AN INTEGRATED WEB MAPPING SOLUTION TO ASSESS THE EFFECT OF SLR ON THE NORTHERN COAST OF EGYPT – EGSLR

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ABSTRACT

In its 2007 assessment, the Intergovernmental Panel on Climate Change (IPCC) declared the Nile Delta one of three sites on earth that are most vulnerable to sea level rise. The Panel projected a global average surface temperature will increase by 1 to 3.5C with an associated rise in sea level of 15 to 95cm by 2100. Several recent assessments suggest this figure could be much higher. In one study that considered the impact of a 1m SLR for 84 developing countries, Egypt was ranked the 2nd highest with respect to the coastal population affected, 3rd highest for coastal GDP affected and 5th highest for proportion of urban areas affected. In this study, the methodology to build an integrated web map solution to access the effect of the SLR scenarios (WHAT IF) on the northern coast of EGYPT – EGSLR was presented.

Keywords: *EGSLR; Climate Change and MAPPING*

INTRODUCTION

The northern Delta coast of Egypt on the Mediterranean extends from Alexandria city in the west to Port Said city in the east, with a total length of about 240 kilometers. The coordinates of the upper left (UL) corner of the study area is (latitude: 31.8, longitude: 29.6) and the lower right (LR) corner is (latitude: 30.8, longitude: 32.6).The region in the Mediterranean coastal zone represents the major industrial, agricultural, and economic resource of the country. The Nile Delta and Mediterranean coast include 30-40% of Egypt’s agricultural production, half of Egypt’s industrial production. The three main Delta lagoons are Idku, Burullus and Manzala produce over 60% Egypt’s fish catch. Approximately 15% of Egypt’s GDP is generated in these Low Elevation Coastal Zone (LECZ) areas. This area is at risk from future sea level rise and storm surge. With a large and growing population in coastal zones and a low adaptive capacity, the area is highly vulnerable. In the absence of adaptation, the physical, human and financial impacts of climate change on coastal zones will be significant. Coastal adaptation is therefore likely to be a priority area.

MATERIALS AND METHODS

Global Projected Sea Level Rise:

Projections of SLR have changed over the years as more information has become available (e.g., more advanced climate change models and more accurate data).The 1990 IPCC report a scenario of global warming and consequent global SLR of 18 cm by 2030 and between 21 cm to 71 cm by 2070 (IPCC,1990). In 2001, the IPCC projected that SLR would increase by 9 cm to 88 cm by 2100 over 1990 sea levels (IPCC TAR, 2001). Uncertainties about Greenhouse gas emissions scenarios, temperature sensitivity of the climate system, contribution from the Antarctic, and glacial melt can explain the range of SLR predictions.

Table (1): Projected temperature change and sea level rise (excluding future rapid dynamical changes in ice flow) for the six IPCC emission scenarios

IPCC emission scenario	Temperature rise IPCC-AR4	Sea level rise 2100 IPCC-AR4	Sea level rise 2050 IPCC-TAR
B1	1.8C	0.18 - 0.38 m	0.05 – 0.26 m
A1T	2.4C	0.20 - 0.45 m	0.07 – 0.29 m
B2	2.4C	0.20 – 0.43 m	0.06 – 0.28 m
A1B	2.8C	0.21- 0.48 m	0.06 – 0.28 m
A2	3.4C	0.23 – 0.51 m	0.06 – 0.27 m
A1FI	4.0C	0.26 – 0.59 m	0.06 – 0.3 m

In February 2007(AR4), the IPCC slightly lowered its estimate of SLR to between 18 cm to 59 cm by 2100 over 1990 sea levels because new data and technologies became available about the contribution of thermal expansion of SLR. However, the new range does not incorporate the potential acceleration of melting of Greenland or the West Antarctic Ice Sheet. The estimates include only the steric component of the sea level rise due to the heating of the ocean waters and their consequent expansion. The numbers given by IPCC should therefore be considered as a lower limit of the expected sea level rise. The 2007 IPCC report advises that if ice discharge from these processes were to increase in proportion to global average surface temperature change, it would add 0.1-0.2 m to the upper limit of sea level rise by 2100. The IPCC also acknowledged that "larger values could not be excluded" as shown in Table (1).

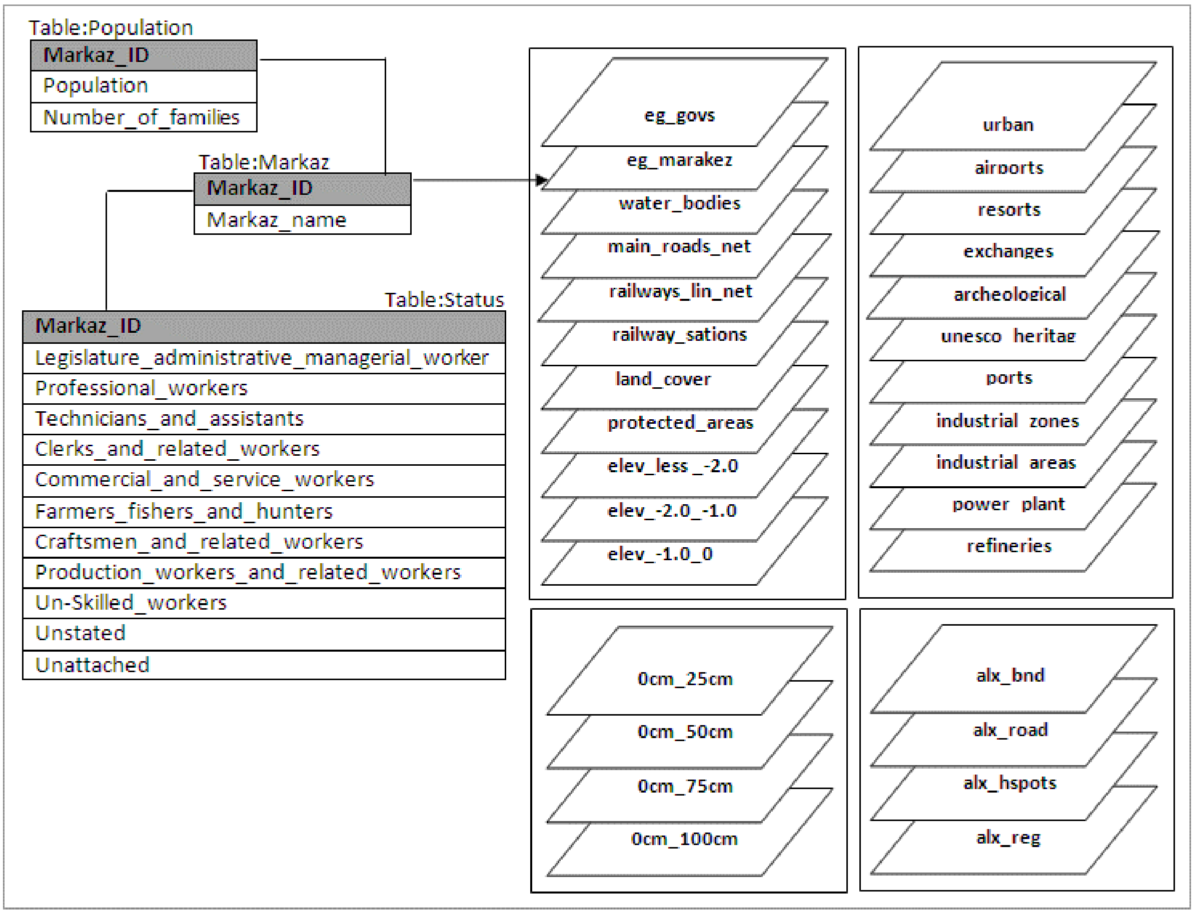
The Methodology of the Development of an Interactive Web Enabled SLR Scenarios (EGSLR)

The most important factors are being included in the designing and implementing of the EGSLR as a web GIS application are functional module, graphic user interface, downloading time, system performance and the technology related. The system must be portable and extendable to accommodate future changes in hardware, software and networking. Keeping in view these factors, EGSLR developed based on two components: the server side and the web client side, which runs in the browser.The framework of the technical development process of the EGSLR is focusing on:

1. Spatial and attribute database collection, analysis and design
2. Data conversion and importing
3. Development environment and tools
4. EGSLR Database Model
5. EGSLR architecture
6. EGSLR main features
7. EGSLR main components
8. EGSLR main functions

EGSLR Database Model:

The database is the most important part of any web application. In the case of GIS web-based applications, it becomes more important because of the storage requirements of the spatial data. Once the spatial data are stored in a database; they can be used, analyzed and displayed in the form of maps by the web-based application. The EGSLR data are divided logically into two categories: spatial data and attribute (tabular) data as shown in figure (1). The EGSLR database model designed to be stored physically different although the relationships between the two categories of data are preserved regardless of whether the division is physically or logical (hybrid database model).This means that two separate database were used in the systems; one for spatial data and one for attribute data. The Shuttle Radar Topography Mission (SRTM) data are used as a source of the elevation data in the EGSLR scenarios application. Two tiles (srtm_43_06 and srtm_42_06) which cover the coastal area from Port Said to Alexandria City are used. In order to use the data in the EGSLR scenariosapplication over the web, The SRTM data must be converted fromraster format to vector layers format.



EGSLR Architecture

EGSLR is a server side application (thin client architecture) where users can send a request to a server (i.e. an address), and the server processes the request and sends the results back as an image embedded in an HTML page via standard HTTP (HyperText Transfer Protocol). The response is a standard web page that a generic browser can view.in server-side web GIS applications, all the complex and proprietary software, in addition to the spatial and tabular data remain on the server. This architecture has several advantages because the application and data are centralized on a server.

EGSLR Main Components

EGSLR is divided into a set of functional units (modules).Each module represents a set of related tasks or functions. Modules are independent of one another but they communicate with each other. EGSLR is developed and deployed using standard web development tools, and is comprised of two elements; the web site framework and the functional tools. The framework presents the EGSLR supporting information via a graphical user interface to the user. The second element is the functional tools that enable access to GIS functions such as SLR scenarios, mapping and query functions.The main modules are:

1. Display Functions - Map tools
2. Cartographic Presentation
3. Utilities
4. Mash up Module
5. Layer Manager Module
6. Sea Level Rise Scenarios Module: This module contains four levels to study:

a. Scenario 1: sea level rise from 0 cm to 25 cm.
b. Scenario 2: sea level rise from 0 cm to 50 cm.
c. Scenario 3: sea level rise from 0 cm to 75 cm.
d. Scenario 4: sea level rise from 0 cm to 100 cm.

7. Population Distribution Module

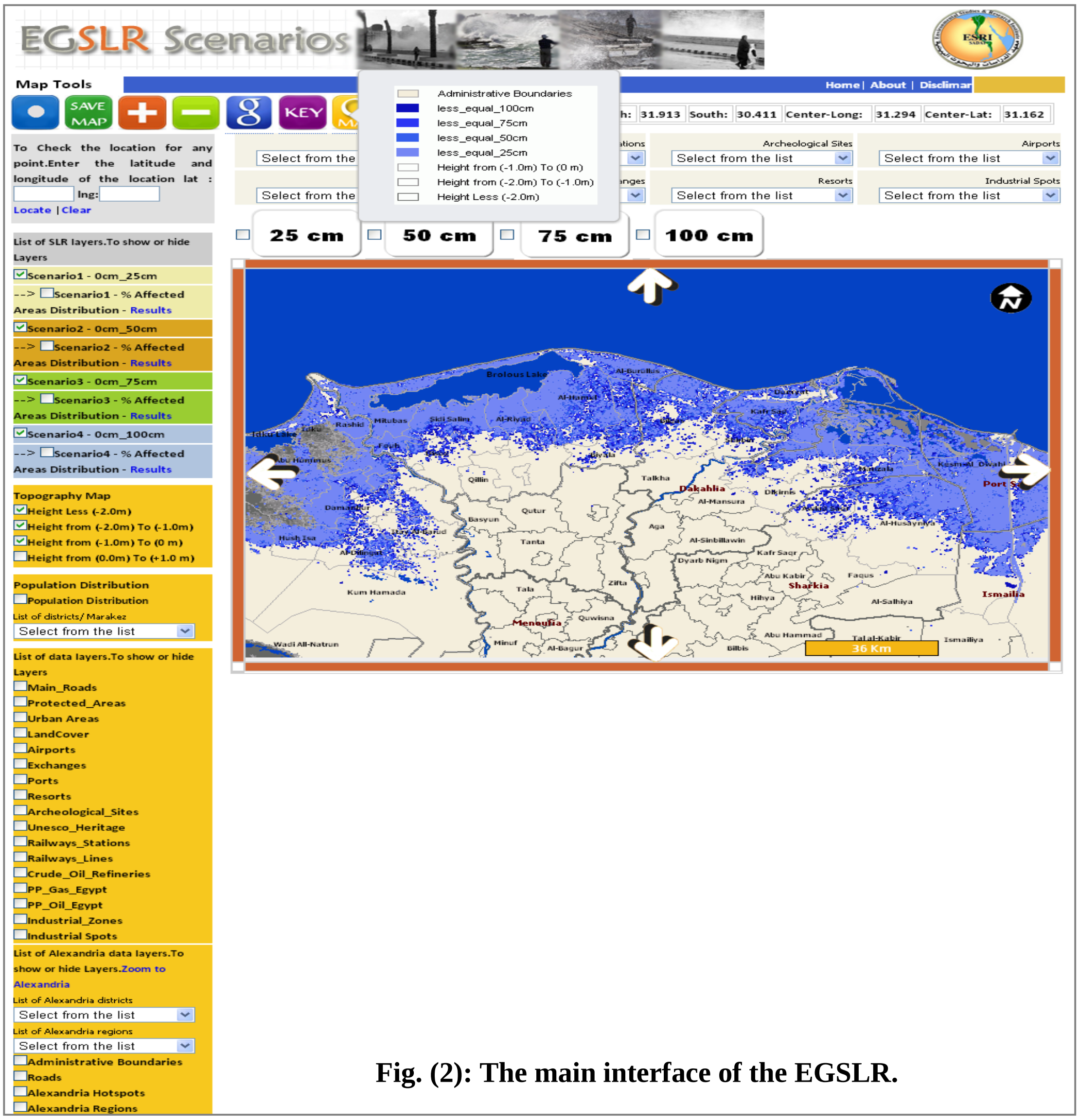


Fig. (2): The main interface of the EGSLR.

For each scenario, the user can:

1. Select any SLR scenario to overlay it on the base mapas shown in figure (3).The user can overlay more than one scenario at the same time. For each scenario, the user can check the affected districts. The affected districts are classified into five categories based on the percentage of area affected of each district divided by the total area of the districtas shown in figure (4).
2. Select any Markaz/district in the study area and locate it geographically on the base map. For any selected Markaz, the application provides:
   - The number of population and the number of families.
   - The affected area of the selected markaz divided by total markaz area for each scenario.
   - Pie chart shows the distribution of labor force in the selected district. The labor force is classified to eleven category

3. Select any hotspot point. The hotspots data include: urban areas, railway stations, archeological sites, airports, industrial zones, exchanges, resorts and industrial spots. For any selected hotspot the application shows its location on the map and which SLR scenario(s) may affect it.
4. Locate any GPS point by inputting its latitude and longitude in decimal degree format to check if it is affected by any SLR scenario or not. to check if it is affected by any SLR scenario or not.

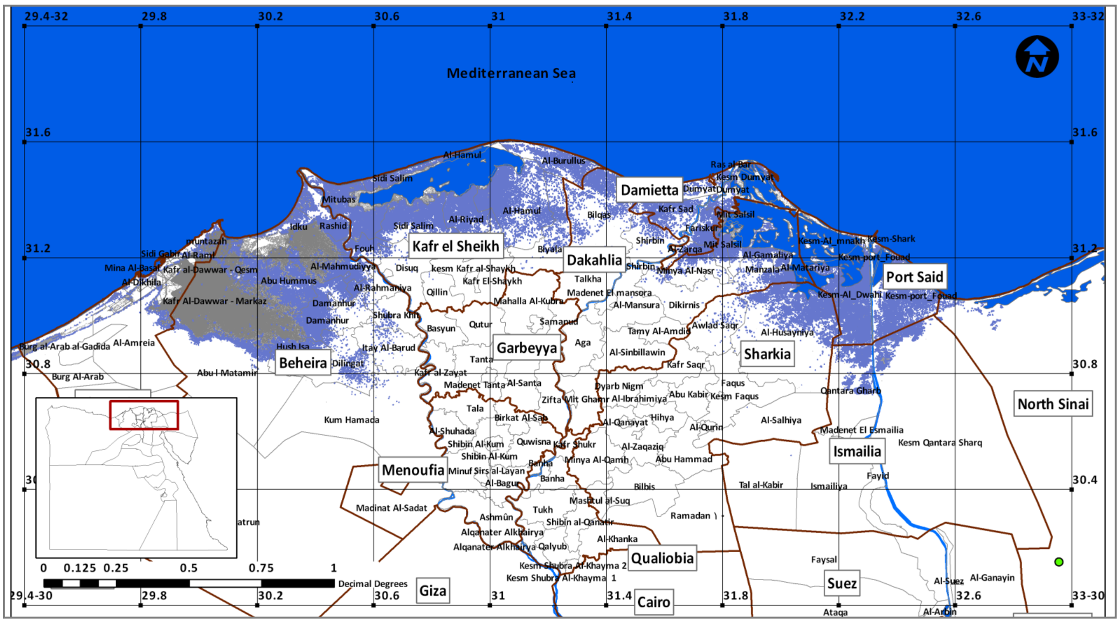


Fig. (3): Scenario (2) the expected impact of a 50cm SLR.

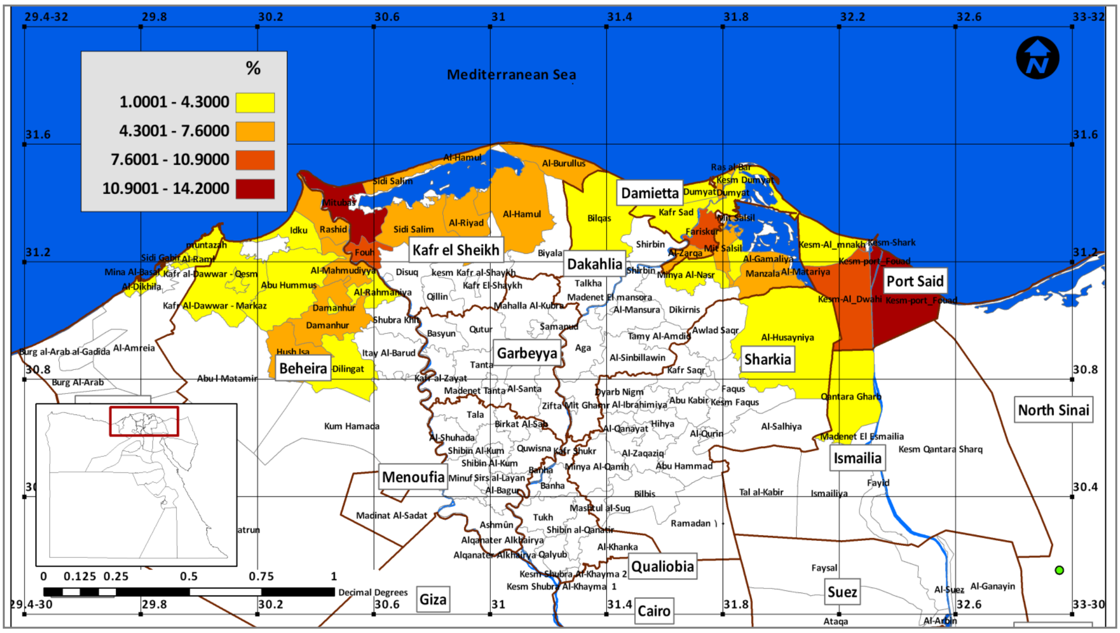


Fig. (4): Map shows the classification of impacted districts by scenario (1) – 25cm.

CONCLUSIONS

1. The most affected areas are part of Alexandria, Behira, Dakahlia, Damietta, Ismalia, KafrAlshikh, Port Said and Sharkia governorates.

2. The most vulnerable governorates are KafrAlshikh, Behira and Port Said which present about 70 to 75% of total affected area by each scenario.
3. The highest vulnerable governorate is Kafr El-Shikh and the highest impacted district (Markaz) is Fouh.
4. Total area affected by 25, 50, 75 and 100 cm SLR is 582, 1058, 1579 and 2200.3 km^2 respectively.
5. The effects of sea level rise need to be seen in the context of other socioeconomic drivers.
6. Geographic Information System (GIS) is capable of creating, analyzing, and displaying sea level rise scenarios enabling local officials and decision makers to address the native effects of elevated sea levels by allowing them to identify affected communities that are at risk, access the situation, and develop mitigation strategies.

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