.

Keywords: Littoral cells · Shoreline management · Shore protection · Beachline development · Coastal processes · Vulnerable area · Sandbars · Shore-suspended ridges

Introduction

The study sector coast of Egypt extends from Sidi Barrani to El Dakkiya (Alexandria) seawards, ~150 km long, along the eastern western side of the Mediterranean coast of Egypt (Fig. 1a). The coastline is interrupted by a pronounced series of beachlands separating embayments and bays (Fig. 1a, 2a). The coast under study is characterized by remarkable diverse coastal morphologies from shore-based to the eastern part to Alexandria and the Nile delta. It is generally rocky covered by a variety of carbonate sand, mostly composed of calcareous oolitic grains (Fig. 2b). This coastline is locally fringed by shore-suspended ridges, salt-marsh and dunes, salt-marsh and recreation centers. The shore-suspended ridges are mostly composed of Pleistocene littoral ridges, which represent the former of carbonate oolite used as the foundation of the western coast and Alexandria (Elkady & El-Hayek 1971). The ridges are separated by elongate depressions



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