الأكاديمية العربية للعلوم والتكنولوجيا والنقل البحري
Arab Academy for Science, Technology & Maritime Transport

Proposal Details

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Title:

imProved fo Recast Of Climatic changEs and its Socioeconomic implicationS along the Northern Coastal zone of Egypt using integrated satellite data and open-source modelling (PROCESS)

Short Title or Acronym: **PROCESS**

Key words: Climate Changes, Open Source, Earth Observations, DEM, Nile Delta

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Abstract

Northern coastal zone of Egypt possesses a complex ecosystem that is wealthy of natural resources attracting nearly 45% of the Egyptian population to live within few kilometers buffer from the coastline. It extends for nearly 1100 Km from Rafah city in the Far East to El Saloum city in the far west. It occupied by large cities, small towns and villages with dense population, industrial states, and large marine harbors, fish farming activities and rural and agriculture in some areas. Egypt vision 2030 is strongly paying attention to the development of the northern coastal zone with various projects such as the nuclear power station, leisure and coastal touristic compounds, infrastructures, harbors, agriculture, etc. Such social and economic development plans are playing major roles in the country's sustainable development contributing to the national GDP. This, indeed, requires understanding of the hazards that might obstacle such development plans including climate changes and natural hazards. Unfortunately, Mediterranean region is the most vulnerable region of the globe under the threat of climate changes, and Egypt is one the most vulnerable countries to the impact of climate changes. The changing pattern of temperature and rainfall would create pressure and negative impact on the social and economic development of this region. It becomes a fact that the global temperature will increase by 1.5 - 2^{o}C by the 2100. Hence, understanding the impact of such rise of temperature on the resources and requirements is needed. This will influence the water needs and consumption, the energy requirements, the ecosystem and livings. Such changes require governance readiness with plans and scenarios for adaptation, resilience and mitigation. The objective of this proposal is to develop an integrated platform for time series analysis of earth observation data and other ancillary data to understand the impact of the climate changes on the northern coastal zone of Egypt. It will provide 1) regular updated maps of the scenarios of climate changes such as sea level rise and coastal erosion on social and development, 2) regular and updated maps on the social and economic responses to the changing pattern of temperature due to climate changes; 3) scenarios of resilience and mitigation of impact of climate change; and 4) regular and updated maps of the consequence's hazards (e.g., salt water intrusion, land subsidence) on the economic development. The platform will support all levels from decision and policy makers; professionals, practitioners and public beneficiaries and stakeholders.

Introduction

Climate change can be considered as one of the biggest threats to our environment, with significant impacts across the globe. Over the coming decades, land-based activities need to be adapted to the effects of changing climatic conditions and at the same time modify practices to reduce their continuing impacts on the environment (El-Nahry and Doluschitz, 2010).

One of the most certain consequences of global climate change is accelerated global sea-level rise (SLR), which will intensify the stress on many coastal zones, particularly where human pressure has already diminished natural and socioeconomic adaptive capacities. Coastlines are shaped by tides, waves, winds and storms so; they are considering one of the most dynamic environments on the planet. Coastal cities are of high economic value due to commercial, industrial, residential and recreational activities and have a high population density (Ibe and Awosika 1991). Rising sea level would bring the risk of inundation, increase erosion rates as well as saline intrusion into rivers and aquifers (Milliman 1992; Warrick et al. 1996).

In the recent past, the Nile Delta has experienced considerable changes in environmental conditions. Some of them have been of natural, some of anthropogenic origin (Becker and Sultan 2009, Syvitski et al. 2009). For instance, there is erosion along the delta coast (Ali & Abou El-Magd, 2016; El Banna and Frihy 2009, Frihy et al. 2008) and the drying up of wetlands (El-Asmar and Hereher 2011), which occurs by expansions of agricultural production areas. Furthermore, there are considerable human-induced changes to the coastal geomorphology in the region of the Nile Delta. Land reclamation projects have added several hundreds of square kilometers of agricultural land (El Banna and Frihy 2009), and previously unproductive land has been converted into fish farms, considerably increasing the economic output in this part of the country. These changes increase the vulnerability of the coastal zone with regard to sea level rise because natural protection is removed and the likelihood of subsidence of the land is thus increased. Therefore, protective measures become more and more important in order to avoid loss of land due to inundation even at moderate rates of sea level rise. (Link, et al., 2013)

The northern coastal zone of Egypt including the delta is subjected to natural hazards and impacts of climate change such as shoreline erosion, salt-water intrusion, and sea level rise (SLR) as well as land subsidence, which create problem on local residents and maximize the impact of SLR. These hazards produce stressful effects on water and agricultural resources, tourism and human settlements. The northern Egyptian lakes, which constitute about 25% of the total Mediterranean wet lands and produce about 60% of the fish products, are also highly vulnerable to the impacts of climate change. Since the lakes are relatively shallow, climate change can lead to an increase in water temperature, which could result in changes in the lake ecosystems as well as changes in yield.

A number of national and sub-national studies have provided estimates of impacts, adaptation and vulnerability to sea-level rise around Egypt, in particular the Nile delta e.g. (El-Raey et al. (1995); El-Raey (1997); El-Raey et al. (1999); Frihy (2003). The previous studies showed that Egypt is sensitive to climate variability, the most vulnerable coastal cities are Alexandria, Rosetta, and Port Said in response to any IPCC scenarios of sea level rise. In addition to the newly developed beaches and tourist sites such as western north coast and Matruh City (western side) and Al-Arish City (eastern side). Sea-level rise is projected to be much accelerated during the coming decades and centuries, reaching 0.2-1.1 m in 2100 (about 0.86 cm in the coast of Egypt; e.g. Ali & Abou El-Magd), increasing the potential coastal flood risks. Low-lying areas account for 37% of the Mediterranean coastline which host around 42 million inhabitants. There is an estimate for the number of people susceptible to risks originated from sea-level rise of up to 130% of inhabitant population in 2100, most of them are in coastal areas of southern Mediterranean countries (including Egypt). Long-term risks are also defined from sustained sea-level rise for other important sectors, such as the coastal settlements, the heritage sites and the ecosystems over the future centuries.

YATES and STRZEPEK (1998) showed the climate changes in water resource availability, crop yields, crop water use, land resources and global agricultural markets affect Egypt's agriculture. Broadus et al. (1986) and El-Raey et al. (1995) reviled that the land losses is estimated by 12 - 15% of Egypt's current arable land in case of a one-meter SLR. Gleick (1991) suggested that the Nile Basin is extremely sensitive to changes in temperature and precipitation. Increased temperatures would increase evapotranspiration, which is likely to increase crop water requirements and lower crop yields (Eid and Saleh, 1992). Nile Delta is highly vulnerable to sea-level rise due to the damming of the Nile by the High Aswan Dam which has reduced the sediment flux to the delta and increased land subsidence and soil salinization, aside to the low elevation of the Nile Delta. Nicholls and Leatherman (1995) estimated that a mean 1-meter global sea-level rise by 2100 would give rise to a 0.37-meter sea-level rise at the Nile delta. This, combined with a non-climate induced subsidence of the Nile Delta of 0.38 meters would result in the movement of the shoreline to the current 0.75-meter contour and a 5% loss of Egyptian agricultural land by 2060. Agriculture below an elevation of one meter is very difficult due to salinization and sea-water intrusion and requires careful water management (Rosenzweig and Hillel, 1994).

Abou Samra and Ali (2020) used satellite observations with GIS techniques to assess the prospective changes along the coast of the Nile Delta, Egypt during the 1984-2018. There study showed that about 44.2% of the region was under erosion and 45% was under accretion while it was stable at 10.8%, in which Rosetta and Damietta promontories are displayed higher rates of erosion than other coastal regions of the Nile Delta.

Objectives

Climate change is one of the major threats facing the Mediterranean basin, the Mediterranean coastal cities suffer from several natural and environmental risks. As there is a growing need to support global, regional and local research and information systems on environmental risks. This study primarily highlights the socio-economic impacts of the recorded hazards of climate change along one of the valuable and highly vulnerable zones in Egypt particularly the Nile Delta.

Egypt Vision 2030 for sustainable development targets the coastal zone area for social and economic development; for example, billions of dollars invested by the government in New Al-Alamien city. However, key challenge is to minimize the impact of proposed climate changes and natural hazards on the existing infrastructures and proposed socio-economic developmental plans. Therefore, mapping and forecasting the types and magnitude of the implications of the climate changes and natural hazards and their proposed impact on the social and economic of the area of study is necessary. This project is aiming at responding to this key problem and create a platform for information dissemination to mitigate and minimize the impact of climate changes and natural hazards on coastal zone.

Project Description

Due to the combination of strong climate hazards and high vulnerability, the Mediterranean region is one of the world's hotspot for the highly interconnected climate risks, including sea-level rise related risks, land and marine biodiversity losses, risks related to drought, wildfire and alterations of water cycle, threatened food production, health emerged risks in urban and rural areas from heat waves and diseases vectors. Subsiding areas in the Mediterranean coastal zone, the Nile Delta (Egypt), are vulnerable to frequent and flooding events, and erosion, as well as to salt intrusion that negatively impacting the agricultural yields of this highly fertile and economically valued zone. The main economic sectors in the region (agriculture, fisheries, forests, tourism) are highly vulnerable to climatic hazards, while socio-economic vulnerability is also considerable. This project is mainly aiming at developing an integrated platform with some good time series analyses of earth observation data of various sources in collaboration with other ancillary data to enhance the understanding of both observed and expected impacts of the climate changes on the northern coastal zone of Egypt.

This project would help to integrate the usage of earth observation data with other ancillary data to understand the impact of climate change on the northern coastal zone of Egypt. Specifically, to achieve the following objectives:

- Identify and map the social and economic activities within the north coastal zone of Egypt.
- Determine the pattern of the shoreline changes (erosion and accretion) along the Egypt's Mediterranean coast,
- Present a forecasting scenarios on what is expected regarding climate change impacts, sea-level rise (SLR) and flooding.
- Estimate the impacts of the environmental and natural hazards on coastal economy,
- Map up the vulnerable hot spots to climate changes impact on the coastal zone,
- Assess and propose mitigation measures and adaptation models.

Study area

Egypt is one vulnerable countries to the effect of Global Warming (World Bank, 2009). Egypt's negative environmental consequences of climate warming is represented by the rise of sea level, water scarcity, agriculture and food insufficiency, and pressures on human health and national economy. Coastal wetland ecosystems of Egypt, such as salt marshes are particularly vulnerable to rising sea level because they are generally within a few centimeters above the sea level (IPCC CZMS 1992; IPCC 2007).

The shoreline of Egypt extends for more than 1100 km along the Mediterranean Sea coast. The Nile delta coast stretches about 240 km of the Mediterranean coastline from Alexandria in the west to Port Said in the east. It hosts a number of highly populated cities and critical centers of industrial and economic activity such as Alexandria, Port-Said, Rosetta, Ras El-Bar, and Damietta. This region includes a large portion of the most fertile low land of Egypt.

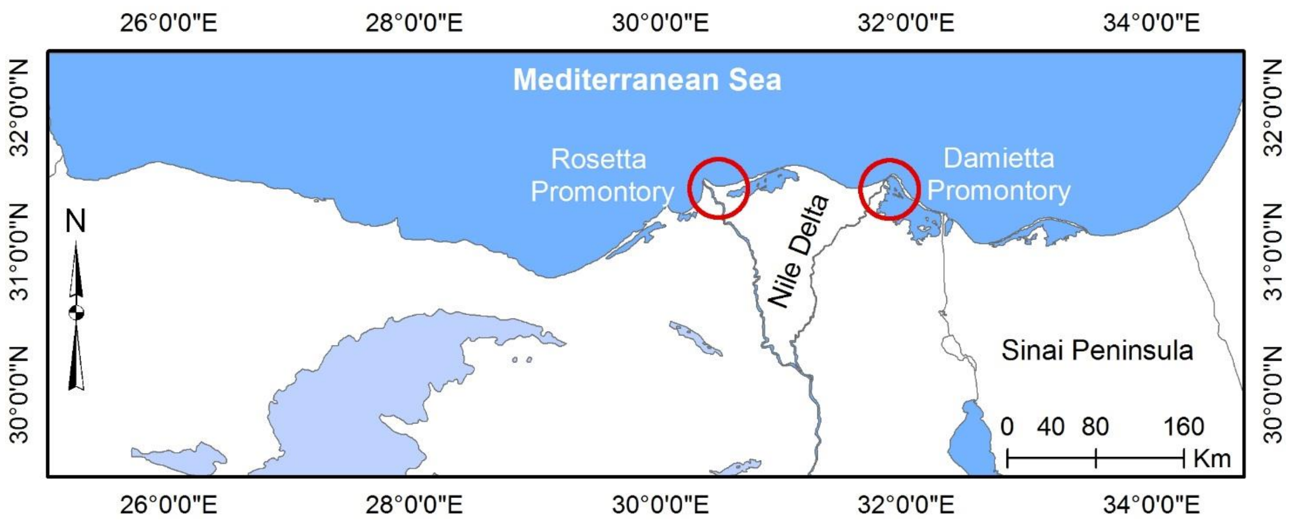

Fig. (1): Location map of the study area.

1. Observed and projects risks

Developing countries are the most vulnerable to climate change impacts because they have fewer resources to adapt: socially, technologically and financially. Climate change is anticipated to have far reaching effects on the sustainable development of developing countries including their ability to attain the United Nations Millennium Development Goals by 2015 (UN, 2007). Many developing countries' governments have given adaptation action a high, even urgent, priority.

The Mediterranean Basin has exceptional biological diversity and cultural richness originating from three continents**.** The nature of the semi-enclosed Mediterranean Sea implies unique physiographic and ecological features. It hosts more than 500 million people, with maximum population and industrial infrastructure close to sea level. The Mediterranean region is amongst the world's leading tourist destination and one of the busiest shipping routes. Climate change and other environmental problems in the Mediterranean Basin contributed much to the increased pollution and biodiversity loss. Various observed impacts are mainly attributed to climate change such as the longer intensive heat waves, floods, droughts, ocean acidification, sea-level rise, and the cascading impacts on marine and terrestrial ecosystems. In addition to the previously mentioned observed impacts, there are also others affecting the land use and sea use (i.e. agriculture, forestry, fisheries, recreation etc.). As anticipated by Nhemachena, et al (2010), changes in climate are expected to have differential impacts on agricultural productivity and food security and other sectors across spatial and temporal scales. In Egypt, increased greenhouse gases and potential global and regional climate change could affect River Nile flows and Egypt's water resource availability.

It is determined that over the last decades, the mean surface temperature has increased rapidly in the Mediterranean region if compared to the global increment mean. On contrary, a negative trends has been determined for precipitation and droughts. Precipitation will mostly decrease in most with extreme rainfall events within the northern part of the Med-region and droughts will become more dominant in several areas. The sea surface temperature has increased by 0.29-0.44°C per decade since the 1980s. During the same period of time, sea level has risen by 1.4±0.2 mm yr^{-1}.

Coastal zones are known to be the most vulnerable to natural and environmental hazards due to the physical characteristics of the high flood probability, the low topography, and the high sensitivity to climatic changes (Milliman et. al., 1989) and should treat with a national commitment and interest targeting coastal management issues.

Delta environment, such as the Nile Delta, is wealthy of natural resources that often support large populations (Syvitski and Saito, 2007). The northern coastal zone of Egypt is highly dynamic with various socio-economic activities and interventions (Abou El-Magd and Hermas, 2010). It is densely populated with nearly 45% of Egypt's population with large activities. Big cities, industrial states and harbors are existing in this area with large economic contribution to the GDP. The area is further under the spot by the government for more economic growth with new Million city of Al Alamien, and other tourism activities in the North West region. It also accommodates the new nuclear power station at El Dabae.

The land productivity in the Nile delta region declined as consequences of the salt water intrusion in addition to reduction in fish catch due to the changes in ecosystem. These changes also lead to socio-economic impacts including migration, unemployment and possibly political unrest.

It has to be noted that the regional implications of sea level rise for the Egyptian coast vary depending on the geographic location. Assessments of historic records indicate that there is a continuous relative increase in sea level irrespective of changing climatic conditions that fluctuates between 1.8 and 4.9 mm/a (Frihy et al. 2010). The highest rates generally occur near the Rosetta promontory while there is less sea level rise near the harbor of Alexandria. These differences can be attributed to the local tectonic settings.

Consequently, it is necessity to monitor, build data basis, analyze data and advice decision makers concerning adaptation measures and follow up implementation of policies and measures to face climate changes, constitute a major problem. This gap is being fixed by development of database to serve all sectors of development. In addition, building human capacity in lines of physical, technological and socio- economic considerations is still going on at very slow rate. The future impact of the negative environmental consequences of climate change on the Egypt's population dimensions and dynamics are the main points of concern in this study.

The figure below (figure 2) shows the approach of integration of risks and impacts with all the processes and environmental, climate and socioeconomic dimensions.

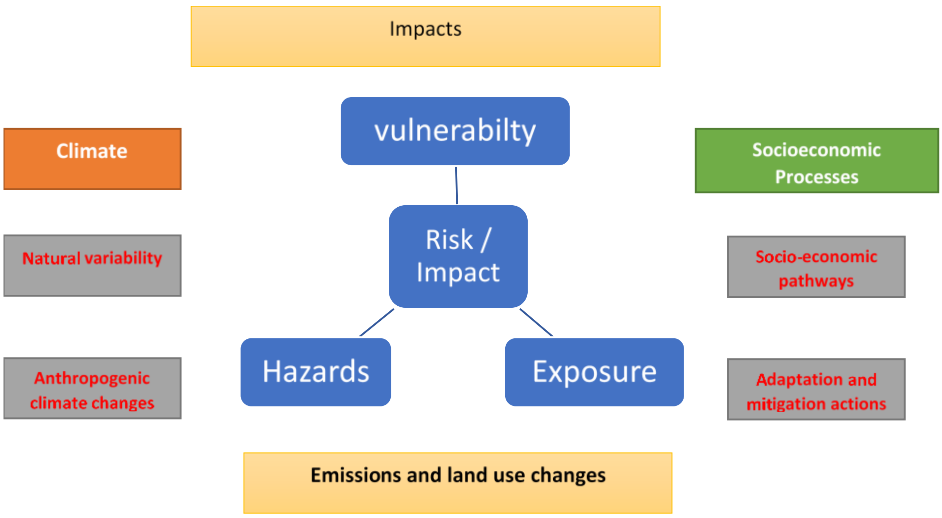

Figure 2- inter-relation between risks and impacts with environmental variables and socioeconomic pathways.

Research Design and Methods

The work plan and required resources to implement this research project are:

1- Field trips and in-situ measurements

- Intensive field trips and *in-situ* measurements should be carried out to make real observations and recording of the current land use and land cover as well as all infrastructures and socio-economic activities. In addition, measurements of other parameters such as climatic data of temperature and rainfall, soil salinity, and seismicity will be investigated for measurements.
- It is anticipated that 2 field trips for onsite observation and measurements will be carried out during this project progress to observe the changes along the coastal region as well as make *in-situ* measurements.
- There is a need to support these field trips with Cars, camera, GPS and the instruments used for the *in-situ* measurements.

2- **Internet connectivity** (high speed) to download the time series satellite images from different sources such as Sentinel data. This will be provided by NARSS and AASTM.

This research will include different approaches to achieve its goals.

The project will use satellite data besides open source software and in-situ measurements in order to model spatial and temporal data and integrate it with IPCC climate changes models to unify and harmonize the data and generate recommended scenarios of outputs. The techniques anticipated to be used according to the thematic focus area are presented in the following section:

1. Climate models

2. Temperature rise and heat waves

Capturing the dynamic variance of extreme high-temperature distributions in a timely manner is the basis for analyzing the potential impacts of extreme heat, thereby informing risk prevention strategies. Estimation of air temperature depends on retrieving air temperature under clear sky conditions based on the Surface Energy Balance Algorithm for Land (SEBAL) (Zhu et al., 2017). The required input data for this model includes satellite thermal data such as MODIS products or Landsat 8 as well as meteorological measurement.

3. **Rainfall pattern and flooding**This model is a main approach to estimate rainfall based on different techniques such as:

1 VIS/TIR technique attempts to correlate the surface rain rate with cloud top brightness temperatures provided by the satellite. The principle behind the use of VIS and IR channels of geostationary satellites is that, in visible imagery bright clouds tend to be thick and thick clouds are more likely to be associated with rainfall. Similarly, in infrared imagery it is said that heavier rainfall tends to be associated with larger, taller clouds with colder cloud tops. These techniques are further divided based on the methodology as Cloud indexing, Thresholding, Cloud model and Cloud life history. The most popularly used techniques include Global Precipitation Index (GPI), Convective-Stratiform technique (CST), Griffth-Woddely technique etc.

2 Microwave technique is based on passive microwave that follow a simple property i.e. at lower frequencies emission from rain droplets leads to an increase in MW radiation and at higher frequencies scattering caused by precipitating ice particles leads to a decrease in MW radiation. Over the water surface the background radiometric signal is low and constant (emissivity, $\varepsilon \sim 0.4$–0.5), therefore additional emissions from precipitation is used to identify and quantify the rainfall using low-frequency channels.

3 Blended techniques combine geostationary satellite data with other accurate rainfall estimates like MW rain rates, DWR rain rates or rain gauge estimates. The satellite-based microwave (MW) data can be used to provide accurate estimates of instantaneous rain rates, but the poor temporal sampling of low Earth-orbiting satellites (once or twice a day) makes these data only suitable for estimation of accumulated rainfall over longer periods, perhaps a month or more but not for daily basis as required for hydrological studies. While the satellite-based thermal infrared (TIR) data benefit from the high temporal sampling (30 min or 1 h) of geostationary satellites such as Kalpana-1, GOES, Meteosat. However, TIR radiances from cloud tops have only a weak, indirect relationship with surface rainfall.

- ***Sea level rise***

Elevation data are critical for assessments of sea-level rise (SLR) and coastal flooding exposure. When an elevation-based SLR or coastal flooding assessment is conducted, especially over broad areas, a simple inundation method known as the "bathtub" model is often used, an approach that has also been referred to as the "single-value surface".

Numerous global or regional DEMs available for this purpose such as:

1) Shuttle Radar Topography Mission (SRTM) data are available for all land areas between 60° north and 56° south latitude at 1-arc-second (30-m) and 3-arc-second (90-m) grid spacing. The SRTM product specification for vertical accuracy is 16 m LE90, which equates to an RMSE of 9.73 m.
2) Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) Global Digital Elevation Model (GDEM) is available for all land areas between 83°N and south latitude at 1-arc-second (30-m) grid spacing. The ASTER GDEM product specification for vertical accuracy is 20 m LE95, which equates to an RMSE of 10.20 m.
3) Advanced Land Observing Satellite (ALOS) Global Digital Surface Model (AW3D30) is available for all land areas between 82°N and south latitude at 1-arc-second (30-m) grid spacing. The AW3D30 product specification for vertical accuracy is 5.0 m RMSE.

4) TerraSAR-X add-on for Digital Elevation Measurement (TanDEM-X) data are available for all land areas between 84°N and south latitude at 0.4-arc-second (12-m) grid spacing. An edited, higher processed version of TanDEM-X is available as a commercial product under the name WorldDEM. The TanDEM-X product specification for vertical accuracy is 10.0 m LE90, which equates to an RMSE of 6.08 m.
5) National Aeronautics and Space Administration Digital Elevation Model (NASADEM) is a reprocessing and enhancement of SRTM 30-m data and a merge with ASTER GDEM and other DEM sources. It is targeted as a successor for SRTM.
6) Multi-Error-Removed Improved-Terrain (MERIT) DEM is available for all land areas between 90°N and 60°S latitude at 3-arc-second (90-m) grid spacing. It is a merge of enhanced 90-m SRTM data and AW3D30.

- ***Land subsidence***

The Nile delta is facing land subsidence due to the large successive column of clay. This accelerate the vulnerability to sea level rise and flooding. We anticipate to use Interferometric Synthetic Aperture Radar (InSAR) to precisely detect the spatial and temporal patterns, as well as the magnitudes of urban land subsidence in the Nile Delta. This will allow accurate detection of the cumulative sea level rise from the sea and from the land subsidence.

- ***Coastal Erosion***

Automated methods of shoreline extraction from remote sensing imagery can be grouped into three categories:

1. the edge detection approaches, which treat the extraction of shoreline as an edge detection problem.
2. the band thresholding methods, in which a thresholding value is selected either by man-machine interaction or by a local adaptive strategy.
3. the classification approaches, which aim to separate the image into land and water components, and then take the boundary line between them as the shoreline.

The shoreline detection is not a simple task that can be executed using a single image processing technique, but rather it is a complex mechanism that requires the use of several techniques. For instance, Landsat data, can be used due to the accessibility of these data, which are available from the USCG web site since 1972. In addition, Landsat images cover all the areas of the earth and allow studies over a long period. Also, SPOT images, is one of the oldest satellites with a wide coverage and high-resolution.

- ***Natural hazard - saltwater Intrusion (Soil Salinity)***

Generally, two remote sensing approaches have been used to map soil salinity at regional scale. The most established approach uses spatial analyses of surface (bare-) soil reflectance. The other obtains an indirect assessment of soil salinity through analysis of crop canopy reflectance.

1 Classification-based Mapping: One of the most conventional applications of remote sensing is to map soil salinity through classification approaches. proposed best band combination (e.g., Landsat TM bands 1,3,5) or optimal band combination (e.g., TM bands 2,3,4 plus thermal band) for mapping salt-affected soils.

2 Spectral Indices and Biophysical Indicators for Salinity Detection and Mapping:

Th following table (1) explores some of the indices that could be used for detecting Vegetation and salinity of soil based on remote sensing.

Table (1): Examples of vegetation and salinity indices (SI)

Index Name	Formula	Source
SI1	SI1 = $(B*R)^{1/2}$	Khan et al. (2001) and Khan et al. (2005)
SI2	SI2 = $(G*R)^{1/2}$	Khan et al. (2005)
SI4	SI4 = $[(G)^2 + (R)^2 + (NIR)^2]^{1/2}$	Douaoui et al. (2006)
SI5	SI5 = $[(G)^2 + (R)^2]^{1/2}$	Douaoui et al. (2006)
SI6	SI6 = (SWIR1-SWIR2)/(SWIR1 + SWIR2)	Al-Khaier (2003)
SI7	SI7 = (SWIR1-NIR)/(SWIR1 + NIR)	Al-Khaier (2003)
SI8	SI8 = (NIR*R)/G	Elhag (2016)
Brightness index (BI)	BI = $[(R)^2 + (NIR)^2]^{1/2}$	Khan et al. (2001) and Khan et al. (2005)
NDII	(NIR-SWIR1)/(NIR + SWIR1)	Hardisky et al. (1983) and Steven et al. (1992)
ND23	(G-R)/(G + R)	Steven et al. (1992)
ND47	(NIR-SWIR2)/(NIR + SWIR2)	Steven et al. (1992)
Normalized difference salinity index (NDSI)	NDSI = (TIR - NIR)/(TIR + NIR) (in digital number)	Iqbal (2011)
Combined spectral response index (COSRI)	COSRI = [(B + G)/(R + NIR)]*NDVI	Fernández-Buces et al. (2006)

** Note: Band named in terms of Landsat TM, e.g., B blue, G green, R red, NIR near infrared, SWIR1 (λ = 1.65 µm) shortwave infrared band 5, SWIR2 (λ = 2.16 µm) shortwave infrared band 7, and TIR thermal infrared*

Anticipated Results and Evaluation Criteria

During the implementation of the project and by the end of the project, it is expected to have the following general and specific outcomes and deliverables.

- Regular updated maps of the scenarios of climate changes such as sea level rise and coastal erosion on social and development,
- Regular and updated maps on the social and economic responses to the changing pattern of temperature due to climate changes;
- Scenarios of resilience and mitigation of impact of climate change; and
- Regular and updated maps of the consequence's hazards (e.g., salt water intrusion, land subsidence) on the economic development.
- Published articles in international peer reviewed journals
- Technical workshops with the project results for stakeholders, public, students and other beneficiaries

Expected Project Outcomes and Impact to AASTMT

I- Technical output and Impact:

New results and conclusion about the behaviours of the Geospatial Studies will be published in international journals.

II- Financial feasibility & Geospatial Studies Impact:

Improve using the Satellite imaging technology.

Maximizing the partnerships between Arab Academy and NARSS

III – Publication:

At least two papers will be published in international journals.

Resources

1-Equipment

- High performance workstation and computer will be required to implement the climate models and process the large size of satellite data. Such HPCs will be provided by the implementing bodies, however a single (1) workstation will be purchased for the purpose of this project.
- Portable laptop for field visits will be provided by the implementing institutions with GPS connectivity for point locations.
- Software packages for data analysis
- Enough storage media, since the satellite data and processing of climatic data and models will generate large files that require high storage capacity. This will be provided by NARSS and AASTMT.
- Professional camera for onsite observation and recording of the actual objects and activities in the area of study. This will be hired or provided by the implementing institutions.
- Hand-held device for measurement of water characteristics including water temperature, salinity, and turbidity, …etc
- Weather or climate sensors (air temperature, precipitation/rainfall
- Hand-held device for measurement of soil salinity.

2-Software

- Remote sensing packages such as ERDAS Imagine or/and ENVI.
- Geographical information system package such as ArcGIS (10.2) and QGIS.
- Statistical analysis package (SPSS).
- Programing language (e.g. python).
- Open-source license

- Specific software module for land subsidence estimation from satellite data will be purchased, since this module is not available in the implementing institutions.

3- Data sources (Details are in separate section)

- Literature reviews from scientific papers, projects' reports, M.Sc. and PhD thesis related to the subject and the area of study.
- Topographic and geologic maps.
- ESA Hub for Sentinel satellite data.
- USGS and earth data hub for Landsat, and MODIS satellite data.
- Unfortunately, there is no high resolution digital elevation model is available free of charge, and this digital elevation model is essential in the estimation of the flooded land due to climate changes and sea level rise. This piece of data will be purchase to ensure high resolution and precise estimation of the flooded land.

Data Sources

Various data sources will be used in this research study including:

1. ***Satellite observations*:**

Most of the satellite data that will be used in this project is available at NARSS since NARSS is hosting ESA hub for most of ESA satellites. The main source of EO data in this project includes:

2. ***Satellite data***
   - Sentinel 2 – Land optical data with high resolution
   - Sentinel 3 – marine optical data with medium to coarse resolution
   - Landsat8 data – Optical satellite data.
   - MODIS and AIRS – climate data
   - TRMM – Rainfall data

3. *Thematic GIS maps*

Thematic maps such as geology, geomorphology, soil and land use will be used in the modelling and data analysis to achieve the objectives.

4. *In-situ measurements:*

The proposed field work and *in-situ* measurements will include:

- Real observations and recording of all infrastructures, socio-economic activities, current land use and land cover to estimate the actual impact of climate change on the society.
- Measurements of soil salinity to detect the impact of climate changes and salt water intrusion on soil salinity.
- Estimation of coastline change patterns, the landform and landscape variations.
- Measurements of some climatic parameters such as temperature, humidity and rainfall.
- Spectroradiometer (ASD) to measure some spectral signatures for specific objects and features.
- The field observations and recording is important for both validation and verifications of the outputs.

5. *Ancillary data*

Ancillary data and sources of in-situ data such as earthquakes network and climate data could be obtained from other research institutes such as the Egyptian Meteorological Agency.

Team Information (Max. of one page per team member)

1. **Dr. Mahmoud Elewa (Principal Investigator P-I)**

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Specialist on: Chemical Engineering – Renewable Energy

The Role in Project: Advisor of all the project stages.

2. **Prof. Elham Mahmoud Ali (Co- Investigator CO-I 1)**

Affiliation: Suez University

Specialist on: Climate change – Environmental Sciences

The Role in Project: Co- Advisor of all the project stages.

3. **Prof. Dr. Nasser Elmaghraby (Co- Investigator CO-I 2)**

Affiliation: Institute of Basic Science, Arab Academy for Science, Technology, and Maritime Transport, Alexandria.

Specialist on: Simulation and Modeling - Numerical Analysis.

The Role in Project: Constructing the mathematical models, Discuss the results, write the papers.

4. **Prof. Mohamed Zahran (Co- Investigator CO-I 3)**

Affiliation: National Authority for remote sensing and space science

Specialist on: Electronic images

The Role in Project: Simulation and Modeling – Testing of Seattleite images .

5. **Prof. Islam Abou El-Magd (Co- Investigator CO-I 4)**

Affiliation: National Authority for remote sensing and space science

Specialist on: Environmental Sciences

The Role in Project: collecting and treatment environmental data.

6. Eng. Ayman Elzagh (Co- Investigator CO-I 5)

Affiliation: Arab Academy for Science, Technology, and Maritime Transport, Alexandria.

Specialist on: Artificial intelligence

The Role in Project: Experimental parts.

Research Team Information Table

Name of Res. Team Member in English	Name of Res. Team Member in Arabic	University / Institute In English	Position / Title	% of time spent on project	No. of months	Incentive per month (LE)	Number of other projects and their IDs	Total % of time spent on other projects	Contact No
Mahmoud Elewa	محمود عليوة	AASTMT(PI)	Ass. Prof.	50%	12	4000	0	0	01001434090
Elham Ali	الهام على	Suze University	Professor	50%	12	6000	0	0	01062239339
Nasser Elmaghraby	ناصر المغربى	AASTMT	Prof	40%	12	4000	0	0	01010009091
Mohamed Zahran	محمد زهران	NARS	Prof.	40%	12	4000	0	0	
Islam Aboelmagd	اسلام ابوالمجد	NARS	Prof.	40%	12	4000			01066343915
Ayman Elzagh	ايمن الزاغ	AASTMT	Eng.	50%	12	3000			

Project Management

The estimated duration of this project is 12 Months, the Gantt chart is shown in the following flowchart figure.

Gantt Chart - Improved forecast of climatic changes and its socioeconomic implications along the Northern Coastal zone of Egypt using integrated satellite data and open-source modelling

Task	M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12	Deliverable
T1. Literature Review	■												D1. Literature review report
T2. Procurement process - Workstation, software, DEM data	■	■											D2. Delivery of WS, Software Module, DEM data
T3. Satellite data download and processing	■	■	■	■	■	■							D3. Intermediate Processed Data
T3. Climate modelling				■	■	■	■	■	■	■			D3. Intermediate Processed Data
T4. Socio-economic impacts								■	■	■	■	■	D4. Social and Economic vulnerability maps
T5. Communication and outreach - Workshops, seminars, social media, etc.		■	■	■	■	■	■	■	■	■	■	■	D5. Communication and outreach media, publicity materials
T6. Reporting						■						■	D6. Technical reports
T7. Publications												■	D7. Published papers

A DETAILED PLAN ON PROJECT'S ACTIVITIES (*GANTT CHART*):

Activity Description	Key Performance Indicators	Means of verifications
Goal (Overall Objective): The overall objective of the proposed research project is to develop robust models to simulate the impact of climate changes and natural hazards on coastal zone resources and development.	• Number of published maps and scenarios of the impact of climate changes • Number of published maps and scenarios of the impact of natural hazards	• Routine publishing of maps that benefit stakeholders and beneficiaries. • Number of stakeholders and users engaged in the outputs
Specific Project Objectives: • Generating coastal maps of natural resources from earth observation data. • Strengthen our capacity in monitoring and assessment of coastal vulnerability to climate changes and natural hazards. • Strengthen our capacity in generating open source information for decision makers and planners • Developing a unified hub for coastal development with mitigation measures of both climate changes and natural hazards	• Number of published maps • Number of junior researchers trained in coastal hazards and climate changes. • Number of products and information published and disseminated to end users • Number of adopted and developed models that transform EO data into robust information related to climate changes and natural hazards.	• Validation of the number of maps • Validating of the number of reports and decision support information • Validation of the number of capital development. • Validation of the number of stakeholders engaged and benefited from the outcomes. • Validation of the number of visibility of the project findings to end-users.
Expected Outputs (Results): 1. Consolidated maps of climate changes impact on coastal development, 2. Consolidated maps on the impact of natural hazards on coastal development, 3. Strengthened human capacity with methods, models, APIs development related to climate changes and natural hazards, 4. Economical maps for development and integration with SDGs and vulnerability to climate changes and natural hazards. 5. Technical reports. 6. Scientific publication. 7. Conferences and workshops.	• Number of digital copy of the output maps. • Number of scientific and technical reports with technical methods, models and maps. • Number of published papers in peer review journals. • Recommendation for integration with coastal planning. • Number of conducted workshops to engage stakeholders and end-users.	• Existence of junior researcher in the project that are capable to conduct similar projects • Review of the reports from experts • Review of the published paper from the international community. • Discussion and argumentation during the technical workshop • Existence number of stakeholders, beneficiaries and end-users engaged in the project
Activities 1. Collection of literatures, historical and ancillary data. 2. Collection of all satellite data sensors that suit the project objectives (optical multi-spectral, hyperspectral, Radar) 3. Processing of the satellite data 4. Simulation and modelling of the satellite data and other data formats to map the scenarios of impact of climate changes and natural hazards on the socio-economic development 5. Processing of economic models to stimulate the value of coastal development 6. Conducting field surveys for validation measures. 7. Geo-statistical analysis and spatial modeling 8. Publishing the data 9. Writing reports 10. Writing papers	• Digital copy of the output maps • Mitigation strategy • Set of recommendations for coastal development and planning. • Scenarios of mitigation from impact of climate changes and natural hazards. • Technical reports • Published papers • Workshop	• Reviewed reports • Reviewed paper • Technical workshop • Technical meetings

Allowable Project Costs (Max. two pages)

2. Project budget

The estimated budget of this project is 1 Million Egyptian Pound (1,000,000 EGP). The itemized list of the proposed budget is presented in table (1) below.

#	Item	Description	Estimated Cost
1	Personal cost	The cost of the working hours of the technical and administrative staff working in the project.	300000
2	Equipment's	• Purchase of 1 workstation for computation the data. • The technical specs of these WSs are below	175000
3	Software	• **SARPRO software tool for land subsidence analysis**	100000
4	Data	• High resolution digital elevation model sourced from 50 cm satellite images	150000
5	Data	• In-situ data measurements of 3 field trips to make observation and onsite measurements	85000
6	Communication and outreach	• Organizing 4 meetings • Organizing 1 technical workshop • Organizing 1 stakeholders workshop • Design of dissemination materials • Printing materials, brochures, banners, flyers and dissemination media • Making video of the project outcomes	150000
7	Publication	• 2 papers publication in international high impact factor journals	40000
8	**Total**		**1000000**

1. Technical Specification of the Workstation – Budget item 1

- Chassis: Tower.
- Processors: Dual Intel Xeon Gold 5122 3.6GHz, 3.7GHz Turbo, 4C, 10.4GT/s 2UPI, 16.5MB Cache, HT (105W) DDR4-2666 as minimum.
- System RAM: 64GB 8x8GB DDR4 2666MHz RDIMM ECC as minimum.
- Graphics & video Adapter: at least 8GB 4 DP.
- Hard Disks: the workstation should be delivered with 2 X 2.5" 1TB SATA Class 20 Solid State Drive.
- The delivered workstation should support Raid 1 as minimum.
- Integrated Drives: The workstation should be delivered with DVD RW
- Ports :
  Front: (2 USB 3.1 Type A, 2 USB 3.1 Type C, 1 Universal Audio Jack) as minimum.

  Rear: (6 USB 3.1 Type A ,1 Serial ,1 RJ45 Network, 2 PS2, 1 Audio Line out ,1 Audio Line in/Microphone) as minimum.

- Minimum I/O Expansion Slots:

All slots PCIe Gen 3

2 PCIe x16

1 PCIe x16 wired as x8

1 PCie x16 wired as x4

1 PCIe x16 wired as x1

1 PCI 32/33

- Operating System: pre-installed Windows 10 Pro for Workstations (4 Cores Plus) English,
- Monitor 24 Ultra HD 4K Monitor as minimum, the monitor must be of the same brand of the PC manufacturer.

Accessories

- Mouse (with the same machine brand).
- Arabic / English Keyboard (with the same machine brand)
- All drivers for system components, manuals & documentations,
- all cables, and power cords (Complied with Egyptian Standard Electricity Outlet)
- Warranty: the system must be delivered with at least 3 years warranty.

2. Technical Specification of the Software – Budget item 2

SARPROZ is a very powerful and versatile software that implements a wide range of Synthetic Aperture Radar (SAR), Interferometric SAR (InSAR) and Multi-Temporal InSAR processing techniques.

Main characteristics of SARPROZ:

- User friendly Graphic Interface: no coding knowledge is required for standard uses
- Based on Matlab: advanced users can very easily develop their own software extensions.
- It can be compiled and it can run independently from Matlab on any platform (Unix, PC, Mac).
- Completely parallelized: SARPROZ can run on multiple CPU cores or computer clusters automatically.
- Most Satellites/data formats supported, including Sentinel IW (TOPS) data.
- It can be run in automatic mode from the command line without graphic interface.

SARPROZ is the best tool for SAR/InSAR data investigation and for detailed infrastructure monitoring.

SAR PROZ

- - It is a software tool written in Matlab for processing InSAR, Persistent Scatterers InSAR, Q-PS InSAR (Synthetic Aperture Radar Interferometry, Persistent Scatterers, Quasi-PS)
- - It can be compiled and it can run independently from Matlab on any platform (Unix, PC, Mac).
- - Most Satellites/data formats supported, including Sentinel IW (TOPS) data.

3. Project time frame

The estimated duration of this project is 12 Months, the Gantt chart is shown in the following flowchart figure.

Plans for Disseminating Research Results

Summary of consolidated deliverables

D1. Literature review report

D2. Delivery of WS, Software Module, DEM data

D3. Intermediate Processed Data

D3. Intermediate Processed Data

D4. Social and Economic vulnerability maps

D5. Communication and outreach media, publicity materials

D6. Technical reports

D7. Published papers

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Declaration of original submission and Other Grant(s) (Max. one page)

We declare that their proposal did not and will not be submitted in whole or part for funding; twice within the same cycle, or to other funding programs within AASTM, or other funding agencies. This is to avoid any possible double funding.

PI

Dr. Mahmoud Elewa

الأكاديمية العربية للعلوم والتكنولوجيا والنقل البحري
Arab Academy for Science, Technology & Maritime Transport

Acknowledgment Form: ***Please copy this section, sign and scan it as a part of your proposal***

By signing below, I acknowledge that I have read, understand and accept to comply with all the terms of the foregoing application, mentioned in AASTMT general conditions and guidelines for submitting a research proposal, including, but not limited to:

- The total number of the application pages should not exceed **30 pages** excluding a cover page, as well as all sections of the proposal (as mentioned in AASTMT General Conditions and Guidelines for Submitting Research Proposal).
- At any time, a contracted AASTMT project team member should only be participating in a maximum of one project.
- Allowable budget maximum limit should be strictly adhered to in the project proposal. In all cases, requested budget has to be justified in detail.
- AASTMT guidelines, IPR rules, code of ethics, etc. (www.aast.edu), should be read carefully and adhered to. These are integral parts of the contract.
- All proposals – in addition to PI and other data - must be uploaded to the AASTMT website by the designated deadline. Uploaded PI data should conform to the corresponding data in the application form.

Applications will not be considered eligible and will be discarded in the following cases:

- Proposals submitted by e-mail or sent as hard copies or uploaded to the AASTMT website after the deadline.
- Proposals not conforming to the designated format.
- Proposals whose uploaded PI data does not conform to PI data in the proposal file.
- Proposals in which the allowable budget maximum limit has been exceeded.
- Proposals in which maximum allowable contracted AASTMT project participation limit has been exceeded.
- Proposal letter does not include a scanned copy of the signed and stamped PI institution endorsement letter in case of team member work outside AASTMT.
- Proposal does not include a scanned copy of the signed acknowledgment form.

Date & Signature: 12.03.2012

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