



## **Adaptation to the Impacts of Sea Level Rise in the Nile Delta coastal zone, Egypt**

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**Project:**

***Adaptation to the impacts of sea level rise***

***in the Nile Delta coastal zone, Egypt***

***Final project report***

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## ***1. Abstract***

Coastal areas, already affected by coastal erosion, subsidence, pollution, land use pressures, demographic growth, and deterioration of ecosystems, were becoming vulnerable to the effects of sea level rise (SLR). Threats include the loss of habitats, increases in erosion, groundwater salinity and coastal flooding as well as adverse impacts on human populations. Such impacts represent major challenges for planning sustainable development and land use strategies.

However, infrastructure and/or land use management options to protect against rising sea levels can be very costly, and can adversely affect stakeholders. Local authorities, planners, and other stakeholders require tools to identify the vulnerabilities to SLR and share knowledge in the process of deliberating and selecting adaptation strategies.

The proposed research project intended to demonstrate the value of stakeholder participation in evaluating the trade-offs between adaptation options in the stretch between Ras El Bar and Gamasa along Egypt's northern coast, and contribute to the long-term sustainable management of coastal areas in Egypt.

The project attempted, in this respect, to assist in advancing the science and technological aspects that underpin preparations for, and responses to climate related events, and contribute to the information systems that guide policies of public protection. Its results may also support assessment and implementation of adaptation measures in a regional context.

Attaining such goals involved, in addition to scientific research and modeling, vulnerability, environmental and socioeconomic assessments. This was undertaken in a participatory manner with all stakeholders and building capacities of those stakeholders and partner institutions through technology transfer, awareness raising, workshops and trainings, and institutional strengthening. Thus, the value of stakeholder participation' to the policy making and planning community in Egypt has been to great extent demonstrated.

## ***II. Research Problem***

It is expected that climate change will take place over the next century in spite of the international effort to reduce greenhouse gas emissions. This change is expected to exacerbate already existing environmental, social and economic problems in many countries. Human systems that were sensitive to climate change include water resources and agriculture (especially as it relates to food security); coastal zones and marine systems (particularly fisheries); human settlements, energy, industry, and human health. The vulnerability, which is a function of exposure to a risk, sensitivity to that risk and adaptive capacity, of natural and human systems to climate change, and the potential consequences of climate change, will vary with geographic location, time, and social, economic, and environmental conditions. Impacts were a function of the character, magnitude, and rate of climate change and variation to which a system is exposed, its sensitivity, and its adaptive capacity (IPCC, 2001).

The Nile delta has important role in daily life and development aspects of Egypt. This area is roughly contained by the triangle formed by the cities of Cairo in the south, Alexandria in the west, and Damietta to the east. It is very heavily populated, with population densities up to 1600 inhabitants per square kilometre and includes centers with concentration of economic activities. It hosts vital centers for summer tourism and recreation areas as well as archaeological sites from ancient civilization. It contributes 30–40% of national agricultural production and 60% of fish catch (marine and lagoon). Most of the fertile soils of the Nile delta are used for agriculture, irrigated by the water supplied from the Nile system. However increasing pressure for housing and urban space has led to both planned and uncontrolled occupation of agricultural lands by peri-urban and urban areas. Lands near the lagoon margins have been reclaimed for the purpose of agriculture and fish farms exist. Half of Egypt's industrial production comes from the delta, mainly from Alexandria, Idku, Damietta, Port Said and east of Port Said (Frihy, 2003).



The Nile delta coastal zone exhibits a low-lying backshore, which lies between + 3 and -1m from mean sea level. Parts of the backshore are made of narrow barriers; others are partially backed by brackish water lagoons. Three main brackish water lagoons back the Nile delta coastal zone, Manzala, Burullus, and Idku, from east to west. These lagoons extend inland for tens of kilometers, and have minimum protection from the sea. The delta coastal zone is generally low lying, and potentially exposed to inundation from the sea. Therefore, relatively small increases in sea level could have serious adverse effects on the delta coast and its population.

This vulnerability has been heightened by the growing population of the Delta, the natural subsidence of the Egyptian north coast which is sinking at an average rate of 2mm per year, and the loss of sediments following the construction of the Aswan High Dam and consequent destabilisation of the coast and increase in erosion.

In addition, global projections of accelerated sea level rise impacts have highlighted the Nile Delta coast as one of the most vulnerable areas in the world (Dasgupta et al, 2008). Sea level rise (SLR) will exacerbate existing challenges such as coastal erosion and subsidence. Global SLR projections contain considerable uncertainty, with conservative estimates ranging from 18-59cm by 2100 (IPCC, 2007) to up to 2m by 2100 (Allison et al., 2008; USNRC, 2010). Nonetheless, with the extensive backshore of the Delta coastal zone lying below 3m, such projections have highlighted the area's vulnerability. SLR projections for the delta area have, to date, been based on coarse resolution digital elevation models. However, studies in common currency have given concerning impact projections. Dasgupta et al. (2007), for example, projected that a 1m SLR would displace of 10% of population, 12.5% of agricultural production, and 6% of national GDP.

Historically, some construction projects were undertaken to protect some parts along the Nile Delta coast through hard structures as well as artificial nourishment that have been applied at some sectors. For instance, protection constructions were undertaken by Shore Protection

Authority (SPA) and Government of Egypt (GOE) spent about one billion Egyptian pounds from 1982 to 2010 to protect the three promontories of the Nile Delta (Damietta, Rosetta, and Al-Burullus). These hard structures include two seawalls that were constructed to the east and west of Rosetta mouth as well as long and short groins at the eastern and western end of these seawalls. Also, 6-km long seawall was constructed east of Damietta mouth.

Also, there are a number of coastal protection activities that have been carried out to mitigate the effects of relative rises in sea level and associated problems such as groundwater intrusion. These activities included the construction of a new drain at the western Nobariya drain outlet west of Alexandria; construction of a 180m extension of a breakwater in Alexandria's eastern harbor during the 1980s to reduce wave heights at critical locations of the coast; beach nourishment projects have been done in five beaches in Alexandria; the reinforcement of the Abu Quir Sea wall that was originally constructed in 1780; construction of six breakwaters west of El Gamil; construction of two jetties on the western and eastern sides of the El Gamil outlet (west of Port Said) to protect it from siltation and migration; and the construction of a small bituminous dyke to protect a low lying coastal road to Port Said airport from flooding. Also, beach nourishment and construction of eight detached breakwaters in front of Ras El Bar resort (east of Damiette harbor), and construction of 12 detached breakwaters in front of Baltim area as well as nine short groins west of these breakwaters (Fanos et al., 1995); (El Banna, 2006).

However, it is unclear whether past approaches to managing coastal protection, through the construction of hard defences along the shoreline and through beach nourishment, will remain cost effective in the face of accelerated sea level rise and anticipated increases in extreme weather events.

In UK, for example, large scale trials have been made in managed retreat, or managed realignment, in which sea walls have been withdrawn inland and wetlands and marshes nurtured in the new

flooded areas to provide 'soft defences' that buffer wave energy and reduce wear and tear on hard defences (e.g. Atkinson *et al*, 2001). The possibility of such approaches in Egypt has not been evaluated, and nor has the trade-offs between the high costs of constructing and maintaining increasingly exposed shoreline defences, and the costs and externalities of managed retreat approaches in the Egyptian context.

It could be argued that the above-mentioned studies and projects focused on identifying the areas most likely to be affected by sea level rise in different scenarios. Accordingly, there was a need to examine in more depth the vulnerability and potential impacts of changes in sea level on people, economic sectors, and systems.

In addition, the institutional context of decision making and planning for coastal defences and development in Egypt is weak. There is no policy process for integrated coastal zone management at a governorate level, and the only national institution is a ministerial consultative committee that has met three times since 1996. This has led to individual ministries taking action in isolation, without considering externalities of activities, potential vulnerabilities, or optimum planning of limited coastal space. Amongst other weaknesses, a lack of zoning regulation and enforcement has facilitated an environment of urban development in areas exposed to sea level rise and other impacts. Similarly, the Shoreline Protection Authority, under the Ministry of Water Resources and Irrigation, is responsible for constructing coastal defences, but does so according to physical vulnerability assessments, and without systematic reference to the needs of local communities or a strategic vision for the management of the coastal zone. At the same time, the lack of processes for public participation policy and planning is not only due to the lack of policy and planning, but also due to a general disinclination towards, and lack of capacity for, public participation or consultation in affairs of state.

Research on integrated coastal zone management and climate adaptation shows that integrated, cross-sectoral planning and public participation enhances sustainability and the delivery of pro-poor development (e.g. Sorensen, 1997 and Olsen & Christie, 2000). Research

elsewhere in North Africa has demonstrated that there were significant problems associated with fragmentation in policy and planning and a lack of public participation (Jobbins, 2003). With growing populations and accelerated sea levels both adding to existing environmental and socioeconomic challenges, current approaches to coastal development in Egypt were unlikely to meet the needs of the future.

Based on the foregoing assessment, this project set out to study three aspects of the challenge in detail in a specific area of the eastern Nile Delta:

- To investigate population vulnerability to, and socio-economic consequences of, climate change impacts arising from sea level rise and coastal flooding for each scenario over of these areas
- To develop adaptation strategies and coastal policy land use guidelines that reduce coastal population vulnerability and optimise the socio-economic and political trade-offs for different stakeholders.
- To develop local capacity for multi-stakeholder, participatory policy and planning processes

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### ***III. Objectives***

The project intended to demonstrate the value of stakeholder participation in evaluating the trade-offs between adaptation options in the stretch between Ras El Bar and Gamasa along Egypt's northern coast, and contribute to the long-term sustainable management of coastal areas in Egypt.

In this context, the project intended to advance the science and technological aspects that underpin preparations for, and responses to climate related events, and contribute to the information systems that guide policies of public protection. It is aimed to support the assessment and implementation of adaptation measures in a subnational context.

#### **1. Vision**

The vulnerability of coastal areas inhabitants to SLR can be reduced through an effective adaptation policy framework that involves all stakeholders collaboratively in decision making. Adaptations are carefully designed to improve the general well-being of those affected, who are involved in the design of adaptation options and have ownership of them. All stakeholders have the capacity to identify their vulnerabilities to climate change, and have either the capacity to increase their resilience, adapt, or know how or where to obtain the necessary support.

The coastal zone area is understood and governed by an institutional framework for integrated coastal zone management. Problems and solutions are well understood, impacts and adaptation options are analysed in terms of total costs including social and political externalities, and decisions are made in terms of strategic cost effectiveness. The political will exists to implement challenging adaptation strategies, and information systems are used to inform policy makers, government officials, and other stakeholders.



## **2. Mission**

Over the next three years the project will begin to lay the foundational capacity of key stakeholders for adaptation to SLR and extreme flooding events. This will include building their awareness of climate change impacts and adaptation options, and developing a network of stakeholders including NGOs and CBOs that can support the sustainability of project achievements. Working in a hotspot area especially vulnerable to climate change, the project will identify different adaptation options and their cost effectiveness, including the maintenance and creation of natural buffers such as wetlands and dune systems, hard coastal defences, and the relocation of population. A conceptual framework for an observation, monitoring and evaluation system will also be established, including an information and knowledge sharing system, to provide evidence of the need for this system to address future SLR impacts.

## **3. Overall objective**

Based upon the above mentioned vision and mission of the proposed project, the overall goal of the project was:

To develop and test methods and approaches for determining optimum and feasible adaptation options to SLR in Egypt, by integrating traditional modelling approaches with multi-stakeholder deliberation processes, to reduce vulnerability, and minimise the external costs of adaptation, using the Ras El Barr-Gamasa area as a pilot study.

## **4. Specific objectives**

In order to attain the overall goals a number of specific objectives were identified as follows:

- Produce a vulnerability assessment of different stakeholders and sectors.
- Identify and analyze feasibility of different adaptation options.
- Demonstrate value of, and build capacity for, multi-stakeholder deliberation processes in adaptation policymaking.

## ***IV. Methodology***

### **1. The Study Area**

To conduct this research a case study approach was taken to focus on micro-scale issues of community vulnerability. The area of Ras el-Bar – Gamarsa in the governorates of Damietta and Dakhalia was chosen due to its high physical vulnerability to SLR, the complex set of socio-economic activities present, and because previously studies on coastal management and climate vulnerability have focused on the city of Alexandria and nearby Burullus and Manzallah lakes.

The study area extends about 50 km in length along the Mediterranean Sea from Gamasa area at the west to the Damietta area at the east. It extends for about 16 km inland from the coast line. The study area hosts Gamasa area, new Damietta area, Kafr Saad area and Damietta promontory. The study area has a diverse range of development activities, groups, and communities. These include agriculture lands that approach the shore area, commercial activities, fishing communities, wood industry, tourism activities, as well as urban centres, and port and industrial infrastructure.

### **2. Research Questions**

The project was structured around a series of research questions to help the team focus attention on substantive issues related to key policy challenges. The central research question was: **What were the adaptation options that were most appropriate and cost effective to reduce vulnerability to sea level rise in the project area?** This top line research question was broken down into three secondary questions, which were further broken down into tertiary questions.

The first of these secondary questions related to vulnerability in the project area. The question was: *What were the vulnerabilities under different scenarios of sea level rise?* The tertiary supporting questions were:

- What were the different SLR and extreme events scenarios at each project site?
- What were the characteristics and sensitivities of the affected areas? (land use, activities, population, infrastructure...)
- What were the differential vulnerabilities of sectors, areas and people?

The second subsidiary question related to the selection of adaptation options. This question was: *What are the most feasible adaptation options for the project site, including 'zero adaptation' or 'no-response' measures?* In order to answer this question, the tertiary questions were:

- What would be the impacts of each adaptation option under different scenarios of climate change?
- What would be the externalities of each adaptation options?
- What would be the costs of implementing and mitigating against the externalities of each adaptation option?
- How can analysis of trade-offs amongst costs and risks lead to the selection of the most appropriate adaptation options for the next one hundred years?
- What were the discount rates of different stakeholders, and how sensitive are they under different scenarios of climate change?

The final subsidiary question related to socioeconomic and political characteristics of the research area and how these aspects relate to adaptation. This question was: *What were the social, political and economic constraints to, and opportunities for, creating an enabling environment for future coastal adaptation in the project area?* The tertiary questions were:

- What would be the needs of affected communities to adapt to SLR and cope with externalities of government intervention over time, and how can these be communicated to policymakers?
- How can the institutions, frameworks, policies and sources of finance important for supporting an adaptation policy framework be strengthened?
- What were the tools and methods required to establish an observation, monitoring and evaluation system?

As the project evolved, it was judged that not all of these research questions remained pertinent, and some were not possible to answer. However, they served to guide the planning of activities, and to serve as a road map for substantive enquiry.

## **Conceptual Framework**

### **Methods**

The multidisciplinary nature and wide range of methods used in the project preclude full presentation in this summary technical report. The project conceptual framework involved three main workpackages; the first of which was the identification of baseline conditions, both biophysical and socioeconomic, in the study area. This was followed by the selection of the SLR scenarios, which were employed to conduct the vulnerability analysis in the study area.

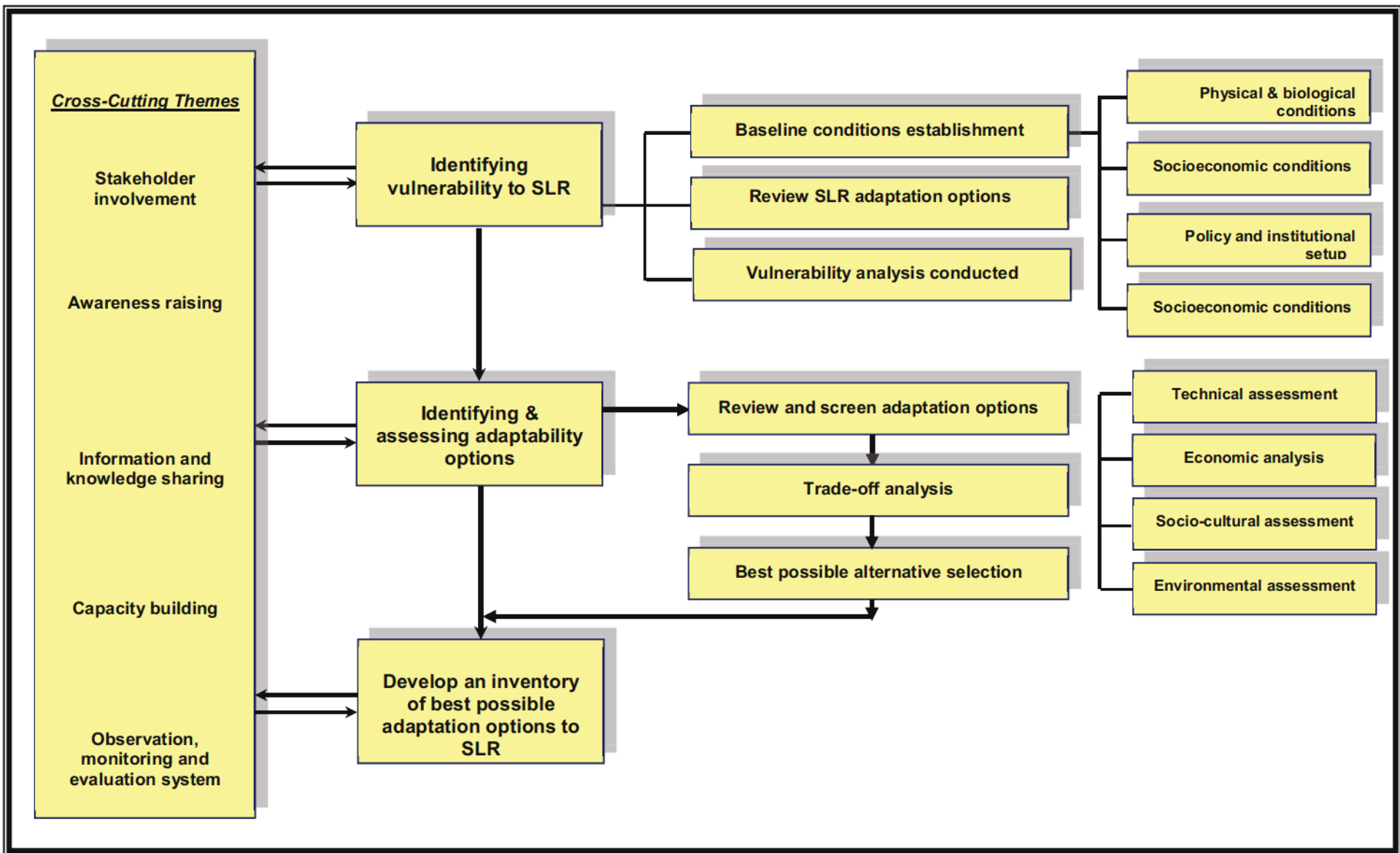
At this stage, the areas and communities exposed to SLR were identified, enabling the second step, where the impacts, biophysical and socioeconomic, were identified and attempts made to quantify them as much as possible. Different adaptation options were then reviewed and analyzed, from technical, socio-cultural, economic and environmental aspects, in order to identify the most viable ones. Following the identification of adaptation options, a participatory socio-cultural assessment was conducted through consultation meetings and focus group meetings that attempted to integrate the various stakeholder perspectives into account, including gender perspectives.

### **Stakeholder Participation**

Inline with project aspirations to promote engagement of stakeholders in participatory planning, the project has integrated stakeholders in different project activities. This began with the identification of vulnerabilities to SLR.

Throughout the project, stakeholders from local communities, the authorities, and the private sector were kept engaged and informed through Learning Alliances and contact groups established by the project

team. The project established one group which was the community leaders committee representing different groups of community including the investors, teachers, city councils, labors, farmers, fishermen, entrepreneurs, youth, and women. Several workshops were held involving members of community leaders committee to introduce for them the project objectives and activities and in return help the project in raising the community awareness on SLR and its impacts.



Framework of the Project



## ***V. Project Activities and Key Findings***

1. **A meeting for all team members of all three partners:** Due to the multidisciplinary nature of the project and to create common understanding of the issues in hand and the boundaries of the study area, a team meeting was held in Abu Qir in CoRI station at the beginning of the project. The meeting covered three main topics; an introductory about climate change and sea level rise, presentation about the project and the need for field work and participatory work approach.

2. **Bio-physical baseline study report:** The current report outlined the physical and biological characteristics of the study area. The coastal processes affecting the study area as a part of the Nile Delta were studied including waves, different types of currents, erosion and accretion patterns, sea level variation and subsidence. The protection work in the shore area as well as their impacts on the protection of the coastal area was also reviewed. In terms of the biological aspects in the study area, as climate change can have various impacts on biological aspects, biodiversity in the study area, both in the marine and on land was reviewed carefully in terms of habitats, species both flora and fauna including fisheries areas; which were one of the most productive in the country. As for the quality of water, biologically, it was found that in the Nile and Gamasa water quality was poor.

As for the ecological change, 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 (i.e. the Aswan High Dam) and manipulation of the natural environment, as well as a growth in population and associated environmental deterioration. Subsequently, many species have either changed their distribution or disappeared completely. It was also found that New Damietta area was considered moderate or less important areas as it contains few fauna and flora that were found elsewhere in Egypt and were affected with the landscape due to rapid urbanization.

Another aspect which was examined carefully at this stage was water and salt balance to describe the soil and water characteristics (salinity

features) for the region located in the extreme east-north part of the Middle Nile Delta. In addition, the report contains the location of the study area and its climatic conditions. Furthermore, the geomorphology of this area was also explained. Floods from the Nile and from the sea have inundated the flat, poorly drained coastal plain. Upon evaporation minerals and salts were left behind. Sedimentation has taken place in marshes and lagoon, depending on the sea level with time. These underwater deposits consist of unconsolidated unripe soil materials mainly of clay texture. In depressions, such as lakes and lagoons, brackish vegetation has developed which has led to the formation of peat and peaty deposits. The soils of the study area were predominantly compact clay soils overlying subsurface strata of varying texture and nature. Only some small parts of the area have loamy soils.

The main criteria on which the soils were classified were the texture and nature of the surface and subsurface, with special attention to the occurrence of permeable horizons and unripe “soft clay” layers in the subsoil. As all soils were more or less saline, salinity has not been used as a classification criterion, but has been treated separately.

Seawater intrusion is the movement of seawater into fresh water aquifers due to natural processes or human activities. It is caused by decreases in groundwater levels or by rises in seawater levels. Pumping out of fresh water rapidly will lead to the lowering of the freshwater in the aquifer forming a cone of depression and this would enhance the movement of saline water into the aquifer. Sea water intrusion can affect the quality of water not only at the pumping well sites, but also at other well sites, and undeveloped portions of the aquifer.

The coastal area of the Nile Delta is one of the most populated regions in Egypt and contains a variety of development activities. One of the major constraints facing the development was the availability of water requirements for different purposes. Although groundwater may represent suitable fresh water resources, it is believed that any further groundwater abstraction may result in saline water intrusion and upcoming, thus rendering the development not sustainable. To properly

manage groundwater, it was important to understand the patterns of seawater movement and mixing between fresh and saline groundwater. In the northern portion of the Nile Delta vertical upward leakage occurs from the aquifer due to top clay thickness and groundwater levels in this region which equal to mean sea level. This phenomenon is confined to the area between the downward leakage areas in the south. It was found that there was no active movement of recent sea water invading the aquifer but the risk now was focused on the movement of the highly saline water trapped within the clay layers in different horizons. The expected impacts of future climatic change in Nile Delta Coastal aquifer can be used these results as baseline monitoring for the coming decades.

3. **Socioeconomic baseline study report:** As the the main objective of this research project was to demonstrate the value of stakeholder participation in evaluating the trade-offs between adaptation options in one of Egyptian coastal areas that were vulnerable to SLR. One of the first steps to achieve such a goal was to assess socioeconomic and institutional aspects of vulnerability. In this context, the socioeconomic assessment report was intended to provide an overall assessment of the socioeconomic conditions, patterns and trends prevailing in the project area. Such a baseline socioeconomic assessment will contribute largely to the development of the conceptual and operational guidelines for next steps of the work. It begins with a brief review of the conceptual framework of socioeconomic assessment. This was followed by discussing the extent of the project study area and the criteria utilised in delineating the area. Thereafter, various socioeconomic aspects were analysed namely; demographic characteristics, access to basic infrastructure and services, gender issues prevailing in the area and finally the economic structure of the area. Prevailing land use patterns in the area were then examined. The report was, then, concluded with the main issues and opportunities in the project area, which in need of a closer examination in future work.

Concerning the determination of the boundaries of the study area, it was decided that such delineation should be objective and takes into

account the needs of the project. Accordingly, two criteria were identified and employed, as follows:

- Physical extent of vulnerability, which was mainly determined by the topography of the area expressed through contour map or DEM. According to this criterion, areas below 1m from sea level, which was the moderate estimation of SLR, were taken into consideration
- Administrative boundaries: as most statistics related to demographic and socioeconomic aspects from various secondary sources were related to administrative boundaries, the area identified under the first criterion was then were modified so as to incorporate whole administrative units.

Based on the above stated criteria, the study area was identified to include four main administrative units namely, Gamasa town, Damietta, Kafr Saad, and New Damietta city. While the first section was located in Dakahlia Governorate, the remaining administrative units were located in Damietta Governorate.

According to the 2006 Census, the study area has a total population size of 776268, of which about 43.08 % were urban population. Meanwhile, the study area has 199657 households with an average family size of about 4 persons. Also, no significant difference in the family size was found between urban and rural sections within the area. In terms of the age-sex composition it was found that the young population category (less than 15 years old) in the study area represents about 30.45% of the total population. This suggests that pressures on educational as well as recreational activities could be expected in this area.

As for the educational status of the population, it was found that about one-quarter of the total population of the study area were illiterate, which was less than the national average illiteracy rate in Egypt. Yet, about 40% of the population have a limited educational level “can read and write”. Concerning access of households to infrastructure and basic services, it was found almost all, 97-98%, of the population in urban and



rural areas in Damietta governorate have access to potable water respectively.

Despite the significant role of women in the community in particular in rural areas where they contribute largely in the agricultural activities, the low educational levels prevailing among women, which was accompanied by high levels of unemployment indicate to the limited role of the women in the community. However, this could be deceiving as most women would be working in owned land or in the informal sector.

A considerable part of the labor force, about one-half, in the study area on was found to work in tertiary activities (mainly services). This followed by secondary activities including mainly manufacturing industries and primary activities (agriculture and fishing). Official unemployment figures in the study area suggest that unemployment rates in the areas were much lower than the national average. Concerning the economic structure in the area, it was found to be based on a variety of economic activities including agriculture, fishing and aquaculture, tourism and to some extent industry. It could be suggested that the former three types of economic activities were highly associated with the environment and thus could be hardly hit by any adverse environmental changes. Industry was located meanwhile near the coastal area which could suggested that it could be affected by any possible flooding or increase in groundwater levels.

4. **Stakeholder analysis report:** Stakeholders analysis is an analytical process to identify major stakeholder groups in the project, while describing the nature of their stake, roles and interests in the project. Particular attention was devoted to primary stakeholders, particularly governmental agencies that were directly involved at the decision-making level. Attention was also being paid to the project beneficiaries, particularly vulnerable groups living and working in the study areas, who will directly benefit from the project. It was of imperative importance to ensure their effective participation in the project. The stakeholders analysis includes governmental organizations, civil society organizations

and private sector enterprises. Local communities as a main stakeholder in the study were incorporated in the socio-economic field study.

All the stakeholders involved in this analytical study lack awareness about the potential impacts of SLR, knowledge of vulnerabilities of coastal communities, technical capacity on how to deal with it, knowledge about adaptation methods and available options to address this phenomenon. Thus, these institutions would benefit from improved awareness and knowledge of SLR, adaptation and the potential impacts on various areas of the coastal zone. Fostering a spirit of collaboration and creating a system for knowledge sharing both intra and inter agency was one way to tackle the lack of cooperation and set into motion better knowledge of and action to address adaptation to SLR, ultimately contributing to collaborative decision making processes.

5. **Institutional and legal framework of coastal zone management:** The report reviews the status of coastal zone management since its initiation in 1992 through 1996 when Integrated Coastal Zone Management (ICZM) was properly addressed with the issue of the Framework of ICZM by the Egyptian Environmental Affairs Agency (EEAA). In recent years, there has been a growing awareness of existing and potential coastal problems in Egypt. This awareness has become manifested in a number of legislative and institutional developments.

The report identified two groups of priority actions needed for the protection of the coastal areas of Egypt; the first of which includes regional problems which need short term actions at the local and subnational level and could be implemented on the subnational level under the supervision of the national level. The second group includes problems of a national nature which will need long term action in all the available levels with national implementation assisted by international expertise. Furthermore, there were four common issues that were identified during the process of formulating the National ICZM Plan, - shore erosion, land use planning, water quality preservation and conservation of resources.



Though, dealing with coastal zone management was initiated during 1992, but, the proper address of Integrated Coastal Zone Management (ICZM) began in 1996 through issuing the Framework of ICZM by the Egyptian Environmental Affairs Agency (EEAA). In recent years, there has been a growing awareness of existing and potential coastal problems in Egypt. This awareness has become manifested in a number of legislative and institutional developments.

There were two groups of priority actions needed for the protection of the coastal areas of Egypt; the first of which includes regional problems which need short term actions at the local and regional level and could be implemented on the regional level under the supervision of the national level. The second group includes problems of a national nature which will need long term action in all the available levels with national implementation assisted by international expertise.

Four common issues were identified during the process of formulating the National ICZM Plan, - shore erosion, land use planning and preservation of water quality and conservation of resources. It has been noted that delays in plan adoption and inability to reach objectives, were due to lack of political commitment and financial resources. It was suggested in this respect that one of the most prominent obstacles to an effective protection of the marine environment was the complex and sometimes unclear institutional framework for addressing marine pollution, as well as the limited, *ad hoc* cooperation among different agencies. The importance of the involvement of the public (local communities, concerned groups and NGOs) in decision-making and management of the marine environment has also been increasingly underscored at the international and regional levels, as well as by several authorities in Egypt. The role of the public can only be effective when public access to information about the marine and coastal environments was encouraged and their participation in planning and decision making was supported.

As previously mentioned, for countries such as Egypt, developing adaptation strategies to deal with impending climate change will be

vital. With just a one-meter rise in the Mediterranean Sea, the Nile Delta stands to suffer tremendously. Rising seas would destroy parts of the protective offshore sand belt, which has already been weakened by reduced sediment flows resulting from the construction of the Aswan Dam in 1964. Without this sand belt, water quality in coastal freshwater lagoons will be altered, groundwater will be salinized and recreational tourism and beach facilities will be inundated. Furthermore, a predicted 6.1 million people will be displaced and 4,500 square kilometers of cropland will be lost.

The selection and timing of adaptive measures in response to sea level rise would depend on the physical, social, economic, political and environmental characteristics of the affected areas. Although such measures could be implemented on case by case bases, growing population pressures and conflicting demands in many Egypt's coastal areas favor implementation of comprehensive and systematic coastal management programs.

6. **Communication strategy report:** A communication plan provides a framework for increasing, enhancing and improving communications among project stakeholders. One of the key activities under the Fourth work package of the "*Adaptation to the Impacts of Sea Level Rise in the Delta Coastal Zone*" Project was development of a communication strategy or plan. The objectives of this plan were as follows:

- Enhancing transparency and accountability to the project's stakeholders and the public;
- Providing a tangible benefit to stakeholders by providing specific direction regarding the impacts of SLR and adaptation models;
- Providing measurable goals and implementable processes regarding communication with the different stakeholders;
- Exchanging messages and information with groups identified in the communication plan;
- Identifying the information and publicity measures necessary to bridge communication and information gaps;

- Reflecting a strategic approach to communication measures and activities with the different project stakeholders.

A participatory methodology was used in developing this communication plan. The preparation was in the form of a participatory workshop to give the participants the opportunity to express their thoughts, views and ideas about the project and its expected outcomes.

Internal communication ensures that the Project's Management and staff members were aware of the project's status, issues and risks. This enables both management and staff to make right decisions and plan ahead in a timely and effective manner.

External communication, on the other hand, ensures that the Project's stakeholders were aware of the project's status, issues and risks. This enables the stakeholders to identify their positions and provide support to the project to achieve its aims.

External communication works at three levels:

- Strategic or decision-making level;
- Executive or implementation level and;
- Public communications and media level.

To undertake effective external communication and outreach activities, it was imperative that the project team undertakes the following steps:

- Identification of the project's sites and areas of implementation;
- Identification of main and secondary stakeholders;
- Identification of roles and responsibilities of the different stakeholders;
- Preparation of introductory letters to the stakeholders, particularly government agencies;
- Preparation of printing materials and media messages such as brochures, leaflets and newsletters explaining the project's goal, objectives and activities;
- Preparation for meetings and contacting the different stakeholders;

- Studying and analyzing opportunities for collaboration with the different stakeholders and identify the frequency of contacts and types of communication with the different stakeholders.

7. **Inauguration meeting report:** the launching event was organized to officially inaugurate the SLR project in three selected areas in the Nile Delta, namely; Ras El Barr, Gamasa, and New Damietta. Along with officially opening the project, the launching event was intended to be used as an opportunity to inform stakeholders of project activities and gain their support to the realization of project objectives. Being a very important event which guarantees acknowledgement to the project, the event was held under the auspices of H.E. the Minister of Water Resources and Irrigation, and H.E. the Governor of Damietta. More than 150 attendants from governmental directorates, universities, research institutions, private sector, and NGOs represented their organizations in the event. The day was divided into two sessions; opening session, and technical session.

The meeting began by a word from Dr. Ibrahim El Shinnawy, Director of CoRI representing Dr. Shaden Abdel Gawwad, Chairperson of the National Water Research Center. In this speech, Dr. El Shinnawy introduced a historical background on Climate change and Sea Level Rise. He stressed the fact that the Ministry of Water Resources and Irrigation realized early on that this problem could affect Egypt's coastal zones and thus established a number of institutes to make researches and develop strategies for reducing effects of this phenomenon on coastal zones. He emphasized that such a project represents another effort initiated by the Coastal Research Institute to adapt to SLR impacts, and this effort should be shared with all stakeholders who have interest in, or were responsible for the three areas of the project. In the end, Dr. El Shinnawy wished the success for the project and the deliberations of the day.

After that, both general secretary of the Dakahleya governorate, and the assistant general secretary of the Damietta governorate spoke briefly to



the audience stressing the importance of the project and wishing for its deliberations to succeed.

Following this speech, Dr. Mohamed Bayoumi, the Deputy Regional Director of UNDP, delivered a speech about the new UNDP climate change project, and wished success to the SLR project.

Mr. Martin Hetherington, representative of the British Embassy in Cairo also talked about the interest of the British government in projects which deal with climate change in developing countries. He stressed the fact that while developing countries need to adapt to different impacts of climate change, the major emitters should take more responsibility towards cutting their emissions. He emphasized the idea that such a project represents the awareness of African country about their role concerning climate change. He wished success to the project, and hoped that in the future similar projects were implemented with the support of the British government.

Mr. Yusuf Rashed, representative of the Canadian Embassy, also spoke to the audience pointing out the importance of climate change project. He said that the Canadian government was specifically interested in this issue and was supporting project in Africa to help them reduce the effects of this phenomenon in their countries. He said that such a project was an illustration of this interest on the one hand, and of the awareness of Egypt about the problem on the other.

Dr. Guy Jobbins, IDRC Senior Program Officer, spoke about different climate change projects implemented by IDRC in Africa. He said the cooperation with Egypt in the SLR project was one of the major efforts which IDRC was looking forward to its outcomes. He stressed the fact that African countries should give more focus to climate change issues and should work early on towards developing adaptation options in vulnerable areas. In doing this, countries should stress on the concept of participation. Involving stakeholders and raising the awareness of the communities about impacts of climate change that might affect them was very important for decision making and implementation of adaptation options.

Mr. Ali Mokhtar, Chief Executive Officer of CDS, emphasized the importance of the project. He wished the success of the deliberations of the day as well as for the whole project. By those wishes, the opening session was concluded.

Session Two: In this session, three presentations were delivered. First, Dr. Ibrahim El Shinnawy did a presentation on sea level rise and its expected effects on the Nile Delta. He explained global scenarios of climate change and compared them to local studies, especially those implemented by the Ministry of Water Resources and Irrigation. He also displayed pictures from sites where actual studies were previously implemented.

Followed by this presentation, Dr. Mohamed Abdrabo, SLR project manager at Alexandria University, delivered a presentation which explained the project in details. He stressed the fact that this project was different from other projects because it takes the socio-economic dimension into consideration and sees the community as a main partner and a stakeholder.

After this presentation, Amira Elmaddah, program specialist at CDS, explained the role of CDS in the project, which involved identifying and involving different stakeholders and the community in all processes of the project.

As a feedback on the presentations delivered, participants made several comments summarized in the following:

- The importance of prior planning of touristic and entertainment projects in the areas as they might be currently established in vulnerable areas which will represent a major waste of public money.
- Cultivating rise in vulnerable areas might represent a first defense line against SLR; using wet land to reduce effects of sea level rise.
- Research should be made on crops which tolerate high concentrations of salt as a way to reduce the effect of SLR on agriculture in the area.



- More focus should be placed on the Manzala Lake area and Al Burullus Lake area because they have high population density and were more vulnerable than some areas of the project because they were already below sea level.
- Sand dunes which were considered one of the defense lines were currently taken by the government to increase the level of land in certain areas in the governorate, which reduces the role of sand dunes as defense lines. If this policy was kept, sand dunes would be eroded.
- An area of land should be used as a separating line between the coast and the habitat areas to work as a defense area. In this area, no establishments should be allowed.

By those remarks the session and the launching event were concluded.

8. **Management meetings report:** Due to the multidisciplinary nature of the project, diverse activities and the involvement of three partners in the project, large number of management meetings were held almost on monthly basis. They were intended to ensure smooth work progress and high level of coordination between tasks and activities carried out by different partners.

9. **A study on socioeconomic aspects of the Nile Delta coastal zone:** The study attempted to capture the perceptions of the respondents in the different field sites about the phenomenon of climate change, especially sea level rise (SLR). All the respondents were asked a simple question about their opinion of the weather.

The study discussed all perception of various stakeholders groups to Climate change and sea level rise in different parts of the study area.

Moreover, the study argued that various reactions between different stakeholders groups, as to what should be done in case there was a rise in the sea level.

10. **A capacity Building Program for CoRI and IGSR** The program was intended to train staff of CoRI and graduate students from the IGSR on implementing socioeconomic studies using qualitative and participatory

research methodologies. Fourteen participants attended the program representing scientists, technicians, young researchers, and administrative staff. This training program was held in order to build the capacity of CoRI and IGSR staff and/or research students on conducting field studies using qualitative methodologies, in particular the socio-economic study.

11. **Downscaling and Estimating SLR Scenarios until year 2100:** A comprehensive study was done along the coastal zone between Gamasa Drain to Damietta Branch spanning about 30 km alongshore and 17 km width; from which 2 km in the sea and the rest 15 km in the land side. The study downscaled the forthcoming scenarios of total sea level rise estimated by the IPCC Fourth Assessment Report (2007). Tidal trend analysis revealed that the maximum total sea level rise rate will not exceed 48 cm at the end of this century (assuming the worst case A1FI scenario). Land subsidence was also investigated along the entire Nile Delta coast and was found to be 0.4 mm/y at Alexandria at the west increasing towards the east with 3mm/y in the middle zone of the Nile Delta reaching 3.5 mm/y at Port Said at the east. This means that by adding land subsidence and sea level rise, then the total SLR would be 73 cm by the year 2100. In addition, the study used several elevation modules included in ARC-GIS software as well as Excel, Auto-cad and ERDAS modules to manipulate and analyze different satellite images, topographic maps and field surveys.

12. **Development of a Geographic Information System for the study area:** Physical and socioeconomic data mapping to produce thematic maps various aspects of the study area including land use patterns, demographic distribution and coastal infrastructure.

The developed GIS contained layers for certain attributes, with more attributes could be added to the system, whenever needed. Current attributes include; land use/ land cover, localities, irrigation system, roads network, human development indicators in different localities and surface elevation.

**13. Theoretical and analytical framework (socioeconomic vulnerability and economic valuation):**

The first paper intends to discuss socioeconomic vulnerability and thereafter economic valuation of environmental impacts in general and those of SLR in particular. The term “key vulnerability” was used widely in literatures of vulnerability. The Fourth Assessment Report of IPCC used the term “key vulnerability” in the context of vulnerabilities that merit particular attention by policy-makers due to characteristics that might make them key. It identifies seven criteria that may be used to identify key vulnerabilities. These criteria were magnitude of impacts, timing of impacts, persistence and reversibility of impacts, likelihood (estimates of uncertainty) of impacts and vulnerabilities, and confidence in those estimates, potential for adaptation, distributional aspects of impacts and vulnerabilities, and importance of the system(s) at risk. Such vulnerability would depend on the magnitude of the impacts, timing, persistence and reversibility, likelihood and confidence, spatial distribution of the impacts and the potential for adaptation.

Generally, there were three broad characterizations of vulnerability from climate change and natural hazards research were identified that, combined, address the dynamic and integrated nature of environmental and social vulnerability. The first perspective treats vulnerability in terms of exposure to hazardous events (e.g., droughts, floods) .Studies from this perspective focus on the distributions of hazardous conditions and on the ways that these conditions affect people and structures. As such, a physical event places people at risk and the focus was to identify vulnerable places. However, reducing physical risk does not necessarily reduce exposure and damages and in contrast, it may increase the vulnerability of populations to such events. For example, flood protection does not necessarily discourage people from living in floodplains, but may encourage development and consequently, increase vulnerability.

The second perspective on vulnerability emphasis on vulnerability as a human dimension not a physical one, rather neglected in past studies of vulnerability and adaptation. In studies following this perspective,

vulnerability was a function of social conditions and historical circumstances (e.g., poverty, development in marginal or sensitive areas) that put people at risk to various external stresses (e.g., global greenhouse gas emission in the case of climate change). In this perspective, not all individuals and groups exposed to hazard were equally vulnerable; rather, affected people display patterns of differential loss. Thus, protection from the social forces imposed on people that create inequitable exposure to risk was just as, or more important than protection from natural hazards.

A third perspective integrates both the physical event and characteristics of populations that lead to risk exposure and limited capacity of communities to respond. This perspective derived from vulnerability of places approach which formalized by Cutter (1996) and Cutter et al., (2000), the vulnerability in this approach was a physical risk and a social response within a defined geographic context. The concept of vulnerability as "hazard of place" first formulated in 1996. In this conceptualization, risk (an objective measure of the likelihood of a hazard event) interacts with mitigation (measures to lessen risks or reduce their impact) to produce the hazard potential. The hazard potential was either moderated or enhanced by a geographic filter (site and situation of the place, proximity) as well as the social fabric of the place. The social fabric includes community experience with hazards, and community ability to respond to, cope with, recover from, and adapt to hazards, which in turn were influenced by economic, demographic, and housing characteristics. The social and biophysical vulnerabilities interact to produce the overall place vulnerability.

Accordingly, it was decided that an integrated approach that incorporate biophysical and socioeconomic vulnerability working at household level will be employed for vulnerability assessment within the framework of this project. Despite the fact this micro level of assessment, households, has not been employed by most studies on climate change vulnerability assessment, this was intended to highlight the variation in vulnerability due not only to the hazards but also the recipients' socioeconomic vulnerability.



Furthermore, we intend to continuously update this document as we go in the project and hope that we'll be able to develop a research paper on this aspect and print some materials in Arabic for wider dissemination.

Turning to economic valuation, scarcity of resources, relative to human needs and wants, means that individuals have to make choices between different goods and services. Making such choices, for goods and services traded in the markets, was usually based on comparing their market prices with the satisfaction gained from their consumption. However, making choices concerning public goods, such as air and water, which were not traded in the marketplace and have no prices to guide choices, was rather difficult. In such cases, it was important to find ways for putting a value to these goods and services.

Generally, the total value of environmental goods and services was the sum of four sub-values including direct and indirect use values, option value and existence value. The first three of the above values represent the use value of an environmental component, while the fourth represents the non-use value.

Economic valuation means simply eliciting measures of human preferences for or against changes in environmental conditions. It represents an essential step in incorporating environmental considerations into economic work. In order to estimate the economic value of different environmental goods and services, economists have developed a number of valuation techniques. Each of these techniques has its advantages and disadvantages and cannot be employed generally to deal with every possible case.

Economic valuation techniques can be laid in one of two categories, namely, market valuation and individual preferences techniques. The market valuation group market valuation of physical effects, dose-response, under the production function, replacement cost approaches. The second group was divided into two sub-groups; the former sub-group was the revealed preferences which involve the hedonic pricing and travel cost approaches. The second sub-group the hypothetical

approaches base their direct or indirect estimation of value, meanwhile, on responses to hypothetical valuation questions.

The economic valuation techniques to be employed within the framework of this project will depend on the type of SLR impacts to be expected in the study area. For instance, damages to property can be assessed using replacement cost approach, while the impacts of saltwater intrusion could be assessed using the under the production function approach. Therefore, the developed theoretical and analytical framework will be updated when the list of potential impacts of SLR to be experienced in the area were identified. It was worth mentioning in this respect, that the three M.Sc. students supported by the project were covering both the vulnerability assessment and economic valuation of impacts on urban areas and on agriculture sector, respectively. Thus, this could be seen as work in progress going through a process of continuously refining.

**14. Theoretical and analytical framework (stakeholder analysis and participation):** The report started by stating the commonly known aspect that stakeholder analysis and participation were interconnected. Participation was a principle or practice, which may also be recognized as a right (right to participation). In fact, the term participation may be used interchangeably with the concept or practice of stakeholder engagement and/or popular participation. It is very important, thus, when conducting stakeholder analysis to employ methodologies which encourage participation of all segments of the community such as participatory rural appraisal (PRA), action-research, gender analysis and the analysis of differences in class and power. The report presented an 8 step process for stakeholder analysis, moving from problem identification, through analysis, and towards utilization.

**15. Focus Group Workshops:** One of the activities set out in the project timetable for the first year was holding focus group workshops. The main aim behind this activity was to raise awareness and involve stakeholders in the vulnerability assessment, and analysis of the different impacts and attitudes toward the various adaptation options.

To achieve this, project partners agreed on organizing a series of focus group workshops along the project to keep stakeholders informed about climate change issues, progress in the SLR project activities, and results concluded by the project, as well as to involve them in the vulnerability assessment, and the evaluation of different adaptation options. The first set of focus groups, thus, was organized with the specific objective of raising the awareness of all stakeholders, including the community, on climate change and sea level rise issues, and the possible impacts on their lives. This was considered very important for project partners in order to create a common base of knowledge and understanding of the project to insure the effective participation of stakeholders at the following stages of the project.

Based on this target, a plan was developed for implementing the first series of focus group workshops as part of the activities set out for the second half of the first year of the project. The project team, earlier trained on presentation and session planning skills, agreed upon the roles each team member was going to perform during the implementation of the plan and set out dates for implementation. The plan included workshops with youth, businessmen, farmers, fishermen, women, children, and officials in Damietta and Dakahliya governorates. CoRI, IGSR, and CDS project management staff approved the plan and agreed that while CoRI and IGSR will independently plan and implement the events, CDS staff will work as coaches who support the implementation team through the process.

As planned, the meetings were organized and implemented by the CoRI and IGSR project team previously trained by CDS. Members of the team were divided into smaller groups according to their scientific background, presentation skills, and gender in order for each group to interact effectively with target groups they were assigned to. For example, a small group of female IGSR researchers held the workshops with women and school children, while a small group of male CoRI researchers held workshops with fishermen and businessmen. For youth seminars, a mixed group of researchers managed the gatherings. A coach from CDS accompanied different groups during workshops in

order to provide them with advice and tips for the best execution of their tasks. As pointed out in the table below, a total of 13 workshops and meetings was held with different target groups which included 411 officials, businessmen, fishermen, farmers, youth, women, and children.

The project management team saw it as very important to start organizing those workshops for a number of reasons; 1) As pointed out above, the project needed to start communicating with different stakeholders and to create a solid base for a relationship that would allow the project to call for their participation in following activities along the project, especially the vulnerability assessment 2) the CoRI and IGSR project team needed to start practicing the skills they have acquired during the ToT program in the field, and they had a very good opportunity during the first series of workshops when CDS coached them closely through the process, and 3) the project team needed to interact early on with different stakeholders in order to give time for each stakeholder as well as the community to respond to the information offered by the project team.

In addition, the project management team used the outputs of the focus group workshops to decide on the procedures they were going to follow to, regularly, involve different stakeholders in project activities. The wide participation during the focus group workshops allowed the project team to nominate representatives from each stakeholder organization in order to set up fixed groups which were going to convene after the completion of each stage of the project. Those fixed focus groups will participate in the vulnerability assessment, the discussion of the adaptation options, and the evaluation of the project activities. They will be used as a link between the project and their organizations in order to consult with and win the support of stakeholders.

It was, thus, important to note that the time separating the focus group workshops and the vulnerability assessment workshops was invested in strengthening the relationship with stakeholders, identifying possible obstacles and resolving issues which came up during the focus group



workshops, as the project team continues to communicate regularly with different stakeholders.

### Target groups and participants in different workshops

Date	Target Group	Venue	Number of Participants
Nov. 21, 2009	Women	Local Unit in Ezbet El Borg	16
	Women	CoRI station in Ras El Barr	14
Nov. 22, 2009	School children	El Gerby preparatory school, Ras El Barr	14 boys 12 girls 4 teachers
	School children	Ras El Barr primary school, Ras El Barr	12 boys 12 girls 1 teachers
Dec. 14, 2009	Businessmen and investors	Businessmen Association in New Damietta	17 businessmen and investors
	Youth	New Damietta Youth Center	35 males 27 females
Dec. 15, 2009	Gamasa City Council employees	Gamasa City Council	27 males 12 females
	Youth	El Rekabiya village Youth Center	45 males 42 females
Dec. 16, 2009	Fishermen	Ezbet El Borg	27 fishermen
	Youth	Damietta Sporting Club	11 males 28 females
January 19, 2010	farmers	Al Kaheel Village Youth Center	35 farmers 4 Agriculture Directorate employees
January 20, 2010	Damietta governorate officials	Damietta governorate meeting hall	15 officials
January 21, 2010	Dakahleya governorate Secretary General	Office of the Secretary General	1 official
<b>Total</b>		<b>13 workshops</b>	<b>411</b>

It was clear that Dakahliya governorate was less interested in the project and was not quite ready to participate in its activities. In order to resolve this, 2 senior members of the project team accompanied by a coach from CDS met with the Dakahliya Secretary General to explain project objectives, and point out the important role of the Dakahliya governorate to achieve those objectives. They explained that the project was implemented for the benefit of the community in Dakahliya, and that being part of this process, the Dakahliya governorate will have the lead in taking action to face impacts of climate change and sea level rise in the Delta Coastal Zone area. The Secretary General was generally interested in the topic, and asked for an official letter from the Ministry of Water Resources and Irrigation to be able to proceed with the project team in the implementation of project activities.

The overall conclusion of the workshops was that most stakeholders were interested in climate change and were ready to receive more information about the topic. They were also ready to cooperate with the project, each on their own level, in order to find practical solutions for the problem and adapt to climate change. This encourages the project to increase the participation of all stakeholders during the next phases of the project. It also paves the way for serious cooperation efforts with some target groups who have the authority and the financial ability to set up an adaptation strategy for the project area such as the governorate, the local authorities, and businessmen. Some of the more specific remarks on target groups include:

- All focus groups asked a similar question which was “What was the proposed solution for the problem, and how can we contribute?” In response to this question, the project team members pointed out that talking about solutions was still early at this stage of the project. They explained that once the project reaches the stage of exploring different adaptation options to respond to climate change, other events will be organized with different stakeholders to discuss options and agree on best solutions and future actions.

- All focus groups stressed the importance of the government's role in adapting to climate change, through enforcing laws which protect the environment, and adopting an effective adaptation strategy.
- Farmers showed readiness towards improving their farming practices to help reduce negative effects of farming activities on the environment, and also showed readiness to adopt new techniques which would help them adapt to expected future changes such as salinization due to Sea Level Rise. However, they said that they need several training programs to be able to adopt those new techniques.
- Businessmen, women and school children showed the most enthusiastic responses during seminars, and seemed to be ready for individual actions.

As their first attempt to organize, plan, manage, and execute focus group workshops within the SLR project, the project team's performance was encouraging. They were able to design a workshop plan, prepare the messages, choose suitable presentation techniques and audio-visual materials, manage the workshops, engage the audience, and deliver the messages. Responses of the audience during all events show that the project team members were on their way to master their roles. However, some of the smaller project team groups performed better than others and seemed to be more well-prepared and ready to deliver their messages.

**16. Training of Trainers for CoRI and IGSR Staff:** A ToT program for the Coastal Research Institute (CoRI) and the Institute of Graduate Studies and Research (IGSR) staff was scheduled to be held during October 24-29, 2009. As the main partner responsible for capacity building, the Center for Development Services (CDS) has prepared a one-week program in order to build the capacity of CoRI and IGSR staff on managing focus group and communication, dealing with different personalities, audio-visualize, and presentation skills in order to deliver information regarding the project objectives and activities for the

community at 16 targeted villages as well as to be able to provide awareness campaign.

The program was designed to cover ToT skills in 5 intensive working days and was implemented in Alexandria, at the Social Solidarity Affiliated Training Center. CoRI and IGSR were represented by selected participants who were varied in specializations, gender, and age group in order for them to be able to address different targeted segments when holding meetings with stakeholders.

The opinion of participants on the content, organization, and execution of the training workshop was generally very good. They highly appreciated the performance of the trainers, and the support of facilitators. They were also very interested in the topic of the training and said that this was the first time for them to be exposed to the techniques which they learned during the week. However, they had comments on time management issues during some of the sessions, and wished that the training program was longer in order for them to be able to digest the content and master the skills which they were exposed to.

17. **Website development for the project:** As part of the communication strategy developed for the project and provides accessibility to project members and outsiders about the project objectives, activities, outcomes and issues of concern, a website was developed for the project. Access to the website was intended to be at two levels; the first level was public access which provides general information about the project and its activities as well as the materials, including teaching materials, and reports intended for the general public. The second level of access was for team members to a secured section of the website containing project documentation and data.

18. **Review of possible adaptation Options to the Impacts of SLR in Coastal Areas:** This report began by reviewing main concepts of Climate Change and Sea Level Rise causes, effects and the role of adaptation policies in reducing potential physical and socio-economic adverse impacts in the coastal zone of the study area. Then an examination of adaptation policies to climate change classified into categories has been



presented. Also covered in this report was a summary of qualitative and quantitative approaches for weighing the trade-offs among adaptation strategies so that an assessment can be concluded.

The report provides a list of possible adaptation strategies to Sea Level Rise within the three generic response approaches: retreat, Accommodation, and Protection. Through reviewed literature and case studies, coastal protection alternatives, soft protection measures versus classical hard engineering structures, were presented.

The review in this report also introduces Sea Level Rise adaptation options in more classified manner that cover preserving coastal infrastructure, restoring wetlands, maintaining sediment transport and water quality, and preserving habitat for vulnerable species. The study also emphasis the complexity in choosing among the adaptation policies and importance of being incorporated into coastal zone management, disaster mitigation programs, land-use planning, and sustainable development strategies. Finally, the report comprises a section covers adaptation options to expected Sea Level Rise in the Nile Delta coastal zone.

Still, it was suggested that as the cost of the different adaptation options depends, to some extent, upon the socioeconomic aspects and demographic situation of the studied areas which was at that stage work in progress, the report described only existing types of adaptation options available in other countries including their strengths and weaknesses. Following completing the socioeconomic and demographic studies, the project team can weigh up these options, considering their costs, to determine the potential options for adaptation in the pilot areas of Nile Delta coastal zone.

**19. Impact of Sea Level Rise on Groundwater Elevation and Salinity Intrusion: Vulnerability Assessment:** This report presented an attempt to assess physical vulnerability of the study area with special reference to the impact of Sea Level Rise on groundwater elevation and salinity intrusion. The report begins by presenting selective reviewed approaches of saltwater/freshwater interface behavior and modeling

concepts. Then, predicted changes in salt intrusion and elevation in groundwater levels as well as advancement of saltwater/freshwater interface as a result of projected SLR scenarios in years 2025, 2050, 2075 and 2100 were demonstrated. Accordingly, and while considering land elevations and soil characteristics, physical vulnerability analysis for the study area was conducted to highlight spots with low resilience capability and hence need for special attention. It was suggested, in this respect, that lateral and upward movement of saltwater/freshwater interface resulting from saltwater intrusion into coastal aquifers showed that an increase of 73 cm of sea level by year 2100 would cause intrusion of saltwater by about 1 kilometer into aquifer. Furthermore, elevation of groundwater table would cause vulnerable areas to have near surface groundwater causing serious cultivation and drainage difficulties, or even be inundated.

Furthermore, it was found that certain spots, in the study site, raise concerns of being more susceptible to inundation as a result of reduces thickness of clay cap coincide with Piezometric Head reaching land level in present conditions. Finally, mitigation strategy, based on the concept of stabilizing Piezometric surface and interface position, with alternative policies for adaptation to be considered within the study area was presented in order for alleviating adverse impact of sea level rise-related salinity intrusion. They include measures such as:

- Pumping of brackish/saltwater from the vicinity of the shoreline and Northern part of the delta in order to reduce the saltwater head and help the freshwater to push the interface seaward.
- Compensating lowered recharge rates in areas with increased urbanization and thus impervious surfaces
- Artificially recharging the groundwater table by means of injection wells of freshwater or primarily treated sewage along the shoreline

- Restricting, via quantitative rates, withdrawals from coastal aquifers especially in the areas located within the interface boundaries
- Constant monitoring system for groundwater level and saltwater/freshwater interface for continuous observation

Meanwhile it was recommended to reconsider certain Land-uses in the study area; for instant, altering vegetation patterns (i.e. salinity tolerant crops), applying management practices that have direct impact on hydrological processes through evapotranspiration and surface runoff. Changing in these components can be employed to maintain and recharge of groundwater in the study area.

**20. Vulnerability of Drainage System Infrastructures to Expected Mean Sea Level Rise and Salt Balance of (Ras El-Bar – Gamassa Area):**

The degrees of vulnerability for infrastructure as a result of the expected Sea Level Rise as well as salt balance within the study area have been reported by the Drainage Research Institute (DRI). This report investigates possible impacts of the sea level rise in the study area with special reference to the drainage system's infrastructure and possible changes in soil salinity. Field investigations for land description, water table levels and hydraulic conductivity at five selected profiles represent the study area were performed. Finally, simple mathematical model based on salt storage equations was used in Excel worksheet to predict the change in soil salinity.

Results of examined soil profiles showed that the affected distance was expected to reach about 1 Kilometer from shoreline of the study area. However, predicted salinity levels were found to be related more to the profiles locations and initial soil salinity. For instance, for the profiles' locations with elevations higher than expected sea water level after intrusion, soil salinity will not change. Locations with elevations lower than expected sea level that had initial soil salinity lower than the sea water salinity; it was found that their salinity levels would increase. Moreover, the locations that have initial soil salinity higher than the sea water salinity, would be expected to decreased or have negative values.

## **21. Changes in Wave Climate and Sediment Transport within the Study**

**Area:** This report investigated the effect of climate change on wave climate and sediment transport in the study area within the Nile Delta coast. This involved analyzing S4DW wave gauge by computer software to get the different wave parameters such as: significant wave height, significant/peak wave period, and wave direction. The ImSedTran-2D model and GENESIS modeling techniques were applied with the purpose of simulating wave distribution and sediment transport rate in order to conclude the effect of changes in bed morphology on wave characteristics and sediment transport between years 1997 and 2010.

Results showed increase in both significant and average wave height from 1997 to 2010, with change in predominant wave direction from North North-West (NNW) to North-West (NW) direction. Meanwhile, the report highlights pattern of changes in sediment transport and area of concern. Also reported was that wave height and wave energy have been increased within the near shore zone due to the shoaling effect and the orientation of the bed contour. The maximum wave height in 50 years will increase to 7.60 m at 18 m depth and will reach 3.5 m (after 50 years) at the detached breakwaters locations at Ras El-Barr. The stability check of the breakwaters shows that the structure was designed to face 5.0 m wave height and remain stable when the water depth in front of the structure reaches 7.0 m.

In addition sediment transport rate was estimated (erosion rate) hence the amount of artificial sand needed for nourishment for protection work was defined.

**22. Demographic and land use projections:** In considering some long term events, there was a need to determine the potential rather than current system's vulnerability, which aims to pursue long-term adaptation strategies. This, of course, entails the system profile in the future. In this respect, population was one of the main elements of such profile. This means that there was a need to estimate population size in the future. This work intends to provide an estimation of population size of the Ras El Bar and Gamasa coastal area at local level up to 2100.



In order to attain this objective, the study began by reviewing current demographic trends prevailing in the project area to determine the most appropriate methodology that can be employed to project the area's population size in the future. Thereafter, the main future changes in land use pattern were projected.

The main objective of this report was to provide an estimation of population size of the Ras El Barr - Gamasa coastal area at local level up to 2100. In order to attain this objective, the report begins by reviewing current demographic trends. This was followed by adopting two population growth scenarios; the first of which assumes that current demographic trends would continue, while the second assumes a more rapid population growth. In addition to these two population growth scenarios, two demographic distribution (between urban and rural areas) settings were considered. The first demographic distribution setting assumes that population growth was distributed more evenly, while the second setting assumes a more concentrated patterns of distribution. Thereafter, the impacts of such scenarios and settings on land use patterns in the area were examined. The report was then concluded with a discussion of the results.

According to scenario A, the moderate population growth scenario, the population of the study area was expected to reach about 1,438,339 and 2,439,873 in 2050 and 2100, respectively. This was compared to scenario B, the rapid population growth scenario, where the population would reach as much as 1,950,666 and 6,337,157 in 2050 and 2100, respectively.

Land use changes were projected according to projected population size in each locality under different assumptions concerning spatial population distribution; whether dispersed or concentrated. This has led, in turn to different proportions of land being allocated to built-up area and cultivated land<sup>1</sup>. It was found, as the concentrated development assumes that there would be a tendency for the share of

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urban areas to increase, that the size of the built-up area would be larger than the dispersed development. This could be due to the use of the per capita area in urban areas was larger, than that prevailing in rural ones, as they experience lower density per total built-up area.

According to scenario B, no matter the patterns of development, large areas of agricultural land would be encroached upon built-up areas expansion. Yet, this was less than other projections concerning built-up area expansion at the expense of agriculture land. For instance, Egypt State of the Environment 2006 suggests that there would be significant depletion of agricultural land. Figures show complete loss of traditional agricultural lands, either within fifty years, if current development efforts and expansion outside Egypt's populated areas would be ineffective, or by the end of this century if such efforts would succeed.

In terms of vulnerability, densely populated large built-up areas, located in areas exposed to the impacts of SLR meant higher vulnerability for those areas and vice versa. Thus, scenarios leading to such situations would be less favorable. Accordingly, it could suggested that among the four developed scenarios, scenario A1 could be considered as the most optimistic one as it comprised small number of population and built-up area which implies low levels of vulnerability. As the areas and population that could be exposed to most of the SLR impacts, for instance, were located in or adjacent to the coastline, involve four urban localities namely; Ras-el-Barr, New Damietta, Damietta city and Gamasa. According to Scenarios A1 and A2 these four localities would host 16.1% and 32.8% of total study area population in 2100, respectively. Moreover, scenario A1 involves limited loss of cultivated land, which was a highly valuable resource. Scenario B2 could be considered to be the most pessimistic scenario as it suggests largest number of population and built-up area in addition to massive loss of agricultural land.

However, scenario A2, it could be argued, can be considered as a realistic scenario, because the trend of population growth (declining fertility and death rates) and the gap between urban and rural, in terms of infrastructure and services as well as job opportunities provision,

were expected to continue. Therefore, dealing with vulnerability and adaptation options should work on scenario A2.

Action in the study area, whether at national or local levels, needs, meanwhile, to guide development towards scenario A1 as the most favorite one. This action should deal with various driving factors determining population growth and the expansion of human settlement in the area that could contribute to decreasing vulnerability levels.

**23. Socioeconomic vulnerability at localities level:** One of the main objectives of the project in hand has been to assess socioeconomic vulnerability to SLR in Gamasa – Ras El Barr coastal area. In order to attain this objective, a study was conducted beginning by identifying the spatial extent of expected SLR biophysical impacts in the study area according to different SLR scenarios; namely those of the IPCC and the one developed by The Coastal Research Institute (CoRI) (Table 1)

Table (1) IPCC and CoRI Average Annual Sea Level Rise (cm) Scenarios Relative to Year 1990 Sea Level in the study area

Scenario	2025	2050	2075	2100
B1	12.25	26.5	42.75	49
A1T	13.25	30.5	46.75	61
B2	13.25	27.5	44.25	60
A1B	13.25	27.5	46.75	63
A2	13.25	27.5	46.75	67
A1FI	13.25	30.5	51.75	73
CoRI	12	24	36	48

The area threatened by inundation was estimated by as much as 9.70 km<sup>2</sup>, which represent about 1.31% of the total study area. The expected inundated area distributed among. The absolute figures of undated area refer to concentration of the majority of inundated area in Izbet El Borg locality, in the western part of the study area, which holds about 76.33% of the inundated area. Meanwhile, the relative figures indicate that Gamasa locality will be most affected by inundation. Although the inundated area in Gamasa was limited (0.75 km<sup>2</sup>), this area represents large section of total locality area (11.74%) (Table 2).

Table (2): The distribution of inundated areas among various localities by 2100

Localities	Inundated area Km <sup>2</sup>	Total locality area Km <sup>2</sup>	% of total area
Dumyat Al - Gadida	0.47	93.96	0.50
Izbet Al - Borg	7.40	249.12	2.97
Ras Al - Bar	0.24	3.43	7.03
Ar - Rakabeyah	0.38	34.36	1.10
As - Senaneyah	0.46	16.72	2.73
Gamasa	0.75	6.37	11.74
Total	9.70	403.96	2.40

Concerning, changing water table in the area and salinization of groundwater, it was found that large sections of the study area will be adversely affected. The high levels of ground water will adversely affect an areas of about 242.8 Km<sup>2</sup>, representing about 59.65% of total study area (Figure 1). This in turn would negatively affect agricultural productivity and also damage buildings and infrastructure located in the built-up area.

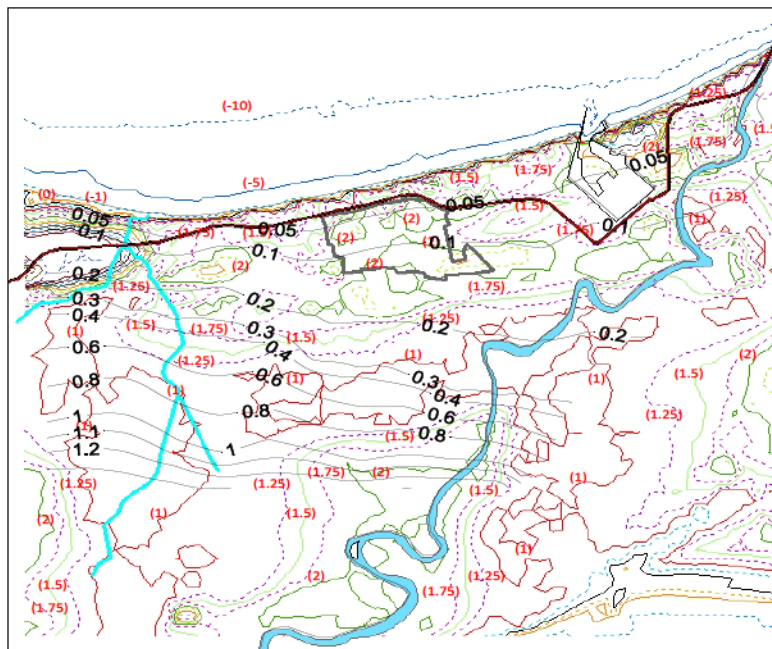
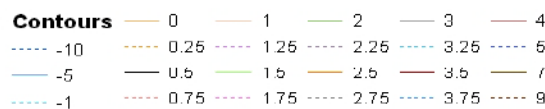




Figure 1: Contour map includes ground water depths in 2100 due to SLR

After considering the spatial extent of the physical impacts of SLR in the study area, local baseline socioeconomic conditions as well as Human Development Indices (HDI) prevailing in the area were examined. Thereafter, a Geographic Information System (GIS) was developed for mapping physical and socioeconomic data of the study area and conducting spatial analysis to evaluate various impacts of SLR. Then a vulnerability index employed was based on five main variables, three of which were previously extracted from the developed GIS; namely, affected area, projected population, and built-up area in each locality in addition to local human development indices and speed of change.

It was found that vulnerability to SLR was found to vary greatly between localities, with significant adverse impacts expected in some localities. Damietta (Domyat), New Damietta (Domyat el Gedida), Ras-el-Barr, Gamasa Khafir-el-Batikh and El Rakabiya were the most vulnerable localities to SLR.

The outcome of the vulnerability assessment work, expressed in the developed composite index, shows diversity in the vulnerability level in different localities. The vulnerability index ranges between 0 and 1, with the former reflecting lowest vulnerability and the later highest level of vulnerability. Ranking all 34 localities according to vulnerability index calculated based on various scenarios shows that Damietta city came in first rank recording an index value ranging between 0.799 and 0.638, according to A1 and B1 demographic scenarios respectively. Such high level of vulnerability can be attributed to the fact that the city was expected to host large population size, built-up area and be affected largely by high level of ground water.

In term of projected population size in the most vulnerable localities, it was found that the population size of the most vulnerable localities, in

2100, will range between 795,969 and 3,547,774 according to scenarios A1 and B2, respectively<sup>2</sup>.

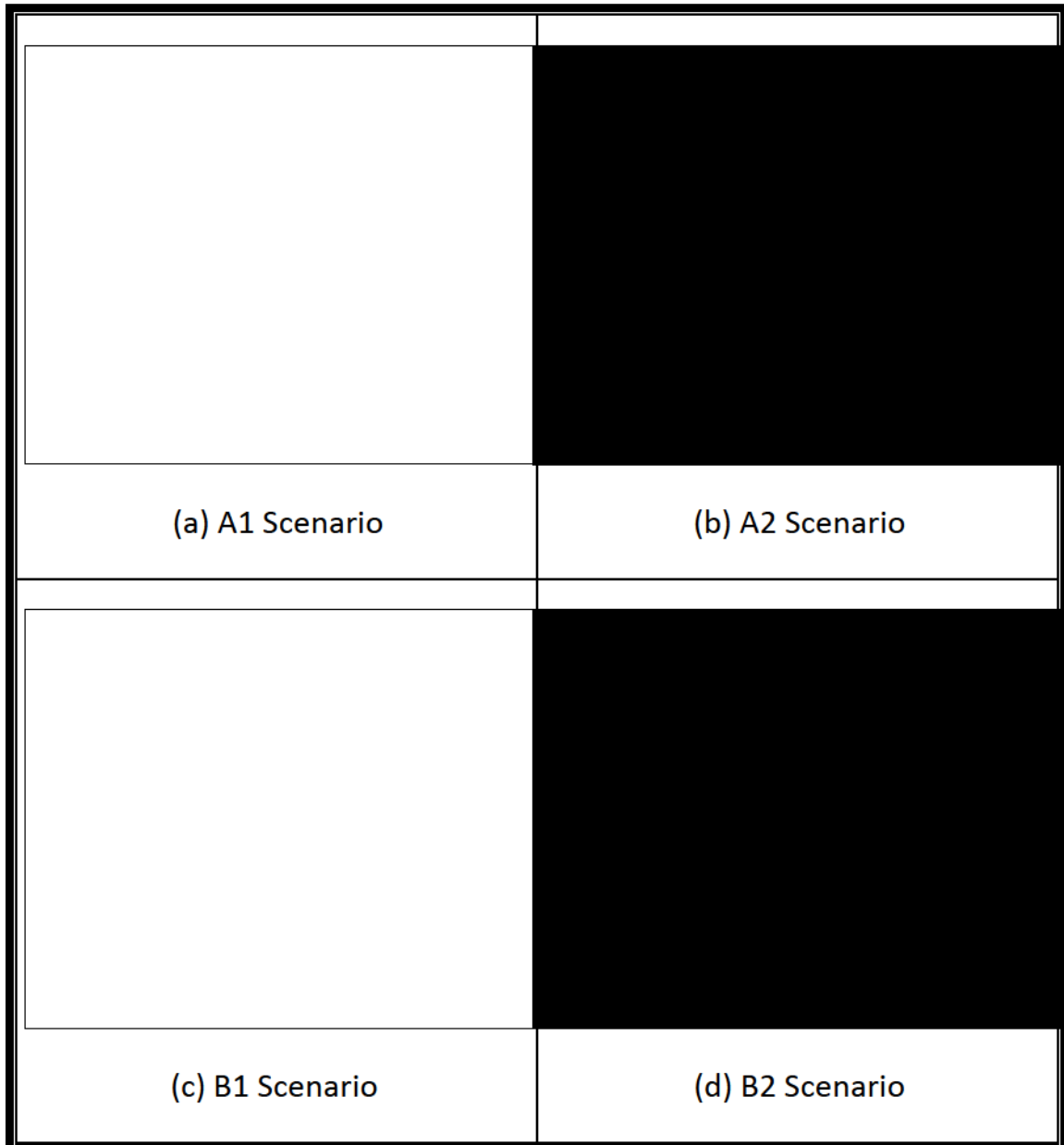
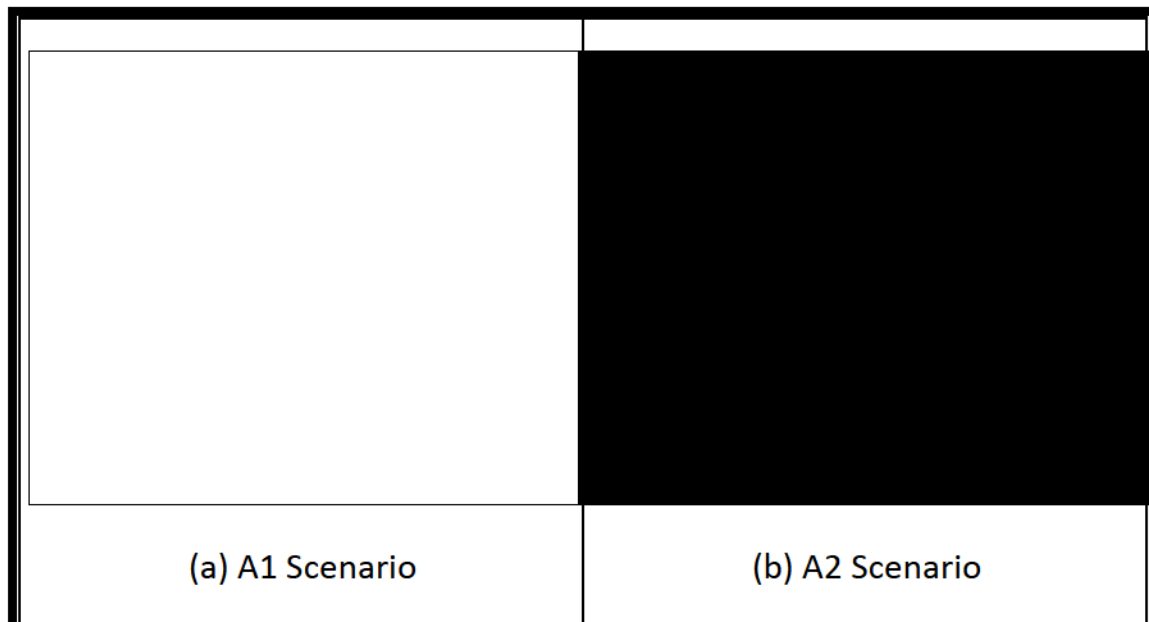


Figure (2): Vulnerability index according to various developed scenarios by 2050

Coastal localities, meanwhile, were found to be highly vulnerable to the impacts of SLR. They include Gamasa el-Balad, New Damietta, As-Senaneyah and Ras-el-Barr again due to affected area and built-up area. This was mainly due to the high level of ground water that was expected to be prevailed there as well as the wide extent of the impacts of SLR in relation to their total areas. From the field work it was noticed that some of these particular cases such as El Rekabyia, was found to suffer from lack of basic infrastructure and services and already having problems with groundwater affecting not only agricultural land but also built-up area. Some of these most vulnerable localities will be covered by detailed, in-depth assessment of socioeconomic vulnerability.

Moreover, it was noted that the vulnerability index decreased remarkably going southward away from shoreline, with most localities located in the southern section of the study area experiencing moderate to low levels of vulnerability (Figures 2 and 3).



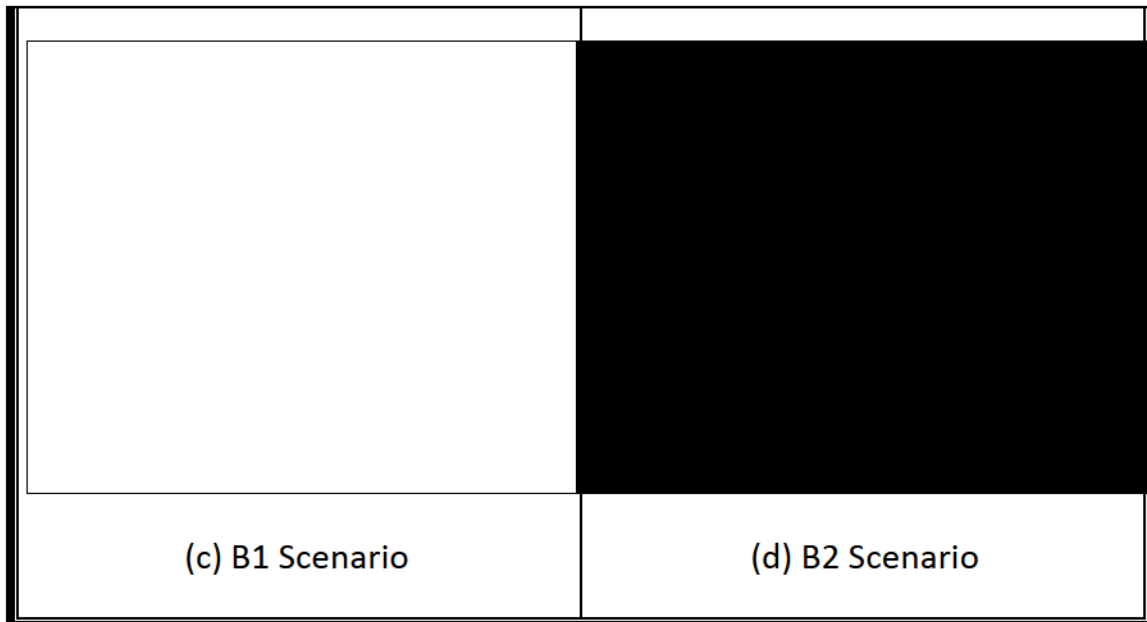


Figure (3): Vulnerability index according to various developed scenarios by 2100

24. **Preliminary assessment of adaptation options to SLR:** Adaptation strategies to sea-level rise were usually presented as one of three generic approaches namely to retreat, to accommodate and/or to protect. The optimal option or mix of options for a given coastal zone strongly depends on the local biogeophysical and socio-economic circumstances, including the anticipated impacts of sea-level rise.

The biophysical assessment of coastal vulnerability has identified three most vulnerable sectors in study area, which include sector 1: located east of Gamasa drain extending 12Km eastward along the Mediterranean coast. Sector 2 was a continuation of sector 1 and extended to the west of the New Damietta City. Sector 5 meanwhile was located at the downdrift side of Damietta harbor extending for 5km eastward to Ras El Barr resort. These sectors have higher rate of coastal erosion and higher level of water table. The predicated future sea level rise would increase the risk degree for these sectors.

No action means impacts were minimized by pulling back from the coast leaving the risky area. Construction expenses for this option were zero, and the environmental impact was fair; i.e. there is no immediate stress upon the environment. However, this option will lead to flooding of land



adjacent to the coast to the east of Damietta port; covering an area of about 0.45 km<sup>2</sup> of a sandy beach important for recreation and tourism. There was also the area to the west of Damietta port a strip of sandy beach and has an area of about 1.55 km<sup>2</sup> will be flooded and lost. Consequently, the resorts and recreation areas east and west Damietta harbor, which have national and local value, will be badly affected and the employee in the tourist sector may also be affected. It was worth mentioning that an attempt was being made to assess the economic value of potential damages (external costs) of such changes on the affected area. This in turn will assist in providing preliminary assessment of the economic feasibility of various adaptation options, including no action.

The high levels of ground water will threaten 242.84 Km<sup>2</sup> of the study area and damage buildings and infrastructure located in the area. Rising water tables will impede drainage of all the agriculture land in the study area and cause salt water intrusion to the ground water aquifer. Agriculture which was one of the main economic activities prevailing in the study area will be damaged. As stated above, an attempt was being made to assess the economic costs of potential damage to buildings and infrastructure located in the affected area.

Based on reviewing the different adaptation options for maintaining shorelines through hard measures and on the previously tested technique for coastal protection with hard structure in Ras El Barr area, erecting detached breakwaters system to protect the beach of "sector 5" may be an appropriate adaptation options to the future impact of sea-level rise. This option was relatively very expensive; the cost of protecting 1 km of the beach with hard structures was between EGP 30,000,000 and 50,000,000. The cost for building 8 units of detached breakwaters system in the area was about 120,000,000 L.E. The environmental impact of this option was positive on the environment. Accordingly shoreline will advance creating new wide area for recreation purposes. Coastal land and development will be preserved; also habitat for coastal species will be conserved.

Another adaptation option may be to trap sand in the area of sector 5 through construction of a groin system – a barrier type structure perpendicular to the shore that traps sand by interrupting longshore sediment transport. This option has good benefits, and was excellent in regard to conserving coastal land/development; and maintains shorelines. Nevertheless, it involves large expenses, needs regular maintaining, monitoring and adjustment. The construction of such groin system will cost about EGP 200 M. Moreover, it will trigger or accelerate erosion and loss of beach habitat on the down drift side.

The soft measures strategy was appropriate for the coastal low areas with eroded shores that located in sectors 1, 2, 3 and 5 (the New Damietta City, Gamasa and east of Damietta harbor). The amount of sand nourishment was calculated to meet the maximum erosion rate ( $-25 \text{ m}^3/\text{m}/\text{yr}$ , **east Damietta harbor**), which was calculated from beach profiles investigated between years 2006-2010. The cost for nourishment at sectors 1- 3, east Gamasa drain (about 17 km length) was about **60 M.LE (50 m<sup>3</sup>/m length x 17000m x70 LE)**. The cost for nourishment at sectors 5 and 6 east Damietta harbor (about 5 km length) was about **17.5 M.LE (50 m<sup>3</sup>/m length x 5000 m x 70 LE)**.

The environmental impact of this option has a positive impact on the environment. Accordingly, shoreline will advance creating new wide area for recreation purposes. Coastal land and development will be preserved; also habitat for coastal species will be conserved.

Accommodation measures meanwhile may include enhancing the efficiency of the Gamasa drain system, which was one of the principle drains in the Nile Delta and consists of several collectors and sub-collectors open drains and pumping stations. However, the siltation of the drain outlet represents a serious problem that increases waterlogging and salinity in the study area. The siltation also at the drain outlet prevents fishermen in the area from moving with their boats through the drain to the Mediterranean. Expected SLR will accelerate these negative impacts on both the agriculture and the fishing sectors. To enhancement Gamasa drain system's functionality, the western jetty

of the drain has to be extended about 100 m seaward combined with periodic dredging of the outlet.

Other measures in this category may also include increasing and enforcing shoreline setbacks to apply a coastal buffer zone, elevating human structures and land surfaces and elevating. There was also the possibility for reinforcing the international road along the Mediterranean coast to act as a second line of defense for the protection of the northern zone of the Delta.

**25. Detailed assessment of the SLR impacts on groundwater quality and level:** The main purpose of the study was to investigate the impact of saltwater/freshwater interface behavior with different Sea Level Rise scenarios and set alternative adaptation options to saltwater intrusion in the study area. In order to fulfill the requirements of the study, several activities were carried out including; collection of previous available hydrogeological studies, field investigations, well inventory and simulation of solute transport model.

For this purpose Visual MOD Flow 4.2 software, SEAWAT, was employed. The model was calibrated with regional and local data concerning groundwater heads and vertical groundwater salinity distribution. Several scenarios were proposed for the expected sea level rise 0.25, 0.5 and 1 meter. The output results indicate that the sea level rise will affect the groundwater aquifer system to a certain limit. The selected simulated time of the model, 30 years, was chosen by trial and error methods until the model reached the steady state. The expected variation of heads after 30 years due to sea level rise would lead to a change in head ranging from 0.1 to 0.5 meters. Also, the change in groundwater salinity will be marked only at a distance of 7 km from the sea (southwards).

Several adaptation measures were proposed and evaluate using the model related to the three expected SLR scenarios. These adaptation measures included artificial recharge through injection wells, impervious barriers (slurry wall), constrains on land-use and groundwater extraction and implementation of local monitoring network.

Socioeconomic impact, of the adaptation measures on coastal settlements indicates that the injection wells contribute in retarding the seawater intrusion. But the disadvantage will be that these injection wells will contribute to raising the groundwater level in the area. Furthermore, increasing the barrier depth delays the salt water intrusion in the coastal aquifer. However, in the far future the subsurface barrier will not be effective whatever the barrier depth would be. This means that blocking the entire thickness of the aquifer to prevent saltwater intrusion would be the most effective option technically. Nevertheless, it may not be viable in practical or economic terms for thick aquifers like the Nile Delta aquifer.

Based upon the discussed outcome of the study, a number of recommendations were proposed to support groundwater work in the study area including:

1. Implementing a local monitoring network to fill data gaps related to groundwater head and vertical groundwater salinity in shallow and deep groundwater aquifer.
2. Conducting a detailed survey work for the study area for accurate simulation of the model, particularly concerning ground surface and depth of groundwater.
3. Using environmental isotopes to study the high saline layers to determine its age, source and recharge mechanism between aquifers and adjacent layers.
4. Implementing a detailed study to determine optimal design for injection wells which will be used to inject treated sewage water into coastal aquifers, in terms of their locations, depths and injection rates to avoid any negative impacts concerning immersion of low land areas near the coast.
5. Studying the technical, environmental and economic feasibility of artificial recharge.

26. **Detailed study of SLR impacts on drainage infrastructure and potential adaptation options:** The Egyptian National Assembly has recently approved new regulations to integrate Integrated Coastal Zone



Management (ICZM) into developmental plans for better management of coastal resources and protection against impacts of climate change. Such a move would require, among other things, strengthening of institutional monitoring capability. It was worth mentioning that adaptation options were generally site-dependent and necessarily involve multi-criteria analysis to assess levels of technology, maintenance, impact assessment and cost. Therefore, the following adaptation measures on the local scale were proposed for possible implementation:

#### *Irrigation and drainage infrastructure*

- Increased drainage discharge flow to drains (surface and subsurface) will result in a corresponding increase in the drain water levels. This increase was expected to affect the main irrigation and drainage infrastructure, specially water treatment plants and drainage pump stations. For example the Sewage Treatment Station of the city of Dumiat El-Ghedidah where the ground level was 1.05 m<sup>2</sup> above MSL.
- The rise of the sea level will affect the feeder to El-Benah Canal from Drain no. 2, where the level of Suction and Delivery Levels ranges from 0.8-0.9 m above MSL. A rise of 0.73 m will require the modification of the Engineering Structural Design to accommodate expected changes.
- The Water Treatment Plant [WTP] of the city of Gamasa which gets its water supply from El-Batekh Canal, where the average ground level was 2.10 m<sup>2</sup> above MSL. Although it was safe from that rise, but the engineering design of the intake should take into account those changes as there was a high possibility of the submergence of its intake due to the effect of the sea level rise.
- Intakes of WTP levels were generally safe from any adverse impacts of sea level rise, i.e. there were no requirements for any changes to the current WTPs.

- Redesigning the whole surface and subsurface drainage network to accommodate the expected additional discharges to maintain sustainable conditions.
- Using controlled drainage subsurface drainage system to provide flexibility for the drainage system to adapt to any unforeseen conditions.

**a. Cost of subsurface drainage adaptation:** Despite that there may be excess water that may enter the drains at different sections and the capability of each section to pass such added discharge, there will be no need to modify the cross sectional area of any of the study area drains. However, dredging was highly suggested to keep the drains as close as possible to their design dimensions.

The cost of dredging 1 m<sup>3</sup> of soil ranges from 10 to 15 L.E., based on the type of dredging technique. The estimated dredging volume for 1 km drain length was approximately 7533 m<sup>3</sup> of soil. The total drains` length was approximately 52.6 km. Therefore, the estimated costs of dredging works in the study area range between L.E. 4.0 and 5.9 Million.

**b. Cost of subsurface drainage adaptation:** The cost of installing a subsurface drainage system ranges between 2300 and 2500 L.E. per feddan. The area served by subsurface drainage system will need to be rehabilitated to accommodate the intensification of the subsurface drainage system



This option was considered the best available tool for protecting the eminent beach of the new Ras-El-Barr resort and the army force resort. It is an already tested technique for coastal protection in the old parts of Ras-El-Barr resort; adjacent to the current vulnerable sectors. The environmental impact of this option was fair, as detached breakwaters system act as a littoral-sediment trap causing advance of shoreline and creating new wide area for recreation purposes. This means that coastal land with great development potentials will be preserved and habitat for coastal species will be conserved. The best advantage of applying this proposed structure in that the down beach of this site ( old Ras El Bar beach) was already protected, therefore, erosion in the down drift side of the structure, as a side effect, will be avoided. This protection (detached break water) system did add vast areas of accreted land to Ras-El-Barr beach and the area has become safer against erosion.

c. Create Dunes System: The study of impacts of sea level rise until 2100 in Gamasa- New Damietta City revealed that in the worst scenarios an area of about 1.55 km<sup>2</sup> will be flooded and the maximum shore line retreat will be 40 m. Hence, protection through Soft Measures could be an appropriate adaptation option for these areas. The cost for sand to be placed on the beach off the sectors in addition to the costs of planting dune grasses and fencing) was estimated to be about L.E. 30 million. There would also be additional L.E. 0.5 million annually for continuous maintenance and plantation. This would involve creating dunes along the backshore of beach, including planting dune grasses and sand fencing to induce settling of wind-blown sands (CoRI 2011). The best advantage of this strategy was in retaining the beach for tourism and recreation purposes. Accordingly, this can provide opportunities for investments and job creation in the tourism sector.

In addition, the following steps should be considered for implementation:

- Enhancing the functionality of Gamasa drain system, the western jetty of the drain has to be extended for about 100 m



seaward. This action would also need to be accompanied by periodic dredging of the outlet.

- Increasing and enforcing shoreline setbacks to apply a coastal buffer zone.
- Elevating human structures and land surfaces.
- Elevating and reinforcing the international road along the Mediterranean coast can act as a second line of defense for the protection of the northern zone of the Delta.

28. **Economic valuation of SLR impacts on agricultural sector:** This study was intended to estimate the economic value of the physical impacts of SLR on agriculture sectors in Ras-El-Barr – Gamassa area. This was meant to assist in assessing the economic feasibility of various adaptation options related to agriculture sector. In order to attain this objective,

The main adverse impact of SLR on agricultural activities was expected to be in the form of higher groundwater levels. Based on the levels of groundwater levels, which were assessed in various points of time in the future, those parts that will have a groundwater table less than 0.5 meter were considered to be among the areas affected by higher levels of groundwater. Such a threshold limit was identified on the basis of the proven relationship between the level of groundwater and crop productivity, where crop productivity declines considerably with higher levels of groundwater.

The estimation of agriculture productivity in the future was carried out under two scenarios for area of cultivated land projections; scenario 1 and 2. While projecting different areas of cultivated land, the two developed scenarios assumed similar crop pattern in the future. The decline in agriculture productivity was valued under each one of the developed scenarios. According to scenario 1, agricultural production value will decrease by as much as 57.4% by 2100 of its current level. Meanwhile, in the case of scenario 2 the agricultural production value will decrease by as much as 66.6% by 2100 of its current level.

The accumulative losses in the value of agricultural production due to higher levels of groundwater as a result of sea level rise was

estimated to be as much as L.E. 9238 and 10179 million up to 2100, for scenarios 1 and 2, respectively. It was worth mentioning that these projected losses in agricultural production represent the case of no action. Such a value may be reduced considerably in case some adaptation actions have been undertaken to reduce the adverse impacts of higher groundwater levels.

**29. Vulnerability and Adaptation Options Workshops:** As part of consultation with various stakeholders, two workshops, on Vulnerability and Adaptation Options Workshops were held on 11<sup>th</sup> - 16<sup>th</sup> of September, 2011 at the Doctors' Syndicate in Ras-el-Barr.

These workshops were meant on one hand to introduce community representatives and various stakeholders to the outcome of the research conducted within the framework of this project. Furthermore, the experience and feedback from community and stakeholders representatives were considered to be of paramount importance for the enhancement of the project outcome. These workshops were also intended by the project to empower the community and create some communication means between concerned authorities with SLR impacts and community representatives.

Accordingly, different stakeholders groups namely; government officials, Non-governmental organization (NGOs), and Community Leaders Committee participated in the workshops with a total of 60 participants. Government officials covered a wide range of sectors including agriculture, environment, irrigation, tourism, education, and housing as well as local authorities. The NGOs were from the Community Development Association, Agriculture Cooperatives, and Civil Society Organizations, while the community leaders committee was consisting of representatives of different communities and sectors.

The workshops involved brief presentations by the project members concerning vulnerable areas to the physical and socioeconomic impacts of SLR. The project members also presented available adaptation options that could be applied in the study area according to their scientific and research studies. The representatives of Drainage Research

Institute (DRI) and the Groundwater Research Institute (GWRI), also, presented the vulnerable areas to the intrusion of groundwater and potential impacts on drainage networks. Both institutions presented the adaptation options related to the groundwater and drainage issues and the total cost to implement them.

These presentations were followed by open discussion with different stakeholders. Thereafter, participants were divided into several groups to share and discuss their experiences concerning potential vulnerability and adaptation measures. They also discussed and provided their opinions and feedback on what project work proposed as possible adaptation options. Furthermore, the participants were asked to present from their perspective the SWOT analysis of current institutional setup regarding its capability of dealing with the SLR and how this could be reconsidered.

Participants were aware about the climate change and SLR phenomena and were interested to receive more information regarding the SLR project and the outcomes of the research and studies conducted in the study area from Ras El Barr to Gamasa. Participants expressed their frustration of having to accept the proposed adaptation options; and others were very pessimistic towards the SLR issue stating that nothing would help in decreasing the gradual raising of the sea level and the expected impact would not be controlled by the offered adaptation options

30. **Validation field survey:** Stakeholder consultation was one the most common participative techniques, that were generally used to involve stakeholders in policy or program formulation and/or evaluation. Stakeholder consultation activities were typically were undertaken to provide stakeholders with an opportunity for early participation in the planning and development of a proposed project. Such participation can lead to improved decision-making by the proponent, while fostering good neighbor relationships with project stakeholders. Accordingly, it was employed in the project in hand to identify priority of action among various adaptation options to the impacts of sea level rise.

The methodology developed for stakeholders consultation concerning adaptation options was three folds; the first of which involved consulting a variety of stakeholders' representatives through three workshops. The purpose of these workshops was to inform the attendees of the results of the project activities in terms of the identified spatial and magnitude scale of impacts, potential vulnerabilities and adaptation options. Thereafter, attendees were asked to provide their views and feedback on each of these aspects. The first workshop included officials from various government agencies at local level as well as local authorities in the area. The second and third workshops were intended for community leaders and representatives and non-governmental organizations present in the area, respectively. This was to be followed by two more consultative activities; a field survey and a set of workshops to validate the results obtained during the earlier workshops.

The report in hand was concerned with planning, implementing and analysis of the validation field survey, beginning by discussing the rationale for the field survey. This was followed by description of the field work implementation and thereafter the results obtained through this field work.

The main purpose of the field work covered by this report was to assess the outcome on potential adaptation to SLR consultation workshops conducted earlier in the project on the most appropriate adaptation options to deal with impacts of expected SLR in the Gamassa – Ras El Barr area.

The validation field work was intended to target various groups of stakeholders including farmers, fishermen, local residents, officials ...etc. These various groups of stakeholders covered in the field work were identified on the basis of the stakeholder analysis report that was prepared at earlier stages of the project. Simultaneously, a list of various adaptation options was developed, based on the outcome of the consultation workshops, details of which were contained in previous technical reports.



To conduct such validation work, a variety of approaches could be employed. The selection of the most appropriate approach depends, among other things, on various socioeconomic conditions and capabilities of different stakeholders groups. Yet, due to similarities in socioeconomic conditions of different stakeholders groups, a common approach was applied, using face-to-face individual interviews. In order to ensure organized and effective data gathering were undertaken through interviews using a questionnaire form. Also, different questionnaire forms were designed to various groups of officials in different sectors; namely, agriculture, fisheries, roads, and NGOs.

It should be noted that the cases interviewed were selected through stratified random approach. This is because such an approach provides an equal opportunity to different individuals of the target population, while proper representation of different localities within the project area.

The field survey was conducted in December 2011, covering 280 cases in five localities namely El Senanyia, new Damietta, Kafr El Bateikh, Gamasa and El Rekabiya. Thereafter, filled questionnaire forms were tabulated and the data and information were collected. Moreover, 75 cases of officials from various departments of different sectors were covered during the field survey.

When asking the sample individuals on the adverse impacts of expected sea level rise on the project area and the implications of these impacts on their life, it was found that less than one-half of the sample (43.93%) had no idea about the impacts of SLR, while 56.07% had a good idea about these impacts.

An attempt was made to identify the factors influencing the awareness of the cases covered by the survey about SLR impacts. Such an assessment examined possible relationship between the educational status and/or occupation of the respondents and the level of awareness about SLR impacts. Concerning the influence of educational status of the respondents it was noted that large proportions of those having no idea on SLR impacts had various educational statuses including,

university graduates (53.85), followed by illiterate (51.06%), and then secondary school graduates (48.33%). Those who can read and write had, nevertheless, noticeably lower proportion of those who had no idea on SLR impacts.

These figures suggests that there were no clear association between the level of awareness among respondents about SLR impacts and their educational statuses , Moreover, this large proportion of cases that suggested they had no idea about SLR impacts suggests that more effective means of communication with the residents need to be considered. This was especially true with the size of the study area and its population size.

Also, it was found that the awareness levels about SLR impacts varied noticeably among various groups with different occupations. In this respect, the higher awareness was recorded among Students, farmers and workers, with about 80%, 72.41% and 63.73% of their total number, respectively

The awareness level about SLR impacts was found noticeably high among officials, where all the respondents of officials had a good idea about these impacts.

Respondents were asked to identify the most significant impacts of SLR on the study area, from a list of various SLR impacts, 92 of the cases suggested the decline in agricultural production as the one. Furthermore, about 92.14% of the respondents stated that they would be expected to be vulnerable to such impact. This was followed by damaging building foundations, damage roads, decline in fish production, loss of real estates and re-settlement of local residents.

Among officials of the agricultural sector, it was found that 94% thought that the expected SLR will lead to Loss of agricultural land, while 67% believed that there will be a need to re-allocate the residents of the study area due to the impacts of SLR.

Similarly, 95% of the fisheries officials thought that the expected SLR will lead to loss of aquaculture and declining fish production in the study area. Compared to agricultural officials higher proportions of fisheries officials (77%) thought expected SLR may lead to re-allocation of the residents of the project area.

Moreover, all NGO representatives thought that the expected SLR will adversely affect building in the project area, fish production and roads. Also, they thought that it may lead to inundation of economic assets in the project area.

As for officials of road sector, it was found that while all of them believed that the expected SLR will adversely affect building and roads in the area, a relatively low proportion of those officials thought that there will be a need to re-allocate the residents of the project area due to SLR.

Concerning the level of awareness of the respondents about potential adaptation options to SLR, it was found that about one-half of the sample (53.57%) had no idea about any adaptation options. This, again, suggests that more effective means of communication with the residents need to be considered. Once more, educational statuses of respondents had no significant impacts on their awareness about the adaptation options to SLR. For example, both illiterate and university graduates had the lowest level of awareness, with 60.64% and 61.54% of each group, respectively. Meanwhile, the highest levels of awareness were recorded among those who can read and write, with 62.50% of them having reasonable idea about potential adaptation options.

The level of awareness was found to be relatively high among some groups than others, for instance farmers and workers, with (55.17%), and (50.98%), respectively. The groups of respondents who recorded lowest levels of awareness about adaptation options included students, retired people, and housewives, with 20%, 25%, and 33.33% of these groups, respectively

Generally, assessment of the association between the level of awareness of various groups about the impacts of SLR and their awareness about

adaptation options, suggested that no significant correlation existed. For instance, the awareness with the SLR impacts was highest among students, whereas their awareness about the adaptation options was the lowest compared to other groups.

This conclusion was emphasized further when the correlation coefficient between level of awareness about impacts of SLR and awareness about adaptation options was calculated. The correlation coefficient, found to be +0.1160, suggested that insignificant interrelationship between the awareness about SLR impacts and awareness about adaptation options among respondents in different groups.

Similarly, the level of awareness of the official covered by the survey about potential adaptation options to SLR was found to be low. For example, about 75% and 83% of the agriculture and fisheries officials, respectively suggested adaptation options irrelevant to the agriculture and fisheries sectors and could not deal with the adverse impacts of SLR on the two sectors in the area.

Concerning the various adaptation options, respondents were asked to prioritize a given list of potential adaptation options including:

- Improving existing drainage system to increase its efficiency;
- Modifying current irrigation practices and adopting more conservative systems such as sprinkler and drip irrigation;
- Constructing protective engineering works e.g. seawalls;
- Changing the building code to deal with potential of SLR impacts on building foundations; and
- Changing crop patterns to crops more resistant to higher groundwater level and salinity intrusion.

Generally, constructing protective engineering works came in as the top priority action, selected as number 1 by about 40% of the respondents. This was followed by improving existing drainage systems and increasing



its efficiency, which came in the first priority for about 34.29% of correspondents.

It should be noted, however, that only 218 of the respondents prioritized a complete set of adaptation options. For those who prioritized a complete set of adaptation options, constructing protective engineering works and improving drainage system came in as the 1<sup>st</sup> and 2<sup>nd</sup> priority, selected by 68.35% and 63.77% of all respondents, respectively.

Meanwhile, some adaptation options were found to be less of a priority to respondents, for instance changing current irrigation practices, which came in 3<sup>rd</sup>, 4<sup>th</sup>, or 5<sup>th</sup> priority, out of five options, for about 71.09% of the total sample. Changing irrigation practices into sprinkle or drop irrigation could not be adopted in the project area due to the soil characteristics which need to be irrigated through flood irrigation system.

The same happened with changing building code with 70.18% of total respondents suggesting that change building code was less of a priority as it came in the 3<sup>rd</sup>, 4<sup>th</sup>, or 5<sup>th</sup> priority. This was because local residents already carry out certain measure to protect their building foundations from the implication of high levels of groundwater table, which were already high in the project area. Also, change current crop patterns came in the 5<sup>th</sup> priority according to 50.46% of the total sample, which was due, according to the respondents, to the fact that current crops were grown because they could resist higher groundwater level.

As for officials, it was found that while engineering works had high priority level for major percentage (76%) of the agriculture sector, improving drainage system and crop patterns had high priority level for low proportions (24%) of the agriculture officials. Meanwhile, improving irrigation system is considered to be irrelevant in the context of the project area, where none of the agricultural sector officials assigned it high priority.

At the same time, engineering works had the first priority for about 77%, 50% and 54% of the fisheries officials, NGOs representatives, and officials of road sector, respectively.

The outcome of this validation field survey suggests that some of the proposed adaptation options were found to be more desired by the residents, such as the case of constructing seawalls. This was associated with their firsthand experience about the seawall that was constructed along the coast of Ras-el-Barr. Other adaptation options were less desired by the residents, which was usually associated with their practicality for the study area and their style of work and life. For example, changing crop patterns was not considered as a viable adaptation option, as suggested before, because current patterns were considered to be the most resistant to high levels of groundwater.

Further consultation was needed to actually capture the priorities for action from the perspective of different stakeholders. For this purpose, another survey was being conducted with different officials to identify and prioritize potential adaptation options to SLR.

**31. Validation workshops:** To complete the work of the project team in the development of adaptation options to the impacts of SLR on the Nile Delta coastal zone, a field survey was conducted to receive the community's feedback on the developed adaptation options. The field survey was conducted by IGSR and targeted different community groups and stakeholders in the six most vulnerable villages. The outcome of this field survey was presented in the so called "Validation Workshops", conducted from the 20<sup>th</sup> to the 23<sup>rd</sup> of February 2012. Validation Workshops were held for four days in the project's areas; namely: Ras El Barr, Ezbat El Borg, El-Khyata and El Shiekh Dorgham. The objectives of the workshops were to present the survey result and receive feedback regarding the validity of the proposed adaptation options as well as acknowledging any alternative options from the workshop participants' perspectives.

In most of the group discussions the project team started with a presentation portraying the project study area that extends from Ras El

Bar to Gamasa, housing a large population and including many agricultural and industrial lands. The presentation showed that the sea level was expected to rise to 73 cm by 2100, whereby the consequences of such an occurrence include the fact that the land located along the shoreline is expected to flood in the absence of protective methods. These threatened lands represent only 2.4% of the study area and therefore, flooding was considered a minor risk. The major risk was the gradual increase of groundwater levels. The presentation clarified that a large area was likely to be affected by the high levels of groundwater and consequently, will have a negative effect on the agricultural lands and their productivity, as well as the foundations of buildings.

In order to identify the most vulnerable areas to groundwater intrusion, a vulnerability measure was developed. This vulnerability measure was based on four main factors: the current level of groundwater, the expected population size by 2100, the area of vulnerable localities and the socio-economic conditions of the population. According to the vulnerability measure, vulnerability increases at the northern side of the study area and decreases south of the study area. Furthermore, the project team presented two scenarios to calculate the approximate loss of agricultural productivity by 2100 in accordance with current prices. The first scenario was done with the same agricultural areas that were present today, while the second scenario was done with a decrease in agricultural areas due to urban expansion. The project team then illustrated these scenarios using Kafr El Batiekh as a model. They also put together two scenarios to estimate the approximated total cost of loss of urban building by 2100 in cash. The first scenario was the cost of renewing the current buildings, whereas the second scenario was the cost of establishing new buildings through using protective methods.

Finally, the project team presented a number of adaptation options that were suggested by different community groups and stakeholders. These include:

- The development of new crop strains;
- The establishment of a new drainage network;

- Changing irrigation methods used; and
- Setting specific standards for construction.

**Feedback on the Adaptation Options:** Based on the presentations of the project team, the participants started to discuss the advantages and disadvantages of the adaptation option provided. The results of discussion were as follows:

1. Introducing new crop strains that were resistant to high levels of groundwater and high degrees of soil salinity as well as creating new genetically modified crops that can respond to the gradual change of groundwater level, were considered effective options that will help in facing the impacts of SLR and increasing agricultural productivity. Farmers have already started using crops such as rice and clover that can adapt to the high levels of groundwater as well as the high degree of salinity. However, this option was not effective in the cities where fishing was the solely source for fishermen's livelihoods.
2. Establishing a new drainage network is considered a big risk for buildings. This was largely due to the fact that when drainage networks withdraw more drainage water beneath the building, it causes the erosion of the sedimentary layers of soil and makes it more vulnerable to collapsing, resulting in the deterioration and possible collapse of buildings. In addition, Ezbat El Borg was considered an island, surrounded by El Manzala lake at the east, the Nile River at the west, and El Ratma canal at the south; there is thus no specific area to discard wastewater.
3. Changing irrigation methods used from flooding irrigation to sprinkle and drip irrigation was not a practical option. This was because the soil suffers from high levels of salinity, caused by groundwater intrusion. In addition to the economic burden added to farmers However, altering irrigation methods was still important to control the current misuse of flooding irrigation and the waste of water it entails.



4. Regarding the setting of standards for construction of new establishments, the foundations of buildings currently extend to a depth of 50 cm. the buildings will be affected by level of groundwater beneath them. If the foundations of buildings were extended beneath groundwater levels, there was no risk to the buildings. However, if the foundations were extending above groundwater level, the buildings were more likely to collapse. Additionally, buildings that were located above the ground level with no proper foundations were highly threatened by flooding.

It was therefore important to use protective methods while building, such as using water resistant cement, isolating materials and setting foundations beyond the groundwater level. Moreover, these protective methods should be involved in construction licensing as a condition for any individual or company wanting to construct new establishments. The concerned monitoring authority must enforce penalties for those who violate the construction licensing conditions. Furthermore, contractors and consultants should be held responsible for any damages or accidents that might occur due to faulty construction. This should, however be applied after the identification of the current levels of groundwater in each locality in Damietta governorate.

**Questions and Answers:** Participants were interested in learning more about the project in terms of the geographical nature of the selected study area and relevant statistics, indicators and measuring tools, types of research, expected results, suggested adaptation options, advantages and disadvantages of each adaptation option, alternative solutions, and the extent of communication between the research team and the executive authorities. The participants asked several questions that portrayed their interest in the SLR phenomenon and its impacts; and the project team responded to their questions with simple scientific answers.

**Suggestions regarding the Adaptation Options proposed:** During the workshop participants made a variety of suggestion regarding the adaptation options proposed:

- It is important to present the proper scientific information regarding the impacts of SLR on the Nile Delta coastal zone to the stakeholders and decision makers instead of having them get inaccurate information from the media, which claims that the Nile Delta will soon be completely flooded.
- Since the prices of buildings as well as agricultural land were quite variable, it is better to calculate the approximate total loss of agricultural productivity and infrastructure by 2100 in a percent rate rather than in a cash sum figure.
- Since the data on the number of buildings and the populated areas in Ras El Bar were available at the City Council, a case study on Ras El Barr can be conducted to estimate the total loss in terms of buildings, especially those located along the shoreline.
- Deep gaps were created between the wave barriers due to the movement of waves and whirls. When the waves go through these gaps, the erosion of beaches increases. Therefore, setting new barriers between the existing wave barriers will prevent the waves from entering in these gaps and decrease the erosion of beaches.
- To prevent any accidents that might happen because of deep gaps, it was important to warn people to keep away from these gaps by putting warning signs.
- The participants suggested that the Institute of Marine Science contribute with research and scientific opinion regarding the impacts of SLR on fishing activities.
- Drainage and groundwater can be distilled and used in the agricultural processes in order to become consumed, thereby minimizing its quantity as well as its negative impacts on agricultural lands. However, it was important to note that groundwater mainly consists of waste water, pesticides and

chemical wastes, which have considerable negative effects on agricultural land.

- A drainage network can be created around each locality. When wastewater levels rise to a certain point, pumps were activated and start to discard the wastewater automatically. Nonetheless, some localities such as Ezbat El Borg were surrounded by the sea, the Nile and navigational canals and thus, do not have any place for the safe disposal of wastewater.
- While a research entity works on developing research studies, another entity should work in parallel to figure out solutions based on the research results.
- Depending on the level of groundwater, fish farms (similar to those fish farms developed in El Borolos Lake) can be introduced as an adaptation option. This would, however mean that the population's activity would change from agriculture to fish farming.

**Recommendations for the project team:** Workshop participants made several recommendations to the project team for them to take into consideration and/or to take forward with the relevant authorities:

- An abstract on the SLR project including the involved partners, designated study area, activities such as workshops and seminars, conducted research in the project's study area and its outcomes, should be distributed among the participants before conducting the focus group discussions. This would be in favor of providing them with sufficient time to acquire and grasp more information on the project as well as prepare questions for discussion with the project team.
- Decision makers including the City Council staff to know the results of the research and studies conducted in the study area in order to compare between the scientific points of view and the current situation in their locality.

- It was important to conduct a research study on the appropriateness of setting new barriers between the existing wave barriers in Ras El Barr that might help in decreasing the erosion of beaches. This study was to rely on models corresponding to the geographical and coastal nature of Ras El Barr.
- Data will be sent to the City Councils regarding the current level of groundwater in the study area. This data will help determine the vertical change of groundwater under the foundation of buildings as well as its impact on agricultural lands and productivity. Therefore, it was important to send this data to the City Councils and Local units.
- An Environmental study should be conducted in every locality in Damietta governorate. The necessary data and statics are available at the City Councils and Local Units, but need to be updated.
- It was important to raise the awareness of the community regarding the impacts of climate change and SLR as well as share the results of the research and studies conducted in the Project's sites.
- Networking between the different research institutes, executive authorities, and syndicates was crucial in order to unify their efforts and act towards facing the impacts of SLR on the Nile Delta coastal zone.
- This project should be modified to become a national endeavor whereby all the concerned authorities and the different community groups focus on addressing the physical and socio-economic impacts of SLR on the country. SLR project booklets can be sent to the National Council and concerned ministries as a first step achieving this.



- Decision-makers should acknowledge the assumptions and expected results of the impacts of SLR based on all six studied scenarios, not only the A1F1 scenario studied by CoRI.

### 32. Final project workshop:

**Conference opening speeches:** Mr. Ahmed Farouk, Program Manager at CDS and conference facilitator, opened the workshop with a welcome note to the participants, thanking them for their attendance and their interest in and concern with climate change and the impact of SLR at the national level. The welcoming note was followed by a speech by Dr. Ebrahim El Shennawy, Director of CoRI in which he emphasized the fact that the Ministry of Water Resources and Irrigation observed the potential impact of SLR on Egypt's coastal zones and became more interested in conducting research and developing adaptation options to mitigate the effects of this phenomenon on coastal zones. Moreover, Dr. El Shennawy illustrated that the SLR project was unique in terms of its project approach whereby scientific research and studies implemented by CoRI and IGSR research team was conducted in parallel with stakeholders and community consultation.

Following the speech of the director of CORI , Mr. Karimo, IDRC Regional Director, addressed the participants. He pointed out that climate change was a global issue affecting the most vulnerable community groups in Egypt and worldwide. And to address this IDRC established a Climate Change research program to strengthen the capacity of vulnerable groups dealing with the impact of climate change. Mr. Karimo elaborated that the SLR project results proposed a new model for adapting to sea level rise in the Nile Delta.

The speech of Mr Karimo was followed by the speech of Dr. Guy Jobbins, IDRC Senior Program Officer. He stated that the cooperation with the main project partners was very informative. He pointed out that the research project focused on investigating the likely impacts of SLR on the Nile Delta coastal zone through the involvement of multi-stakeholders during the project period. This approach guaranteed the selection of appropriating adaptation options according to the natural geography

and economic conditions of the country. Additionally, the SLR project raised the awareness of different community groups of SLR at several project's sites.

Dr. Mohamed Fawzy, represented Dr. Shaden Abdel Gawwad, Chairperson of the National Water Research Center in his speech, and clarified that climate change and SLR were crucial problems that required more attention and efforts by the relevant authorities. He explained that global warming as a result from the high emission rates of Carbon Dioxide gas has led to the melting of ice polar and consequently the increase of sea level. Additionally, he stated that the National Water Research Center played a great role in dealing with the impacts of climate changes and SLR through the participation in research projects addressing those phenomena. Dr. Fawzy then gave a brief summary regarding the role of CoRI in the SLR project and thanked all the project partners for their effective efforts in the SLR project.

Last but not least, Mr. Ali Mokhtar, Chief Executive Officer of CDS, emphasized in his speech the importance of the project in terms of the implementation of scientific research and socio-economic studies by the project team. The involvement of multiple stakeholders from different entities and raising the community awareness regarding climate change and SLR were essential in the development of effective adaptation options to deal with the potential impacts of SLR.

***Causes of SLR and its potential impacts on the Nile Delta coastal zone:***

Dr. El Shennawy, afterwards, delivered his presentations on the main causes of SLR and its potential impacts on the Nile Delta coastal zone. He explained global scenarios of climate change and compared them to local studies, impacts of climate change from global and local perspective, role of CoRI in calculating total affected area and its percentage to the Nile Delta area. He also displayed pictures from sites where actual studies were previously implemented.

***Presentation of project results by each project partner:*** Session two started with a presentation of each partner explaining its role in the project and the main research/project results.

Mr. Ali Mokhtar introduced the Center for Development Services and its work fields. He explained the role of CDS in terms of technical assistance to CoRI and IGSR team. CDS provided training to the CoRI and IGSR team to involve the stakeholders more effectively and supported CoRI and IGSR in the organization and facilitation of several workshops, the implementation of socio-economic study in the project's sites, establishment of the community leaders committee, stakeholder analysis and development of the stakeholder communication plan

Dr. Abo Bakr, CoRI Director Deputy, explained the role of CoRI in terms of the research into the physical impacts of SLR in the study area. He presented the areas that were expected to be inundated by SLR, physical adaptation options and its advantages and disadvantages such as setting water barriers, vertical barriers, and nurturing coasts with sand dunes periodically. Dr. Bakr then presented the drainage and groundwater adaptation options developed by both of the Drainage Research Institutes (DRI) and Ground Water Research Institutes (GWRI).

After Dr. Bakr's presentation, Dr. Mohamed Abd Rabo, project manager and IGSR representative, presented the socio-economic impacts of SLR on the project study area, the indicators of identifying the socio – economic vulnerability assessment, and the suitable adaption options to adopt with the high levels of sea and groundwater.

### **Comments and Recommendations by the conference participants**

Participants were interested in the SLR project results presented and made several comments summarized as follows:

- Many people do not acknowledge any practical solution to face the physical and socio-economic impacts of SLR. It was, therefore, important to inform the community regarding the project's objectives and provide them with simple practical solutions such as fliers with some drawings illustrating climate change and SLR issues.

- An independent consultancy and executive authority should be established to follow up on the needed procedures for the implementation of project's outcomes and recommendations.
- External funding agencies such as JICA should be requested to support the research institutes financially to help the implementation of research projects..
- Agricultural extension provides farmers with some but limited technical advice to help them adapt to high level of groundwater and reduce production losses. The executive authorities should cooperate and support agricultural extension with extensive recommendations that support farmers to overcome the likely impacts of SLR on their agricultural lands and productivity.
- Participants were interested to know the challenges faced by the project team in implementing this project. The response of the team was that the main challenge was the communication and finding common grounds amongst the project partners and the communication with the variety of stakeholders in the project.
- The relevant authority should forbid selling sand dunes that represent a natural protection for the coasts.
- As the project reached the targeted results and achieved its objectives, the following was recommended by the participants:
  1. Ensuring application of the project's results and that the project's outcomes reach the executive authorities to be implemented before any further unexpected risks;
  2. Informing the media with the recent updates of the project's research studies regarding climate change and SLR; and
  3. finding further funds to implement the adaptation options



## **VI. Project Outputs**

### **1. Capacity building (training)**

- a. Center for Development Services (CDS), A capacity Building Program for CoRI and IGSR,
- b. Training of Trainers for CoRI and IGSR Staff

### **2. Reports**

- a. Coastal Research Institutel (CoRI), Bio-physical baseline study report, August 2009
- b. Institute of Graduate Studies and Research, (IGSR), Socioeconomic baseline study report, August 2009.
- c. IGSR, Development of a Geographic Information System for the study area report, August 2009
- d. CDS, Stakeholder analysis report, August 2009
- e. CoRI, Institutional and legal framework of coastal zone management report, August 2009.
- f. CDS, Communication strategy report, August 2009
- g. Inauguration meeting report
- h. CDS, A study on socioeconomic aspects of the Nile Delta coastal zone, January 2010.
- i. CoRI, Downscaling and estimating SLR scenarios until year 2100 report, February 2010.
- j. IGSR, Theoretical and analytical framework (socioeconomic vulnerability and economic valuation), January 2010.
- k. CDS, Theoretical and analytical framework (stakeholder analysis and participation) report, January 2010.

- l. CoRI, Review of possible adaptation Options to the Impacts of SLR in Coastal Areas report, November 2010.
- m. CoRI and Groundwater Research Institute (GWI), Impact of Sea Level Rise on Groundwater Elevation and Salinity Intrusion: Vulnerability Assessment, August 2010.
- n. CoRI and Drainage Research Institute (DRI), Vulnerability of Drainage System Infrastructures to Expected Mean Sea Level Rise and Salt Balance of (Ras El-Bar – Gamassa Area) report, August 2010.
- o. CoRI, Changes in Wave Climate and Sediment Transport within the study area report, August 2010.
- p. IGSR, Demographic and land use projections report, August 2010.
- q. IGSR, Socioeconomic vulnerability at localities level report, February 2011.
- r. CoRI, Preliminary assessment of adaptation options to SLR report, February 2011.
- s. GWI, Detailed assessment of the SLR impacts on groundwater quality and level report, August 2011.
- t. DRI, Detailed study of SLR impacts on drainage infrastructure and potential adaptation options report, August 2011.
- u. CoRI, Reviewing coastal adaptation options report, August 2011
- v. IGSR, Economic valuation of SLR impacts on agricultural sector report, October 2011.
- w. IGSR, Validation assessment report, December 2011.
- x. CDS, Validation workshops report, February 2012

- y. CDS, Final workshop of the project, April 2012.

### **3. Workshops**

- a. Team members meeting
- b. Focus Group Workshops
- c. Vulnerability and Adaptation Options Workshops
- d. Validation workshops
- e. Final project workshop

### **JOURNAL ARTICLES & CONFERENCE PAPERS**

- Abdrabo, M.A. and M. Hassaan, 2010, Adaptation to the impacts of sea level rise in the Nile Delta coastal zone, Egypt project, A presentation made at Coastal Zone Canada International Conference 2010, held in Charlottetown, Prince Edward Island, 25-29 July 2010.
- Abdrabo, M.A. and M. Hassaan, 2010, Assessment of socioeconomic vulnerability to SLR using GIS: Damietta, Egypt, A paper presented at the Deltas in times of climate change, held in Rotterdam, on 29 September – 1 October 2010.
- Elshinnawy, I.A., and Abayazid, H. O., Vulnerability Assessment of Climate Change Impact on Groundwater Salinity in the Nile Delta Coastal Region-Egypt , Conference on Coastal Engineering Practice: Engineering Sustainable Coastal Development , August 21-24, 2011, San Diego, California, USA

### **M.Sc. Theses**

- **M.Sc. Thesis entitled** “Economic valuation of potential impacts of SLR on Agriculture sector Case study: Gamasa –Ras El Barr

coastal area”, Institute of Graduate Studies and Research, Alexandria University.

- **M.Sc. Thesis entitled** “Economic valuation of potential impacts of SLR on urban areas Case study: Gamasa –Ras El Barr coastal area”, Institute of Graduate Studies and Research, Alexandria University.
- **M.Sc. Thesis entitled** “Assessment of socioeconomic vulnerability to Sea Level Rise Case study: Gamasa –Ras El Barr coastal area”, Institute of Graduate Studies and Research, Alexandria University.

### **Others**

- Website development for the project
- Articles in the press

## ***VII. Project Outcomes***

### **1. Improved awareness:**

Due to the various workshops and meeting held with different stakeholders; local residents, officials and community leaders, in the study area, awareness was raised

This involved awareness workshops about climate change and its potential impacts in general. There were, also, workshops to present the results of impact identification and magnitude assessment in the study area as well as potential adaptation option to sea level rise.

Due to these activities climate change and sea level rise became one of the hot issues in the area and there were questions about what could be done in terms of individual adaptation efforts.



This was revealed through requests by individuals and officials for the results of the studies implemented within the project, so that they can use them to inform higher levels of the decision-making process.

## **2. Improved community participation**

It is worth mentioning that all the workshops and the community group work during the whole duration of the project did not provide any financial compensation to the participants. Still, the level of participation did not diminish, which partly reflects high levels of the willingness of different stakeholders to participate in the project activities.

Additionally, proper identification and integration of various stakeholders groups in the project activities from early beginning enhanced community participation

Moreover, the workshops implementation format and facilitation encouraged participants to express their views meant that they felt the ownership of such activities and that their voice can make a difference.

Such high involvement meant that the potential for identifying more realistic and appropriate options for adaptation, and assessing the extend of externalities and means of mitigating or compensating for them could be enhanced.

## **3. Developed a list of community-based adaptation options**

Through the participation of various stakeholders in project activities and trust built through community interactions with researchers and stakeholders at various levels, a list of most potential adaptation options was developed. For instance, local community and officials were consulted on various adaptation options through a validation field survey.

Such a wide participation of different stakeholders did assist in identifying potential impacts of various adaptation options on different stakeholders groups. This, in turn, provided some insight into the possible trade-offs between the benefits and costs of such adaptation options.

For example, transformation of some farmland in the coastal area into aquaculture could adversely affect adjacent cultivated land.

Similarly, other adaptation options, such as changing crop patterns to more resistant crops, was found to be already implemented in some parts of the study area, which were already suffering from high levels of groundwater.

#### **4. Valuing the impacts of sea level rise at local level**

The main message that the project team felt that should be delivered to decision-makers is that climate change is not an environmental issue, rather it is a development one.

For this message to be adopted by decision makers, potential economic impacts of climate change and sea level rise on different sectors needed to be estimated and highlighted. For that purpose the monetary value of impacts of sea level rise in particular high levels of ground water on agricultural activities as well as real estate in the project area were estimated.

Such an economic valuation may contribute to more informed decision-making process and promote decision makers to adopt more proactive approach to deal with climate change impacts.

#### **5. Reduced vulnerability to SLR and risks are averted**

As mentioned before that project activities contributed largely in improving the potential for adaptation to SLR through the identification of adaptation options and the methods for selecting the most viable of these options. This, consequently, contribute to

national level stakeholder buy-in, which can support further work considering the impacts of climate change on the Nile Delta such as the GEF project.

In this context, the project activities succeeded in identifying the most vulnerable parts of the project area and developing most effective adaptation options. Such a proactive approach to deal with the implications of climate change can contribute largely in averting risks resulted from climate change.

## **6. Capacity building**

Concerning researchers and members of the research team, a wide range of training activities targeting researchers of Coastal Research Institute (CoRI) and the Institute of Graduate Studies and Research (IGSR) staff were planned and conducted. For instance, a one-week program was prepared to build the capacity of CoRI and IGSR staff on managing focus group and communication.

Also, due to the adopted approach within the project that based on multi-disciplinary work approach, members from different partners were exposed to new experience and disciplines while working in this project. For instance, CoRI staff have been always mainly concerned with the physical aspects of the climate change and sea level rise. IGSR and CDS members were more interested in socioeconomic aspects of the same topic. Due to the work of the project, the perspective of the three partners became wider and a common language was developed.

Moreover, the project provided three M. SC. Scholarships for IGSR students. These scholarships provided them with the chance to experience research project works and team experience.

As for officials and decision-makers, through their participation in various project activities, gained adequate information and skills that enhance their knowledge and participation capabilities to deal with climate change and their implications.

## 7. **Protecting community assets**

Through the development of most effective adaptation options **infrastructure** and other investments and the vulnerability of these assets to the implications of the climate change reduced considerably.

Also, it can be argued that the project has played a crucial role in changing attitudes and building awareness amongst policymakers. In this respect, the project provides a success story in terms of linking research cycle and policy-making cycle. This is especially true when considering the results of this research projects will feed in A GEF project concerned with implementation of some adaptation options along the coastal area of the Nile Delta.

## ***VIII. Overall Assessment and Recommendations***

The project can be considered as the first attempt to implement a multidisciplinary research work involving three partners with different background and interests.

The project, to great extent, attained its overall and specific objectives. In order to maximize the outcome of this project, further work should be considered, for example, there is a need to:

- Assess potential community needs for community/ individual level adaptation options. On the other hand the community and individuals should be clearly informed by potential adaptation options from technical as well as economic point of views. This may contribute, finally, to develop most appropriate adaptation options.
- Value the impacts of sea level rise on other vulnerable sectors such as aquaculture. This, in turn, can lead to more informative decision-making process. This, firstly, requires exploring the



physical and biological impacts of sea level rise on aquaculture activities in the coastal area of the Nile Delta.

- Investigate some other soft adaptation options such as wetlands.
- Create an effective interface to link between research cycle and policy-making cycle.
- Maintain and strength the communication channels that developed between the research cycle and the local community
- Target most vulnerable parts of the project area to deal with poverty, education and other determinants of vulnerability to reduce levels of vulnerability to sea level rise.
- The project results can contribute largely in formulating a strategic future development plan of the Nile Delta coastal zone. In this context, the approach adopted in the project; participatory approach, could be replicated in need assessments and alternative evaluation
- Also, the approach adopted in the project could be replicated in other project and plans for coastal area management.