**Proposal Form**

**Climate Induced Changes on the Hydrology of Western North Coast of Mediterranean Sea, Egypt (Western Alexandria to Salum)**

**Reducing Uncertainty and Quantifying Risk through an Integrated Monitoring and Modeling System**

**Egyptian Working Group**

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**Keywords:** Risk & vulnerability analysis / assessment - Awareness rising - Risk mitigation - Risk spreading & transfer - Prediction & early warning.

1. **Abstract:**

1.1. **Summary on the benefits of the project and the expected impact.**

Studied area is located on northern part of Nile Delta from Matruh Gov. in western Nile Delta. Studied area is considered as one of the most populated region which has environmental complicated risks on water and soil, in addition to suffering from water management problem. The problem of surface and groundwater quality deterioration, land salinization and degradation, and water use mal practices are environmental hazards that should be focused and deeply investigated. The socio-economic and health impacts are other sides of the problem which needs sustainable water management issue.

Undoubtedly, the need for water resources becomes a vital issue in the development schemes of environmentally risked areas. Surface and groundwater resources evaluation, building up a digital geographic information system (GIS), with computerized updated maps made by remote sensing, which comprise all information about surface and groundwater resources are the main target of the present research. Setting-up a sustainable water resources management planning is an urgent needed in order to favor requirements for all activities, to enable mitigation of water-related hazards, and to maintain the water resources without deterioration.

According to the constructed digital data bases, geospatial GIS modeling techniques will be performed to determine the suitable areas and sites for performing sustainable water resources planning. These areas will be determined according to the availability and potentiality of water, soil resources as well as geotechnical behavior.

constructed digital data bases, geospatial GIS modeling techniques will be used as a core base in order to establish database for risk analysis/assessment to emphasize different scenarios for risk management in different aspects; water, soil, socio-economical, human health,….etc.

1.2. **Description of the project in view of the local need.**

This project will concentrate on the water risk (sea water intrusion, water scarcity, pollutions, contaminations, ..etc) and its effect on human health, socio-economical, population distributions, foundations, soil mechanics, agriculture, …etc. Sea level changes are caused by several natural
phenomenon; the three primary contributing ones are: ocean thermal expansion, glacial melt from Greenland and Antarctica - in addition to a smaller contribution from other ice sheets- and change in terrestrial storage. Among those, ocean thermal expansion has been expected to be the dominating factor behind the rise in sea level. However, new data on rates of deglaciation in Greenland and Antarctica suggest greater significance for glacial melt, and a possible revision of the upperbound estimate for sea level rise (SLR) in this century (Dasgupta, et al., 2007).

It is predicted that, with global warming, global average sea levels may rise by between 7 and 36 cm by the 2050s, by between 9 and 69 cm by the 2080s and 30–80 cm by 2100. The majority of this change will occur due to the expansion of the warmer ocean water (Roaf, et al., 2005). Since the Greenland and Antarctic ice sheets contain enough water to raise the sea level by almost 70 m, people will be directly affected by rising sea levels in several ways. As seas rise many areas of the coasts will be submerged, with increasingly severe and frequent storms and wave damage, shoreline retreat will be accelerated. In addition to expected disastrous flooding events caused by severe climate events such as heavy flooding, high tides, windstorms in combination with higher seas (Dasgupta, et al., 2007).

The impacts of SLR will not be globally uniform, because of local variations in vertical crustal movements, topography, wave climatology, long shore currents, and storm frequencies. Low gradient coastal landforms most susceptible to inundation include deltas, estuaries, beaches and barrier islands, and coral reefs. Regions at risk include the Low Countries of Europe, eastern England, the Nile delta in Egypt, the Ganges–Brahmaputra, Irrawaddy, and Chao Phraya deltas of south-eastern Asia, eastern Sumatra, and Borneo. In the United States, the mid-Atlantic coastal plain, the Florida Everglades, and the Mississippi delta will be particularly vulnerable (Vivian, 2005).

Developing countries are certainly identified mainly at risk. The consequences of SLR for population location and infrastructure planning in developing countries should definitely be reviewed by the developing world.

The paper aims to discuss the dilemma which may arise in Egypt with the diverse effects of SLR; environmentally and socio-economically. It will examine a number of environmental features affected; water resources and coastal zones. As well as highlighting the socioeconomic dimensions influenced; population, agriculture, urban areas and gross domestic product (GDP).
Past, present and predicted sea level trends

(Boko, et al., 2007)

Water scarcity and deterioration is a major problem will be studied as a base core that threatens the ambitious developmental planning of Nile Delta. Sustainable groundwater management is a worldwide trend for favoring the increasing human demands. The project outcomes will be a good source for historical and up-to-date databases, which could be used effectively by the decision makers, researchers, executive authorities, planners, and related governorates. The project will assist in evaluating studied area water resources and planning the optimal development and allocation of water supplies to promote sustainable development depending on water risk analysis, assessment and management. Natives as main end users and essential players will be a major target of the project’s objectives. The project objectives will assist in poverty alleviation, accelerating agricultural development, improved agricultural and food production, combating desertification, unemployment problems and raising the individual income.

1.3. Summary on request.

The work plan will depend on collection of all previous and available works about water and land resources and risks, which are enormous and need to be documented in the planned digital GIS of the project. Remote Sensing (RS) will be used as an effective imaging, mapping and monitoring techniques, where ETM landsat, Spot 4 images, Radar images, Egyptsat-1 images, Quikbird and others will be provided and interpreted for extracting valuable data about drainage system and surface and groundwater resources potentialities. Updating and upgrading the GIS-ready databases will be a good starting point for the project execution. The final stage will be the production of digital up-to-date maps, which will be in the form of hard copy and digital GIS formats capable to be used for future data update and ready for decision makers and planners. The project fund will be used for performing a full planning for surface and groundwater sustainable management with different alternatives, techniques and methods. Sufficient fund needed for supplying materials and collecting databases and running watershed modeling techniques. These data includes purchasing
sophisticated satellite images with excellent spatial and optical resolution, using advanced modeling software in watershed modeling and surface/groundwater assessment, purchasing commercial high resolution Digital Elevation Models (DEM) (30 m resolution), Radar images, etc. These data and equipments need adequate fund to be available and applied in our project. Also, in parallel, collecting of the previous social and economical studies will take part using all required data, statistics and reports in order to scan the previous and current socio economic situations regarding the water risk and its effect on all social and economical aspects as human health risks and economical results which will be the corner base for promoting the socio-economical and environmental expecting scenarios.

1.4. Summary on the objectives and proposed methods.

1-The surface/ groundwater risk analysis/assessment and status of environmental and human health sustainable water risk management will be presented in the form of updated digital maps (i.e., surface/ groundwater maps, sustainable water/land use planning, reports, graphs, digital GIS databases, etc). The future outlook of water resources development by sustainable groundwater management (SGM) will be given. RS and GIS will be integrated as specific data management and manipulation tools in creating digital databases of available water resources. GIS geospatial modeling techniques will be performed for determining priority areas for the sustainable development depending on a full framework of SGM.

2- Socio-economical, environmental and human health expecting scenarios regarding to water management.

1.5. The consequences of the project as a result of funding.

Funding such an ambitious project will assist in performing high quality GIS computerized maps that reflect the up-to-date modern techniques of SGM. Special expertise, sophisticated softwares, satellite images of water risks on surface water, groundwater, soil problematic, socio-economical and human health statistics beside databases are needed for performing the project objectives. Traditional water resources such as Nile surface water irrigation or groundwater in many parts of the study areas became exhaustive alternatives due to the increasing costs of water lifting, salinity problems and maintenance demands which affects as well socio-economic and environmental. SGM techniques and methods have also their own-bearing on groundwater aquifers’ augmentation (groundwater recharging and quality enhancement), enhancement of soil conditions and local environment, ease accessibility of water for direct agricultural use, and thus increase the agricultural net productivity for local consumption, etc. Then, logically, this will reflect on the socio-economic and environmental field as well.

1.6. How the project is innovative.

Innovative ways to improve the capture, storage and use of water resources will lead to more sustainable water risk management.

According to the ever modern worldwide trends and techniques in SGM, which is applied aggressively in many neighboring countries, Egypt should enter this area of using every water droplet for domestic and agricultural development. Conventional water resources will not cope with the increasing water demands. This full planning includes; proposing of the most appropriate and optimum levels of water allocation, groundwater volume calculations and all modern watershed modeling (WMS) techniques that are suitable for the study areas. Additionally, Remote Sensing (RS) and Geographic Information Systems (GIS) are highly sophisticated modern techniques
suitable for performing the tasks of the present proposal. The results of the present research could establish a good example to be applied in the other parts of our country. Socio-economic and environmental studies, collecting data, previous studies, statistics, expecting scenarios, strategic programs...etc consider as innovative ways to improve the current socio-economical situation regarding to water resources.

2. Introduction:

2.1 Description of the Project

Water Risk is nowadays one of the most crucial environmental problems world-wide. Pollution in aquifers and surface waters originates, apart from local sources discharging wastewaters, mainly from diffuse sources, scattered within the entire river basin and aquifers. The problem which must be dealt with is the prediction in space and time of the concentration of a pollutant substance introduced in the water body. The analysis of this problem with mathematical or physical models may assist in the optimal design of wastewater treatment plants, the positioning of wastewater outfalls and the determination of the flow rate and composition of effluents at the discharge outlet.

Definitions:

- The hazard is defined as the “probability of occurrence of a damaging event in a given period of time”.
- The vulnerability expresses the foreseeable consequences of a damaging event on stakes that can be human life or health, wealth, or the environment (Ozer, 2001). In the particular context of early warnings for food security, FEWS (1994) defines vulnerability as a measure of the susceptibility of some groups of persons or regions to have food insecurity.
- The risk is the product of the hazard and the vulnerability. It increases with the increasing occurrence of damaging events and with the vulnerability of a population or wealth. In theory, the same risk can be observed when the environment is very vulnerable but subject to very low occurrence probability of a damaging event as when the environment is not sensitive but very often confronted by damaging events. According to Gommes (1999), the risk is also defined more simply as a loss due to a damaging event. The advantage of this last definition is that it can easily be materialized and measured (e.g. loss of production rate and economical income). An acceptable risk is one that individuals, businesses or governments are willing to accept in return for perceived benefits. The level of acceptable risk is usually defined by local governments, taking into account information on drought hazards and combining it with economic, social and political factors specific to the area threatened.
- Water Risk Security: Water scarcity risks can be classified in terms of insufficient water to meet basic needs and in terms of the consequences which arise from this situation such as political and business instability or lost economic opportunities. There are also risks that arise from poor policy responses to water scarcity. Water scarcity normally arises due to a complex interaction of social, economic and environmental factors. It is seldom the product solely of a lack of precipitation. Similarly, responses to water scarcity require intervention by a range of stakeholders at the local, national and international scales if problems are to be resolved for the long-term. Tackling water scarcity in such a way that reduces long-term risks to a range of stakeholders can have multiple pay-offs in relation to a range of government policy priorities on poverty reduction, economic growth, food security and trade, health and conflict reduction. As businesses seek to secure long-term prosperity, to maintain competitive advantage and brand differentiation, and to secure stability and choice...
in supply chains, increasing water scarcity presents physical, financial, regulatory and reputation risks. The type of business will determine the level and exposure to risk and the appropriate response. Heavily water-dependent businesses with the best known brands will encounter the greatest reputation challenges. But many other businesses will face challenges and uncertainty due to the increasing scarcity of water.

**Risk management in water context:**

When discussing risk management in developing countries, it is important to note that vulnerability to water-related risks and other climate effects is closely linked to sustainable development:

- A range of social, political and economic factors, that are the root causes of vulnerability, depend on development.
- Risks can set back development, jeopardize the sustainability of development projects and eventually threaten progress towards the future development goal.

**Phases of the risk cycle:**

1) Risks Preparedness
   - Risk & vulnerability analysis / assessment
   - Awareness raising & risk mitigation
   - Risk spreading & transfer
   - Prediction & early warning

2) During the Risk
   - Forecasting & early warning
   - Emergency relief
   - Rehabilitation & restoring services

3) Risk Response
   - Rehabilitation & restoring services
   - Recovery & reconstruction
   - Risk & vulnerability analysis / assessment

**The risk preparedness phase consists of:**

- Risk & vulnerability analysis / assessment
- Awareness rising
- Risk mitigation, i.e. longer term measures to reduce risk and vulnerability, risk-proof infrastructure etc.
- Risk spreading & transfer
- Prediction & early warning

Note, that the first steps of the risk preparedness phase are also the last steps of the risk response phase.
The “during the risk as a problem” phase consists of:
- Forecasting & early warning
- Emergency relief
- Rehabilitation & restoring services

Note, that this phase overlaps with the risk preparedness phase on the one hand and the risk response phase on the other hand.

The risk response phase consists of:
- Rehabilitation & restoring services
- Recovery & reconstruction
- Risk & vulnerability analysis / assessment

Note, that the final steps of the risk response phase lead back to the risk preparedness phase.

Other risks associated with water risk can be classified as follows:

- Risk from insufficient water resources to meet the basic needs of people, the environment and business.

- Risk from the consequences of insufficient water resources, such as higher energy prices, loss of competitive advantage, political and economic instability, population migration, or lost economic opportunities.

- Risk from poor water management decisions taken in reaction to water scarcity, with negative consequences for some or all users. Such decisions may be a result of political or economic expediency, short-term thinking, lack of knowledge or capacity or simply desperation and lack of choice. Discussions of risks imposed by water scarcity must involve those who are responsible for, and those who are affected by, the problems of water scarcity. Yet there are major difficulties in applying risk to a broad set of conditions. Water is a public, a private and a social good, and a water scarcity event will have both private impacts and public repercussions, affecting stakeholders differently. Accordingly it is necessary in any risk analysis involving water to establish who is at risk, with the understanding that the risk to an individual might be very different than risk for a society or business, and that certain groups will be more vulnerable to water risk than others. Moreover, risks of different stakeholders overlap. It is also necessary to ask, “Risk of What?” with the understanding that water scarcity is a subjective concept. For a farmer, the danger may be back-to-back years of below average rainfall. For a business such as a processing plant, the risk might be a temporary, sudden cessation of stream-flow during peak operation time. For a government, risks might include the increasing costs of accessing water for utilities and the implications of higher energy costs, or failing to deliver on economic growth and development pathways because of poor water management.

Location of the Study Area

Studied area is located on the western part of Nile Delta from Rashid to Salum which considered as the international border between Egypt and Lybia.
Climate
The area of study is characterized by a warm and often rainless climate. This is due to its location in an arid to semi-arid belt. The arid condition during most of the year prevails in the study area and therefore, a chemical weathering is weak.

The maximum observed temperature was 35.6°C in July and August whereas, the minimum recorded temperature was 6°C in December. The average maximum temperature ranges between 19.1°C in January and 34.7°C in June while the average minimum temperature varies from 8°C in January to 21.3°C in July. In the same area the average daily temperature was about 13.2°C in January and 26.8°C in June.

Topography:
In general, land in the eastern Delta slopes northeastward, and in the west it slopes northwestward, and between the two it slopes to the north. This suggests that the growth of the Delta was faster in the center than in the eastern and western wings. The general slope of the Delta between Cairo and The Sea is 12 m in 170 km., i.e., 1:14,000. The contour lines are closer to each other in the southern Delta, and move farther apart with distance from the apex.

It can also be noted that the shape of the contour lines reflect approximately the shape of the Mediterranean shore, and that they are compressed southward in the east and west edges of the Delta (with more compression in the eastern edge). The eastern portion of the Delta is slightly higher than the western portion. Therefore, in addition to the general slope toward the north, there is a secondary slope toward the west. Because of this secondary slope, the Damietta branch presents the highest level in the Delta at the same latitude line. This explains the direction of the irrigation canals in the middle portion of the Delta, where most of them are fed from the Damietta branch and runs in the northwest direction toward the Rosetta branch (Abu El-Izz 1971, Hemdan, 1980, and Serag El-Din, 1989).

Geomorphology:
In the Nile Delta region nine geomorphic units are represented. The units will be described below briefly.

Young Alluvial Plains:
Occupying much of the central portion of the Nile Delta region, the young alluvial plain is underlain by a fertile silty clay layer. This plain slopes very gently northward at the rate of about
Old Alluvial Plains:
This unit is underlain by dark brown gravels and coarse sands with different degrees of cementation and occupies the outer fringes of the present floodplain. The surface of this plain is gently undulating and displays classical examples of landforms by wind deflation.

Mediterranean Foreshore Plains:
The foreshore plain occupies the area determined by the coastal lakes and their inland extension into the brackish water lagoons. Landforms represented in that plain include the wetland areas of the main lakes, the sabkha or evaporites consisting of gypsum, halite and clays mixed with quartz sand and silt.

Old Coastal Plains:
The Old coastal plain occupies a portion of the northwest corner of the Nile Delta depression and can be a remnant of the offshore plain, which escaped submergence in early Holocene times. Features designating this plain comprise the series of calcarenite bars (Kurkar), formed on a receding shoreline in Pleistocene times. Such bars alternate with shallow elongated depressions, which display classical lagoonal environment of depression.

Turtle Back:
In eastern portion of the Nile Delta, the surface is dotted with a number of hills, known as turtle backs are built up of coarse sand belonging to an older phase of the Neonile system.

Sand Dunes:
The mobile coastal dunes and the stable coastal dunes, which represent the older generation of the dunes in the foreshore belt.

Depressions:
Two negative landforms marking the outer limit of the Nile Delta. These are Wadi El—Tumilat (5 m +MSL) on the eastern side and Wadi El-Natrun (22 m −MSL) on the western side. In the surroundings of the two wadis shifting sand deposits have accumulated.

Structural Plains:
The Structural form the outer margins of the old Nile Delta. The surface is underlain by medium hard Neogene sediments and is characterised by a series of structural ridges of low topographic releif.

Limestone Plateau:
These are present at the southeastern and eastern portions of the mapped area. The surface rises to more than 500 m +MSL and is underlain by resistant limestone. The surface is generally complicated by faulting and folding. The structural plateaux act as the principal watershed areas.
**Geology:**

Surface exposures belong almost totally to the Quaternary and Holocene in general. The Nile Delta itself is a morpho-tectonic depression, which is bounded on the western side by the North Western Desert and on the eastern side by the Cairo-Suez district.

In the Nile Delta, the Quaternary sediments attain a thickness in excess of 1000 m. They lie unconformably over the Pliocene or older sediments. In the adjacent desert areas, the Quaternary section is thin and incomplete.

Deep boring for oil in the Nile Delta and in the adjacent areas (Fig. 4), points to the fact that the sedimentary section has a total thickness of about 3 km in the southern portions and rests unconformably on the Precambrian-Early Cambrian Basement rocks. The thickness increases to more than 10 km north of the so-called “Hinge Belt”, which crosses the delta in the center in an E.NE-W . SW direction.

The Quaternary sediments in the Nile Delta have been classified into two main units (Rizzini et al., 1978): Bilqas Formation which is assigned to Holocene, overlying Mit-Ghamr Formation which belongs to Pleistocene. Other Holocene formations that appear in the Delta include sand dunes and coastal deposits. Other Pleistocene deposits that appear in the northern wet edge of the Delta include the oolitic limestone ridges. Brief descriptions of these formations are given below.

**Holocene**

**It** is composed of silt and clays and includes peat layers at the northern portion of the Delta (Rizzini et al. 1978; Said, 1981). It covers the whole Delta area and disappear gradually at the Delta fringes. This formation shows a distinct lateral variation from clayey silt, with intercalations of medium and fine sand lenses, in the southern and central parts of the Nile Delta, to silty clay with few intercalation of silty sand covered by sabkha deposits at the northern part. The thickness of the Holocene sediments varies from 5 to 30 meters in the southern part of the Nile Delta, and increases to more than 60 m at the north. The thickness and lateral continuity of Bilqas Formation varies from place to place depending on the local conditions present at the time of deposition (Sestini, 1989).

**Sand Dunes**

Sand dunes are scattered throughout the Nile Delta, large areas are found in the north and edges of the Delta.

**Coastal Deposits**

Coastal deposits are found in a thin strip along the coast. They are composed of loose fine to medium quartz sand with different percentages of silt, marine shell fragments, and sea weeds.

**Pleistocene**

**It** is covered by the holocene Nile silt and clay (Bilqas formation) and underlain by Pliocene deposits. This formation crops out in the southwestern and southeastern portions of the Nile Delta, and is covered by sand dunes in some areas. It appears also isolated islands (turtlebacks) surrounded by cultivated areas (Bilqas Formation). The sediments of this formation are composed of sand and gravel intercalated with clay lenses in the south and middle of the Delta, and changes to intercalations of sandy and clayey layers in the north. The thickness of Mit Ghamr Formation ranges from 100 m to 400 m in the southern parts of the Delta, ranges between 500 to 700 m in the central parts, and reaches to more than 1000 m in the northern part of the Nile Delta.
Hydrogeology:

Fissured aquifer Extensive or local generally moderately productive aquifer:
This unit is locally exposed in the southern parts of the map outside the Nile Delta and is also recorded in the subsurface.

Extensive, moderately to low productive aquifer:
It is represented by the Nubian sandstone aquifer. It has been found in a number of wells in the deep southern portion of the map.

Extensive or local, low productive aquifer:
It occupies most of the southeast portion corner of the area, including Wadi El-Natrun. The unit is composed of variety of clastic rock units, including Pleisto-Pliocene, Pliocene, Miocene and Oligocene.

Hard Rocks:
It is found in small patches in the eastern and western desert fringe of the Nile Delta. It comprises the Oligocene basalts which are exposed locally.

Hydrochemistry
Pollutants as Water Risk:
Pollutants toxic and even health hazard to human beings even at relatively low concentrations because of their tendency to accumulate in the body.

Trace Elements as Water Risk:
- Copper content in perched water ranges between 0.057 ppm and 0.1136 ppm
- The concentration of zinc in perched water ranges between 0.015 ppm and 0.7693
- The concentration of lead in perched water ranges between zero and 0.0694 ppm. High lead content (>0.05 ppm) is noticed in samples nos. (3, 10, 14 and 19). Lead accumulates in the bones and soft tissue, such as the kidney, aorta, liver, and brain cortex. In advanced cases of lead poisoning, kidney damage is often encountered in addition to neurological symptoms. Lead poisoning is a known cause of mental reduction, cerebral palsy, and Optic atrophy in children.

- Manganese content in perched water ranges between zero and 0.5848 ppm (>0.1 ppm)
- Iron content in perched water ranges between 0.294 ppm and 0.18595 ppm

  - Nickel content in perched water ranges between 0.0115 ppm and 0.2043 ppm. No guideline value for nickel in drinking water was set. Nickel is relatively non-toxic element for man. So, it is possible to conclude that the nickel content in perched water is low.
Environmental problems under consideration in this project:

Problems of Soft and Very Soft soil Associated water risks:
Problems associated with construction on soft clay e.g. excessive settlement, low bearing capacity, unstable slopes, unstable excavation, problems with pile foundations and problems with tunneling.

Considerable amount of settlement is experienced by the clay layer due to the weight for the hydraulic fill itself.

Different problems face the tunneling engineer when approaching soft clay zones. Problems include face instability, wall and crown instability, large displacements and settlements, and excessive lining loads. The overload factor is used to predict the behavior of the clay around the tunnel.

The improvement of very soft clay using sand cushion reinforced with geogrids led to significant improvement to the load-settlement properties in general and increased greatly the bearing capacity, the ratio of sand layer depth to footing width increased, soil could stand higher stresses.

The improvement of soft clay soil characteristics using the lime column techniques leads to consolidation rate increased after installing the lime column.

The improvement of soft clay characteristics due to stone column installation. A method is proposed for evaluating the improvement of the Young modulus of (soft clay) in which a vibrocompacted stone columns is installed. By considering a composite cell model a numerical analysis is carried out using Plaxis software to simulate the vibro-compaction technique, which leads to a form of primary consolidation of the soft clay.

Studying the improvement of soft clay characteristics using prefabricated vertical drains (PVDs). Carrying out a large scale laboratory model test to assess the suitability of the selected PVD in the consolidation of the ultra soft soil. The model tests indicated that the discharge capacity of the drain can decrease substantially after the drain has experienced large deformations. To overcome this problem, PVDs were installed in two rounds. The first round was before the application of surcharge, and the second was after substantial settlements have taken place. Field instrumentations were utilized to monitor the performance of PVDs during consolidation. The monitored settlement and pore water pressure results are presented and discussed. The study shows that it is effective to use PVD for the consolidation of the ultra-soft soil, if special care has been taken in selection and installation of PVD and in fill placement to overcome the difficulties involved in the consolidation of ultra- soft soil.

The improvement of soft clay characteristics using geocell reinforced sand underlain by soft clay. The effectiveness of geocell reinforcement placed in the granular fill overlying soft clay beds has been studied by small scale model tests in the laboratory. The test beds were subjected to monotonic loading by a rigid circular footing. Footing load, footing settlement and deformations on the fill surface were measured during the test. The influence of width and height of geocell mattress as well as that of planar geogrid layer at the base of the geocell mattress on the overall performance of the system has been systematically studied through a series of tests. The test results indicate that with the provision of geocell reinforcement in the overlying sand layer, a substantial performance improvement can be obtained in terms of increase in the load carrying capacity and reduction in surface heaving of the foundation bed. An additional layer of geogrid placed at the base of the geocell mattress further enhances the load carrying capacity and stiffness of the foundation bed. Its beneficial effect decreases with the increase in the height of the geocell mattress. A seven-fold increase in the bearing capacity of the circular footing can be obtained by providing geocell reinforcement along with a basal geogrid layer in the sand bed underlying soft clay.

2.2. The reason for the grant request - issue, problem, or need.

Performing the proposed activities require an adequate funding for data inventories,
collection, field trips, incentives, reporting, sophisticated satellite images, softwares, expert staff salaries etc. The development problem involves numerous issues related to rights of indigenous and exogenous communities to raise their income, raise their awareness about the technology of SGM and enhance life circumstances. Water resources should be accommodated in depth due to the nature of each case. Also the sensitivity of some of these issues (i.e. socio-economics) needs to be taken into consideration.

2.3. The objectives to be achieved through this funding.

- To use Landsat TM/EgySat-1 images (SPOT 4), Radar images and others for mapping purposes and production of important essential maps.
- To prepare a series of surface/groundwater resources maps to evaluate surface/groundwater evaluation maps.
- To evaluate surface/groundwater resources for the sustainable development, urban allocation and hazard protection.
- To recognize land capabilities for deteriorated lands cropping.
- To propose the optimum levels of water resources protection to people and property and suggest the water control works to optimize the use of surface groundwater resources and minimize their economic and environmental hazards.
- To plan for water resources sustainable management.
- To provide digital GIS infrastructure data, plans and related information as required for structural and non-structural (planning) investigation related to water resources development.
- Water management from socio-economical point of view and establishing many expected scenarios.
- Data base for water risk causes in order to establish a base of studying risk analysis/assessment to reach the finalize purpose which is water managemet
- Training for all fields that are concerning on water risk (hydrologists, engineers, scientists, geographer, medical scientists, ......etc)

2.4. The major focus of the proposed project and stresses why this particular program should be undertaken.

The project aims to provide a sustainable water risk managemet for rural communities through a number of innovative strategies designed to promote traditional water use technologies. The project proposal specifically aims to:

- Provide a sustainable source of clean drinking water.
- Provide water for agriculture to guarantee reliable locally produced food.
- Improved community health (by reducing the level of waterborne diseases).
- Improve industry (stimulate sustainable economic growth through a revival of the water-Dependant agricultural industries).
- Improve local environment.
- (Reforestation, soil conservation, groundwater recharge, protection of biodiversity, etc.).
- Combating desertification and drought.
### 3. Statement of Proposed Research (SPR):

#### 3.1. General objectives:

2. To use Landsat TM/EgyptSat-1 Spot-4 images, Radar images and others for mapping purposes and production of important essential maps.
3. To prepare a series of water resources maps to evaluate water potentialities and assessment.
4. To formulate water resources development master plan by SGM.
5. To evaluate water resources for the sustainable rural development and urban hazard protection.
6. To propose the optimum levels of water resources protection to people and property and suggest the water control works to optimize the use of water resources and minimize economic and environmental hazards.
   
   To document project output through digital GIS-ready data bases, maps, drawings, photos and printed reports and maps.
7. To use Field visits in to the research area (Governorate) for an inter face with Governorate officials to know about Governorate plan of sustainable planning and management of water resources.
8. To Initiate and prepare scientific papers to promote sustainable socio-economic planning and management of water resources in the area.
9. Studying water risk concept in order to manage
10. Training

#### 3.2. Specific objectives:

1. To construct a complete digital GIS data bases.
2. To construct different thematic maps including water resources, water quality, water supply, water level records, soil and land capabilities, land degradation, etc.
3. To construct surface water potentiality map.
4. To plan for SGM.
5. Studying the treatment technical procedures in Bahr El Baqar as a case study.
6. Using the treated water in fishing lakes
7. Water Strategy strategies

#### 3.3. Actions needed during the period of the project.

The project will be performed in three working years, with activities divided as follows:

**Year 1:**

1. Preparation of infrastructure database and documentation.
2. Digital conversion and preparation of data.
3. 6 Field trips and in situ meetings with the concerned authorities and communities.
4. Official and public presentations for explaining the project’s objectives to raise the public awareness about the SGM.

5. Performing socio-economic investigations

6. Data inventory about surface and/or groundwater and soil profiling (testing land capabilities).

7. GPS recording for wells, water points, land units segregation and profiling.

8. Base map construction.


10. Document the status of water resources planning and development in the area.

11. Presenting a paper on the result of the fieldvisits as part of technical and non-technical aspects.

12. finalizing a questionnaire to cater for socio-economic development of the area together with findings of certain figures in official plans, and using action research methodology with interface with various stakeholders.

**Year 2:**

1. Construction of thematic multilayer GIS system.

2. Performing and running the watershed model to assess the water resources and land use pattern.

3. Construction of surface water potentiality map using RS and GIS.

4. Soil and land capability map.

5. Water use map

6. Sustainable groundwater management (SGM) planning.

7. Water hazard protection maps.

8. Examining the strength and weakness of Farmers Associations work in the project research area with the view of closing gaps on water planning and management.

9. Initiate a code of conduct of uses and management of water resources, especially in ground water and surface water.

10. Integrate women in all aspects of water planning and aspects of management according to the project implementation phases.

11. Design an e-learning program with school children 8-12 years for water conservation and to eliminate pollution.

12. Studying the living situation of fishermen who are depending on fishing in lakes of the research area.

13. Studying industrial pollution problems for the sake of changing present problems of surface water of the Nile.

14. Studying tourism problems of the area that is connected to water problems of management, especially drinking and sanitation questions, this would be in cooperation with municipalities of the research area.
**Year 3:**

1. Determining priority areas for development according to the SGM.
2. Final reporting with maps, illustrations, photos and digital copy of all outputs.
3. Digital copy from the constructed GIS, will be delivered for official use and planning purposes.
4. Results and recommendations.
5. Workshop and presentation of project outputs and results.
6. Finalizing a paper on water and sanitation planning using innovative approaches of systems analysis.
7. Finalizing a paper on sustainability elements of: economic efficiency, social equity and environmental sustainability as well as triad of relationship between the three elements with special reference to the research area.
8. Finalizing a paper on present low and regulations under which water resources is management.
9. Finalizing a paper on water use ethics with the view of enforcing the implementation of law and regulations.
10. Finalizing a paper that setout indicators and standards on best ethical practices in the research area (success stories), the paper deals with aspects of: water uses, water management and local conflicts resolution.
11. Finalizing a paper on existing institutional mechanisms with the view of strengthen management and governance in the project area.
12. Finalizing a paper on capacity building with special emphasis on shaping leadership skills from local people. The paper should identify elements of a training program that includes: team work, promoting the negotiation skills for local conflict management, adaptive management, promoting water ethics (norms of behavior), promote the art of listening and social learning dialogue.
13. Finalizing a paper on bench marking and bench learning of best ethical practices that sets out indicators and standards in a form of data base.

**Year 4:**

1. Studying the water risk sources
2. Water risk analysis
3. Water risk assessment
4. Water risk management scenarios and strategies

**3.4. The procedural aspects of the project.**

The Water Risk Excellency center of Zagazig University (ZU) with different considering authorities and institutes will be concerned.

The study consists of hydrological and hydrogeological investigations, evaluation of development potential by surface and groundwater, water use, formulation of groundwater development plan,
socio-economic evaluation, and environmental aspects.

Recommendations will be made for the management of present and future water resources, including development, conservation, and monitoring.

The data, which will be used to execute this project, includes meteorological data (Meteosatellite Data), satellite ETM+ images of different dates, Egyptsat-1 and Spot-4 images, Radar images, stratigraphic data on geologic formations, and data pertaining to wells and springs and data about drainage basins. These data will be inputted in a digital GIS system for making them being available in digital updatable formats.

Analysis, statistical geospatial modeling and mapping techniques will be performed.

The deliverables of the project data base will be in the form of:
- Five half annual progress reports of data base and GIS.
- Final Report, with maps, illustrations and photos.
- Digital copy of Final Report and maps (on CDs).
- Digital copy of the GIS data bases (on CDs).
- Digital copy of models (on CDs).
- 2 workshops for the project and establishing the risk management center in ZU.

### 3.5. The expected results versus objectives.

<table>
<thead>
<tr>
<th>Obj. No.</th>
<th>Objective</th>
<th>Expected Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>To provide digital GIS database about climatic records (Period: 1999-2008). Socio-economic and environmental papers and collecting data and previous studies</td>
<td>Data bases documentation and refining to be ready for inputting in the planned GIS system</td>
</tr>
<tr>
<td>2</td>
<td>To use Landsat TM/Egyptsat-1 Spot-4 images, Radar images and others for mapping purposes and production of important essential maps.</td>
<td>Base maps construction, geological map, geo-morphological map, Drainage net map, buried channels map, present-day water/land use pattern, etc.</td>
</tr>
<tr>
<td>3</td>
<td>To prepare a series of water resources maps to evaluate water potentialities. Socio-economic and environmental papers and collecting data and review of previous studies in order to prepare data base for the current situation</td>
<td>Surface/groundwater capability maps</td>
</tr>
<tr>
<td>4</td>
<td>To formulate water resources development master plan by SGM</td>
<td>Surface water/groundwater Development Master Plan by SGM</td>
</tr>
<tr>
<td></td>
<td>Analyzing the socio-economical data base in order to assessing the current situation and establishing different scenarios (through the whole project parallel to every step)</td>
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<tr>
<td>5</td>
<td>To evaluate surface water resources for the sustainable development, urban allocation and hazard protection</td>
<td>water use map and water/land use map</td>
</tr>
<tr>
<td>6</td>
<td>To propose the optimum levels of water resources protection to people and property and suggest the water control works to optimize the use of SGM and minimize economic and environmental hazards</td>
<td>Water resources hazard mitigation planning, mitigation measures, surface water controlling structures and their localization</td>
</tr>
<tr>
<td>7</td>
<td>To perform Watershed Management</td>
<td>Land Management Master Plan</td>
</tr>
<tr>
<td>8</td>
<td>To present some of the socio-economic design elements of micro-catchments SGM</td>
<td>RWH technology transfer and local society training programming.</td>
</tr>
<tr>
<td>9</td>
<td>To document project output through digital GIS-ready data bases, maps, drawings, photos and printed reports</td>
<td>GIS-ready data bases, digital maps, photos, illustrations, digital and printed 5 half annual reports. One Final report in both digital and printed formats</td>
</tr>
<tr>
<td>10</td>
<td>To present project’s outputs through presentations and workshops Socio-economic and environmental results versus objectives could be added from here</td>
<td>Annual meetings to discuss project progress with one final workshop to present project outputs</td>
</tr>
</tbody>
</table>

**4. Methods & Procedures:**

**6.1. Activities proposed for carrying out project objectives versus research groups:**

<table>
<thead>
<tr>
<th>#</th>
<th>Activity/Tasks</th>
<th>Objective¹)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Collection of infrastructure data and previous works Socio-economic and environmental, collecting data and previous studies</td>
<td>To provide digital GIS database about climatic records (Period: 1980-20010) Socio-economical data base</td>
</tr>
<tr>
<td></td>
<td>Satellite images collection, preparation, geometrical correction, enhancement and processing for mapping purposes including sea water intrusion.</td>
<td>To use Landsat ETM+/EgyptSat-1 Spot-4 images, Radar images and others for mapping purposes and production of important essential maps</td>
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<tr>
<td>3</td>
<td>Field Trips, water points inventory, technical and socio-economical data verification and updating</td>
<td>To prepare a series of water resources maps to evaluate water potentialities Socio-economical data base</td>
</tr>
<tr>
<td>4</td>
<td>Construction of multi-layer GIS system and digital data bases, setting-up SGM policies and strategies, adopting methodologies acc. To local conditions Analyzing the socio-economical data base</td>
<td>To formulate water resources development master plan by SGM Assessing the current situation and establishing different scenarios (through the whole project parallel to every step)</td>
</tr>
<tr>
<td>5</td>
<td>GIS &amp; RS mapping procedures, watershed modeling techniques for runoff &amp; flash floods assessment, etc.</td>
<td>To evaluate surface water resources for the sustainable development, urban allocation and hazard protection</td>
</tr>
<tr>
<td>6</td>
<td>Statistical &amp; geospatial modeling, damming site selection, environmental impact assessment (EIA) assessment, etc.</td>
<td>To propose the optimum levels of flood protection to people and property and suggest the water control works to optimize the use of SGM and minimize economic and environmental hazards</td>
</tr>
<tr>
<td>7</td>
<td>Geospatial modeling techniques</td>
<td>To perform Watershed Management</td>
</tr>
<tr>
<td>8</td>
<td>SGM technology transfer and local society training</td>
<td>To present some of the socio-economic design elements of micro-catchments rainwater harvesting</td>
</tr>
<tr>
<td>9</td>
<td>Reporting, hard &amp; digital copies preparation of all project’s outputs</td>
<td>To document project output through digital GIS-ready data bases, maps, drawings, photos and printed reports</td>
</tr>
<tr>
<td>10</td>
<td>Reporting</td>
<td>To present project’s outputs through presentations and workshops</td>
</tr>
</tbody>
</table>