

CHAPTER V

Results and Discussion

This chapter presents results and discussion in three sections. The first section presents risk assessment of land use in Abu Qir region, using Shuttle Radar Topographic Mission (SRTM) data and contour elevation point map in building digital elevation model (DEM). The second section presents a questionnaire analysis in Abu Qir field. The third section presents adaptation options to SLR.

V.1 Land Use Classification

Abu Qir Bay region is a well-known promising resource for tourism, industry and agricultural activities. The coastal zone hosts important ecological habitats, economic centers and agricultural resources (El Raey, et al., 2010)^[19]. Cultivated areas present 60 %, residential areas present 10% includes the rural area. The remaining part, 30% is occupied by services and facilities as hospitals, schools, health units and tourist facilities and industries as shown in table (V -1). This part will discuss the geo-database that has been built including layers of land use, topography, land cover and population. Analysis of data has been carried out to assess vulnerability of various land use and land cover classes to the impact of the rise of sea level, and to identify the most vulnerable areas to climate change on the study area:

Table (V -1): Total land use in study area

Graphic entity	Total study area	110,763301751772 Km ²	
Polygon	Layer name	Area km ²	Percentage of total area
	Cultivated area	56.967315	51%
	Residential area	10.666914	10%
	Schools, industries, health units, hospital and archeological sites	32.35674	29%

V.1.1 Risk Assessment of Cultivated Areas

The Cultivated area is one of the most important layers of land use in the area of Abu Qir region. It is characterized by the irrigated cultivation of date palms, fruit trees and traditional crops. It represents about 60% of the total area in Abu Qir region as shown in table (V -1).It is classified into orchards, trees and reclaimed land. The percentage of trees and orchards constitutes about 65% from all cultivated area and almost reclaimed land constitutes approximately 35%. These rates are currently decreasing due to the encroachment on farmland as a result of the lack of security due to the political events and because of the high impacts of the rise of sea level.

Table (V -2) approximately risk in cultivated areas in Abu Qir

Elevation Points	Classification of Elevation points	Percentage of Cultivated Areas at Risk
From -4 to -1	high risk	49 %
From 0 to 3	moderate risk	26 %
From 4 to 22	low risk	25 %

From the previous table (V -2) 49% of farmland is located between -4 and -1 meters below sea level putting into flooded farmland in the case of sea-level rise and also displays this land to salinization, presenting the high risk areas. About 26% of farmland is located between 0 and 3 meters above sea level and make this land affected to sea level rise, presenting the moderate risk areas.

About 25% of the farmland is located between 7 and 22 meters above sea level which makes this region a less dangerous area of SLR, presenting the low risk areas. There are 24.054 persons who work in the fields of (agriculture and fishing) (CAPMAS, 2006)^[56]. All people who work in these fields are exposed to the loss of their jobs by any change in climate. The map in **Figure (V-1)** shows the risky areas of cultivated land in the study area.

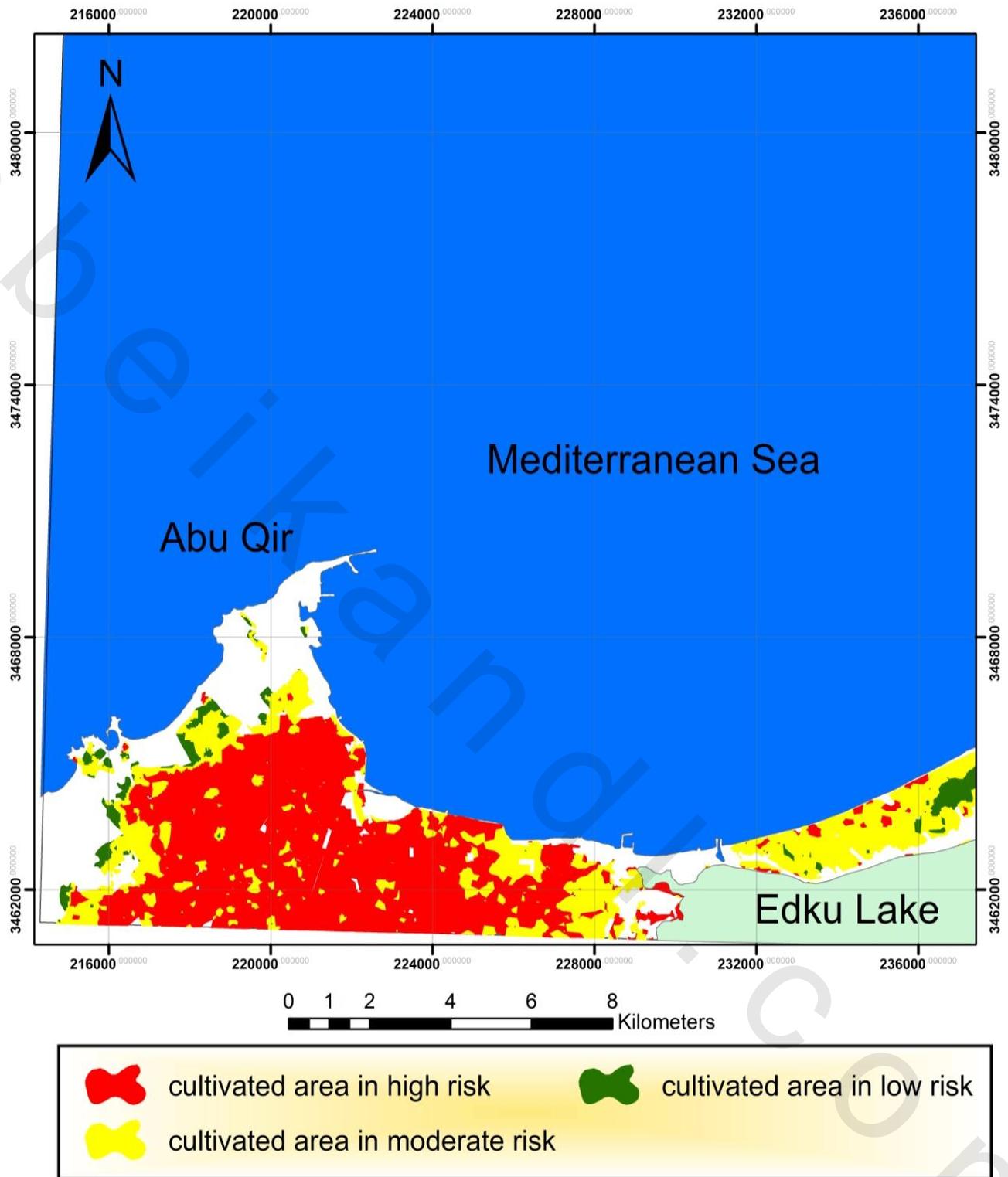


Figure (V -1) Cultivated areas in high, moderate and low risk in Abu Qir Region

V.1.2 Risk Assessment of Residential Areas

The proportion of buildings is approximately 10% of the area of Abu Qir. This area is divided into Eastern Abu Qir, Western Abu Qir and El M'amourah with a population of 72321 thousand people. And it is worth saying that 10% of the total population is in El-Montazah District second (CAPMAS,2006) ^[56]. It was found that the buildings in a continuous increase as a result of the political events and the absence of law and security. it was found that these buildings, especially are located in the west of Abu Qir, represents a great danger to the area of Abu Qir where it's very close to the sea, a distance of 20 meters or less exposing them to the risk of sea level rise, especially that this region isn't protected by any form of protection, as well as the erosion of foundations .which constitutes a great danger to close populated areas.

Table (V -3): Approximate Risk in Residential Areas in Abu Qir

Elevation (m)	Classification of Elevation Points	Percentage of Residential Areas at risk
From -4 to -1	high risk	5 %
From 0 to 3	moderate risk	40 %
From 4 to 22	low risk	55 %

From the previous table (V -3) ,about 5% of the buildings is located between -4 and -1 meters under sea level, it was found that the number of buildings is in a continuous increase because of the lack of security and the intention to build so far in the area of Abu Qir. From the analysis of GIS database, it could concluded that there are some dangers around the buildings in the study area; the next map illustrates the elevation of land and the distribution of buildings all over Rosetta (urban and rural).About 40% of the buildings in the area of Abu Qir is located between 0 m and 3 m above sea level.

About 55% of the buildings are located between 4 or more meters above sea level. The next **figures (V -2)**, show the residential areas that are at risk as a result of the impacts of sea level rise.

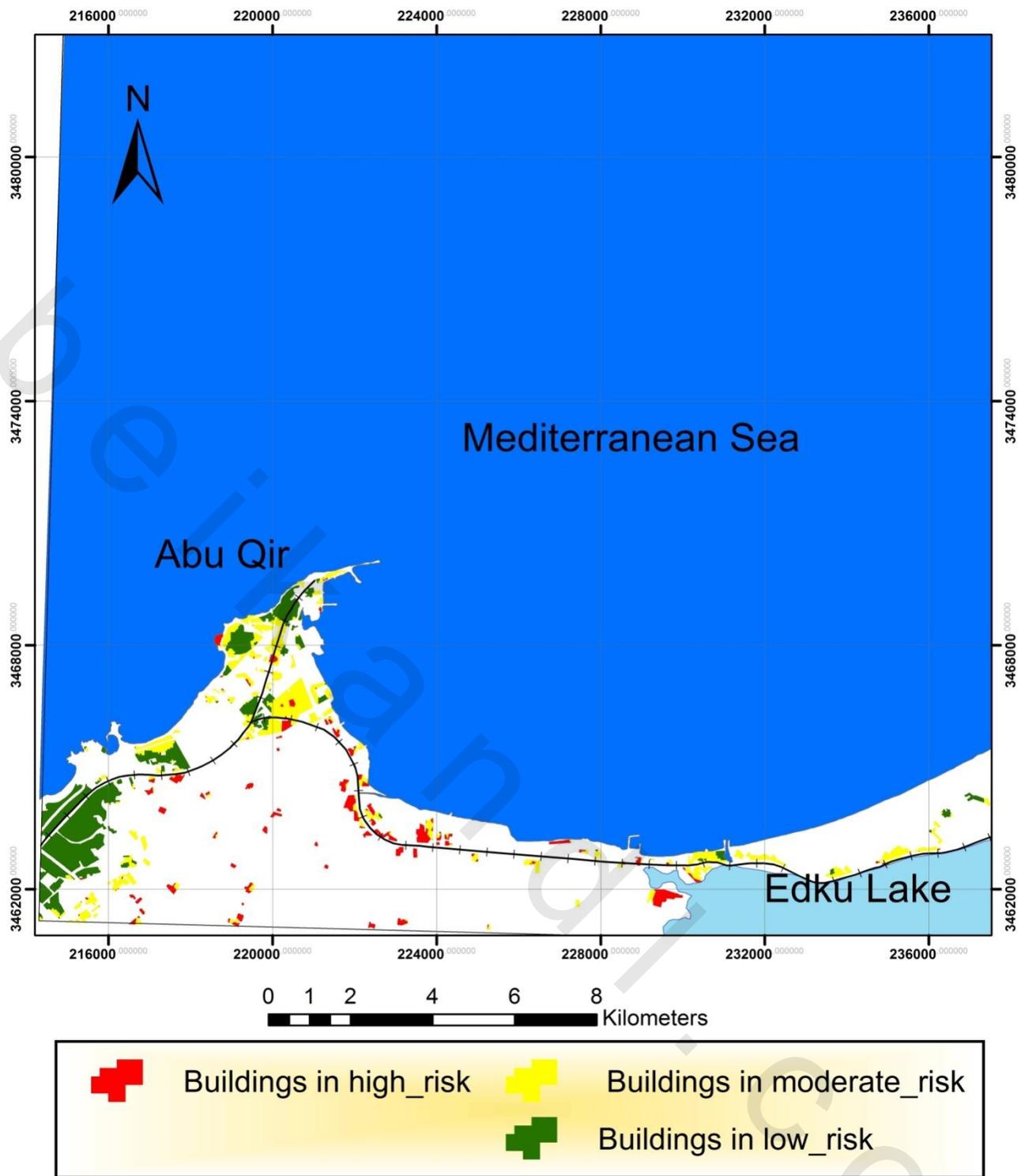


Figure (V -2) Residential areas in high, moderate and low risk in Abu Qir Region

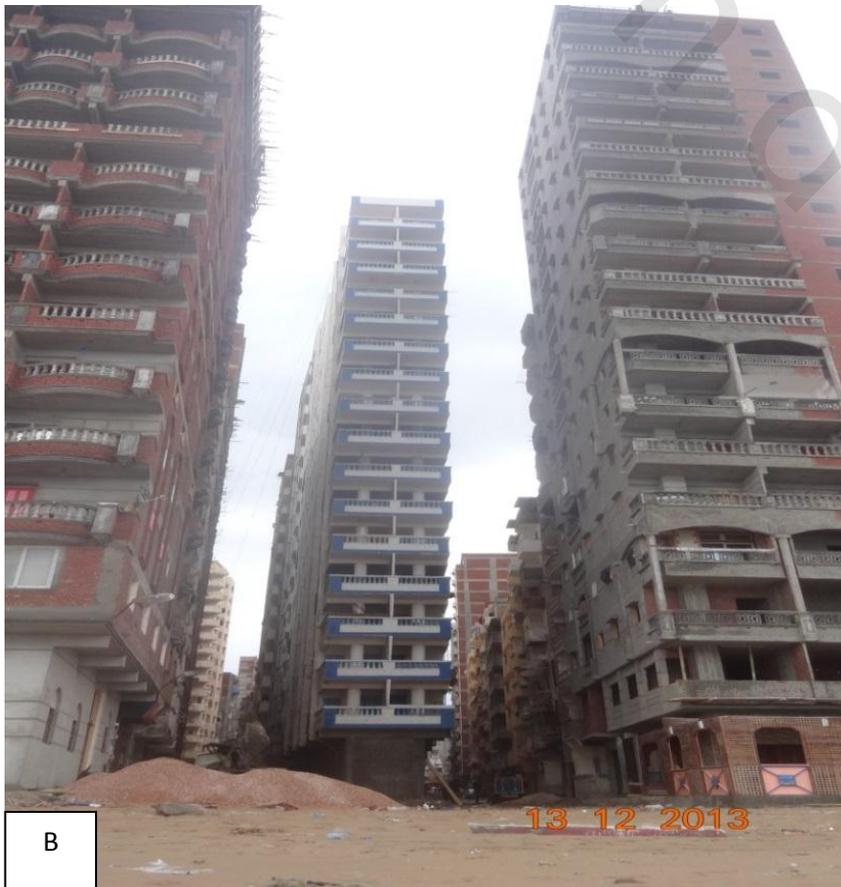


Figure (V -3) A,B erosion in western Abu Qir bay
The same building after one year





Figure (V -4) these pictures where it is found at the position of the mark, this building is located on the western Abu Qir bay and up height of 17 floors is an exhibition of collapse causing a high risk to neighboring buildings



This is the same picture (V -4) after nine months with another building built on coast line in a short time A,B erosion in western Abu Qir bay

The same building after one year

V.1.3 Risk Assessment of Industries

It represents an economic value in the area of Abu Qir and it is important to know that 34% of the plants in Abu Qir area is located between -1: -3 (such as Abu Qir for Fertilizers –Edfina Company for Saved Food –Petrojet Company - Paper Company) and they lie in the most dangerous area. 66% of other plants are in the moderate-risk areas between 0:3 (such as Offshore Oil Services Company - Concrete Company - Electricity –Rakta Company for Paper –Factory of Harby– Company of Alligator - Inc. Qaha). Most industrial activities are highly vulnerable to SLR, since they are located less than 2 meters below SLR and could be inundated by any rise in the sea level as shown in figure (V -5).

Table (V -4) approximately Risk in industries in Abu Qir

Elevation (meter)	Classification of Elevation Points	Percentage of Industrials at Risk
From -4 to -1	high risk	34 %
From 0 to 3	moderate risk	66 %
From 4 to 22	low risk	-

According to the previous table (V-4) it is found that about 34 % of industrial components are exposed to the impacts to SLR. They are located in areas of high risk and these industrials lie on the coast line in Eastern Abu Qir .It worth saying that the only protection to these industrials is Mohammed Ali sea wall. 66 % of the industrials are located in moderate risk and any sea rise effects on these industrials as shown in figure (V -5).According to the analysis of GIS, most of industrial activities such as petrol and natural gas companies are highly vulnerable to sea level rise.

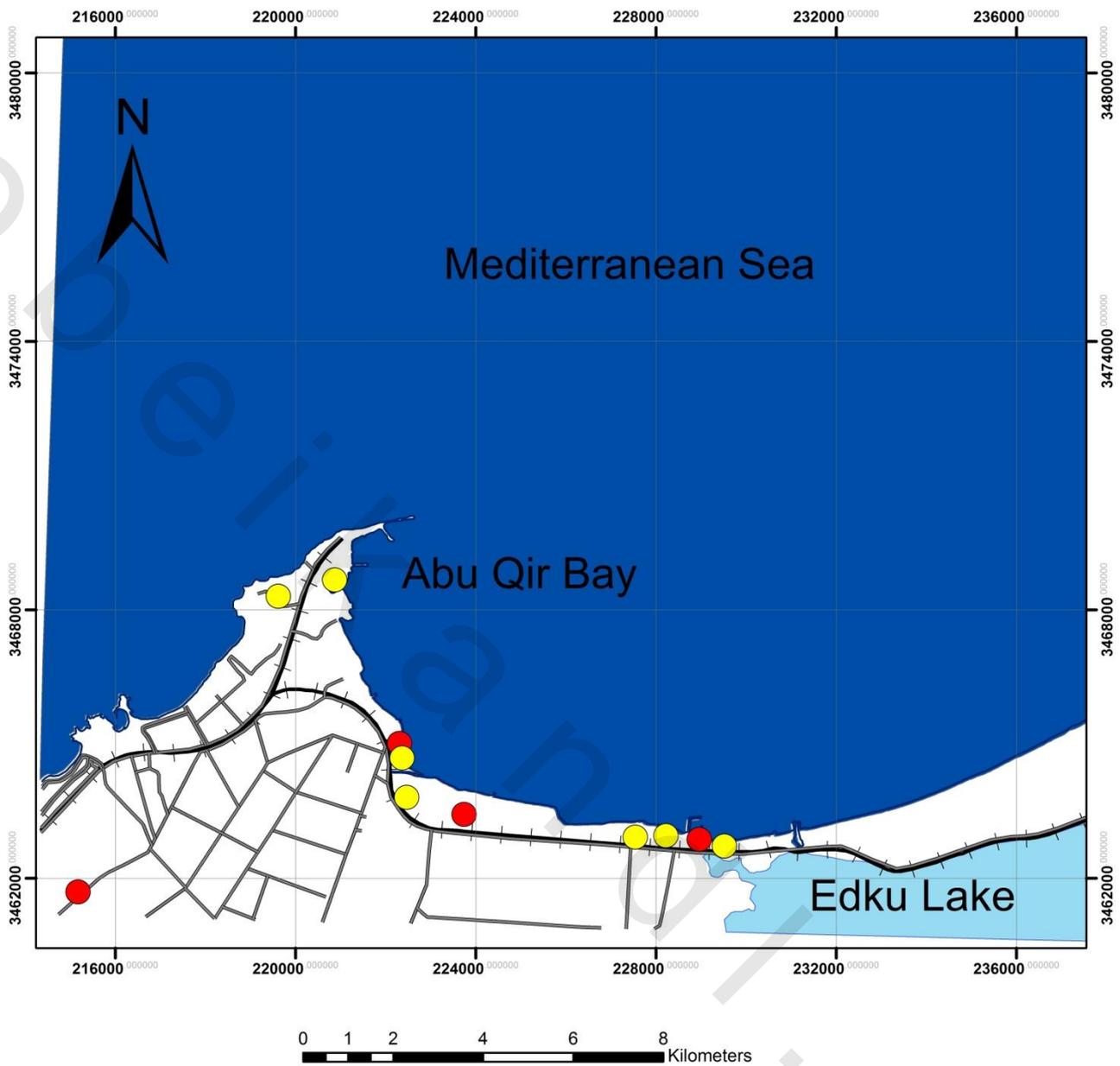


Figure (V -5): Industry in high and moderate risk in Abu Qir Region

V.1.4 Risk Assessment of Schools

One of the important services in the area of Abu Qir and Toson is the large proportion of schools-primary and secondary- especially in the area of Toson where 10% of the schools in the area of Abu Qir is located between -1: -3 below the surface of the sea in the most dangerous areas and 70% of schools is among 0:3 above sea level, and lie in the medium-risk areas and 20% of the schools is located between 4: 22 meters above sea level in low-risk areas as shown in figure (V -6).

Table (V -5): Approximate Risk in schools in Abu Qir

Elevation (m)	Classification of Elevation Points	Percentage of Schools at Risk
From -4to -1	high risk	10 %
From 0 to 3	moderate risk	70 %
From 4 to 22	low risk	20 %

According to the previous table, it is concluded that most of the schools are highly vulnerable either to inundation or to water logging because of their low elevation. If extreme events such as storm surges happened during the school day there will be a great risk on children because most of schools have no access to the main health and safety services.

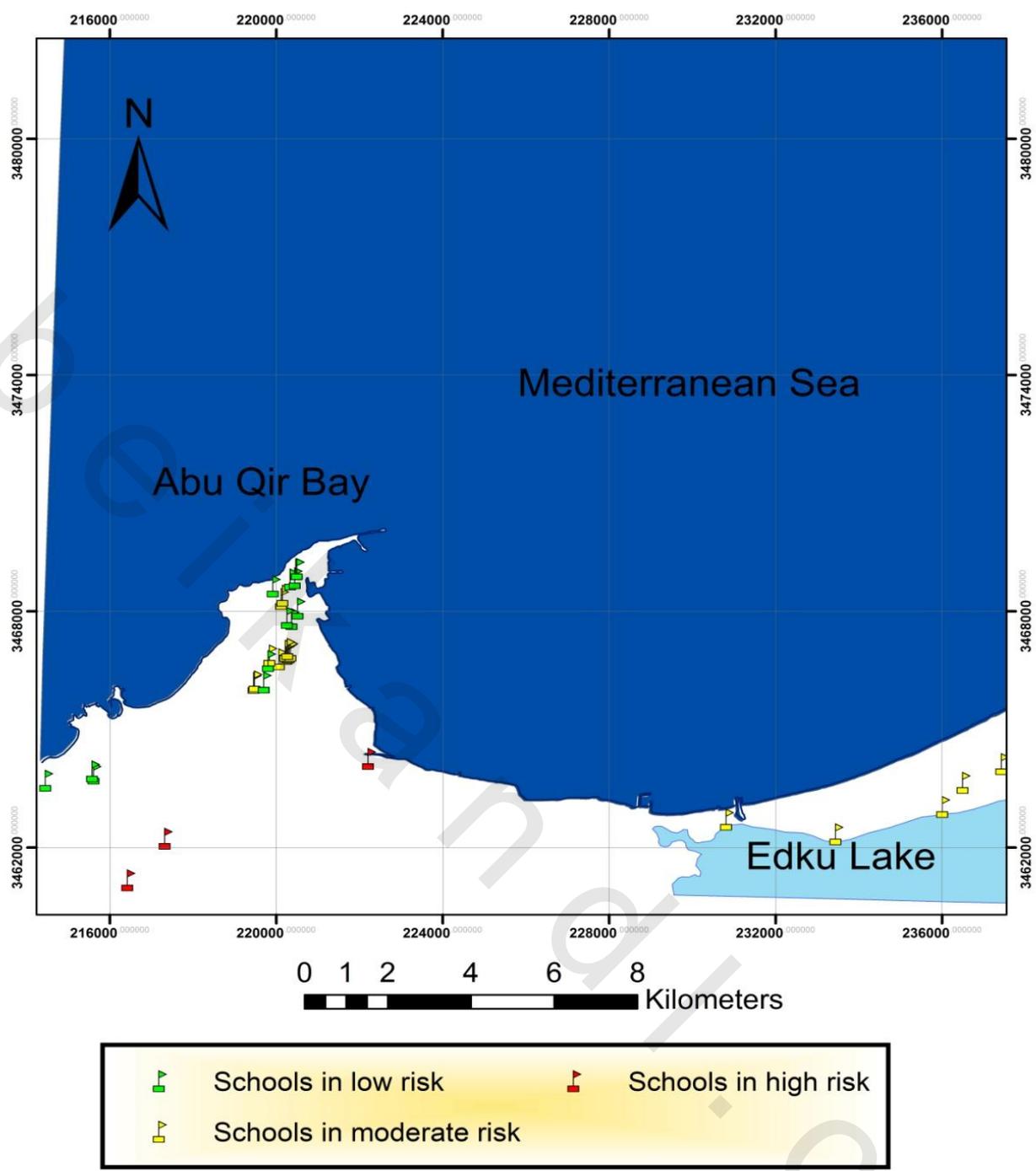


Figure (V -6): Schools in high, moderate and low risk areas in Abu Qir Region

V.1.5 Risk Assessment of Hospitals and Health Units

It is considered one of the important services in the region. It was found that there are a percentage of hospitals fall into the low-lying areas where 84% of the hospitals is located in moderate-risk areas between 0:3 meters above sea level and there is a 16% lie in low-risk areas located between 4:22 meters above sea level. Regarding Health Units there is 75% of the health units are in the most dangerous areas of -4: -1 meters below sea level. A 25% of the health units lies between 4:22 meters above sea level as shown in figure (V -7) and figure (V -8)

Table (V -6) Hospitals and Health Units in High, Medium and Low Risk Areas in Abu Qir

Elevation points	Classification elevation points	Percentage hospitals in risk	Percentage health units in risk
From -4 to -1	high risk	-	75 %
From 0 to 3	moderate risk	84%	-
From 4 to 22	low risk	16 %	25 %

From previous table it is found that most of hospitals and health units located in dangerous areas affected to impacts of SLR. There is a very big need for emergency points in places that don't have health services; this could be just one location or ambulance at the entrance of Abu Qir.

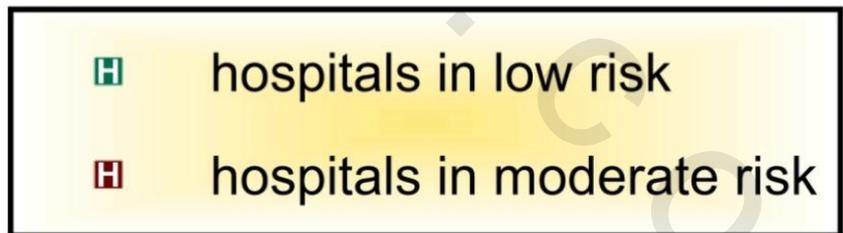
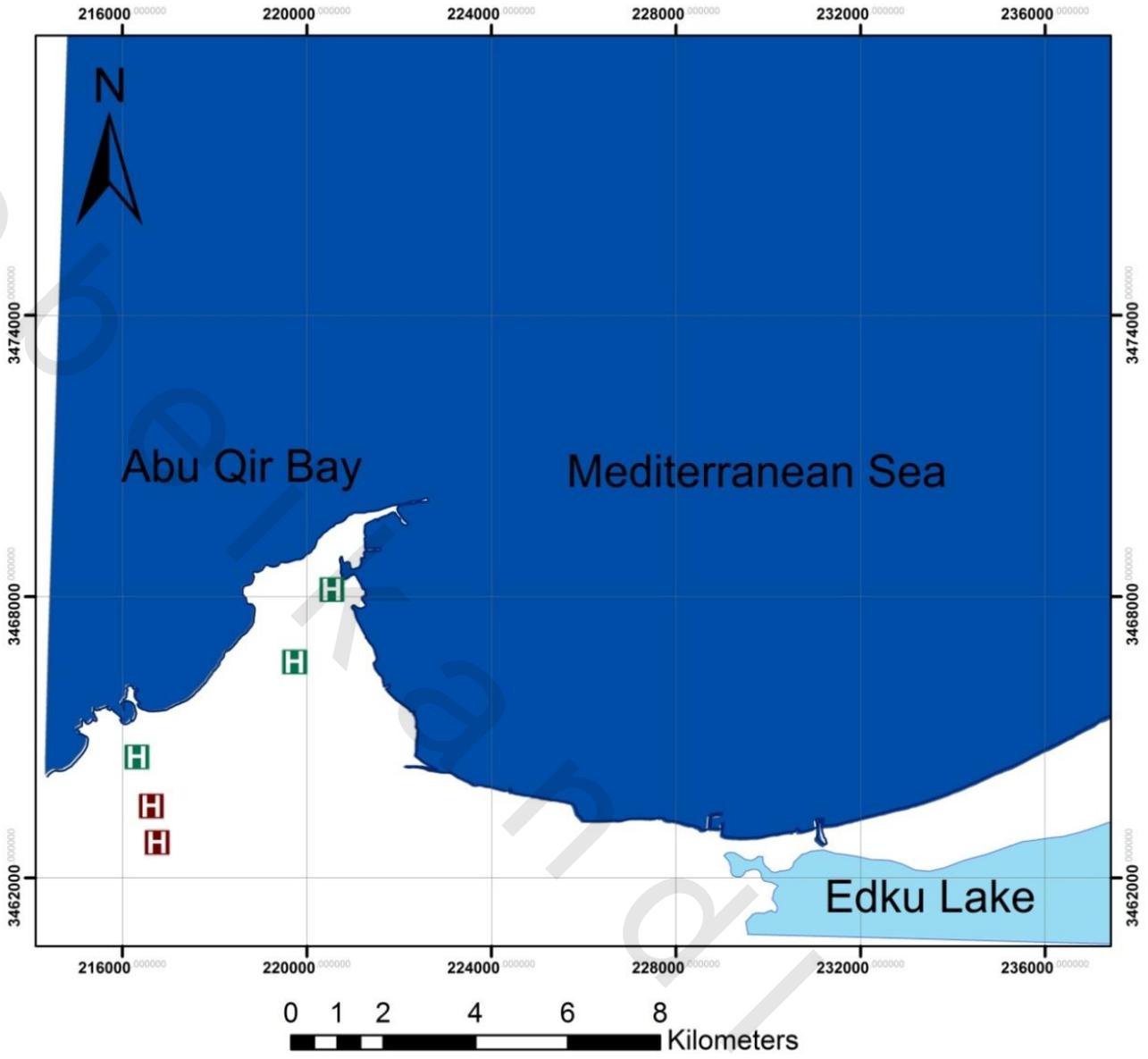


Figure (V -7) : Hospitals in high, moderate and low risk in Abu Qir Region

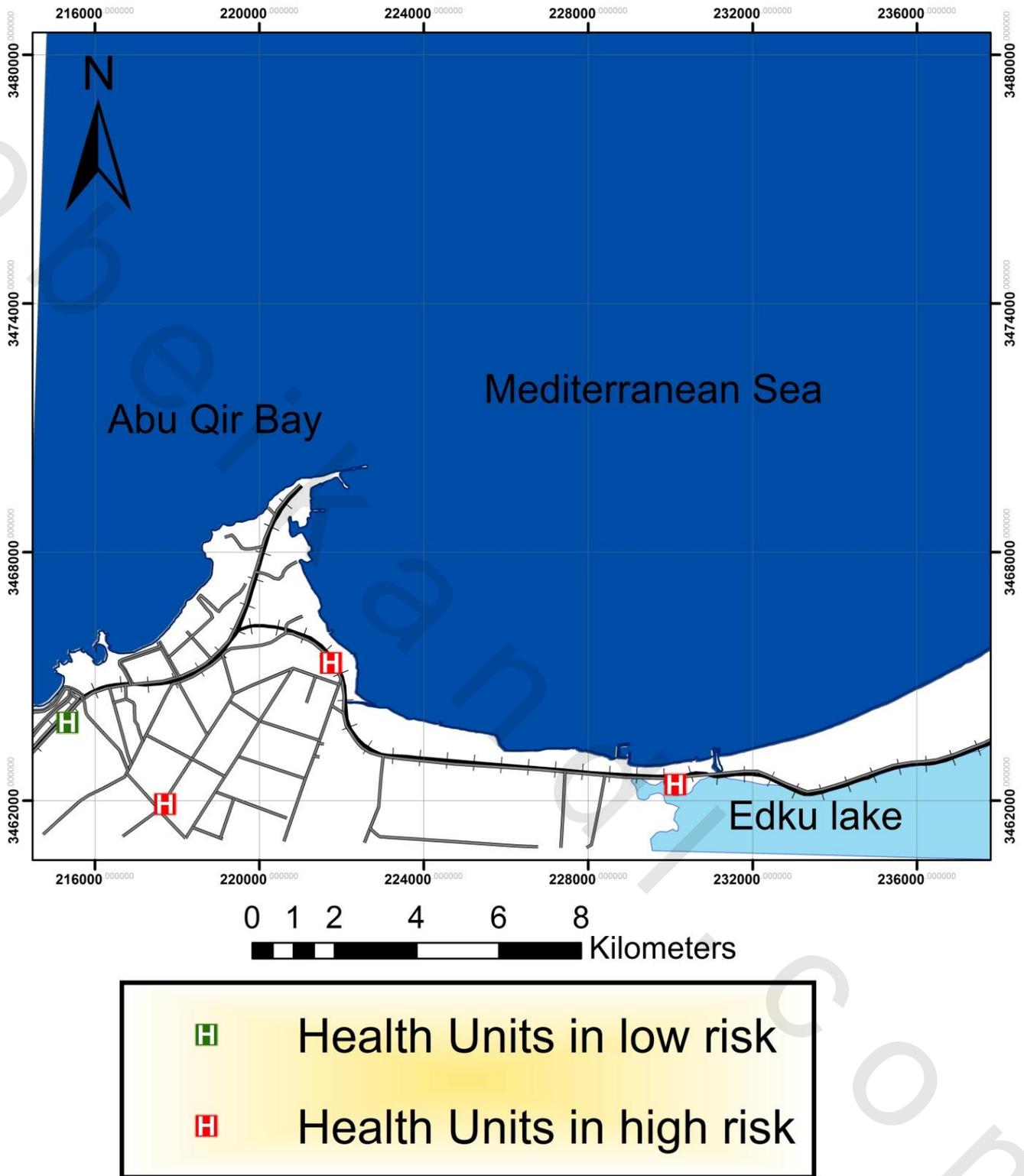


Figure (V -8) Health units in high, moderate and low risk in Abu Qir Region

Table (V -7): Vulnerable sectors and percentage area at high, moderate and low risk obtained by overlaying elevation with land use

Feature class	Percentage Located at high risk	Percentage Located at moderate risk	Percentage Located at low risk
Residential areas	5 %	40 %	55 %
Cultivated areas	49 %	26 %	25 %
Industries	34 %	66 %	-
Schools	10 %	70 %	20 %
Hospitals	-	84 %	16 %
Health units	-	75 %	25 %

It is noticed that the most vulnerable sector of Abu Qir region is the agricultural sector followed by the industrial sector. The least vulnerable sector is the residential sector. This is again represented diagrammatically in Figure (V -13)

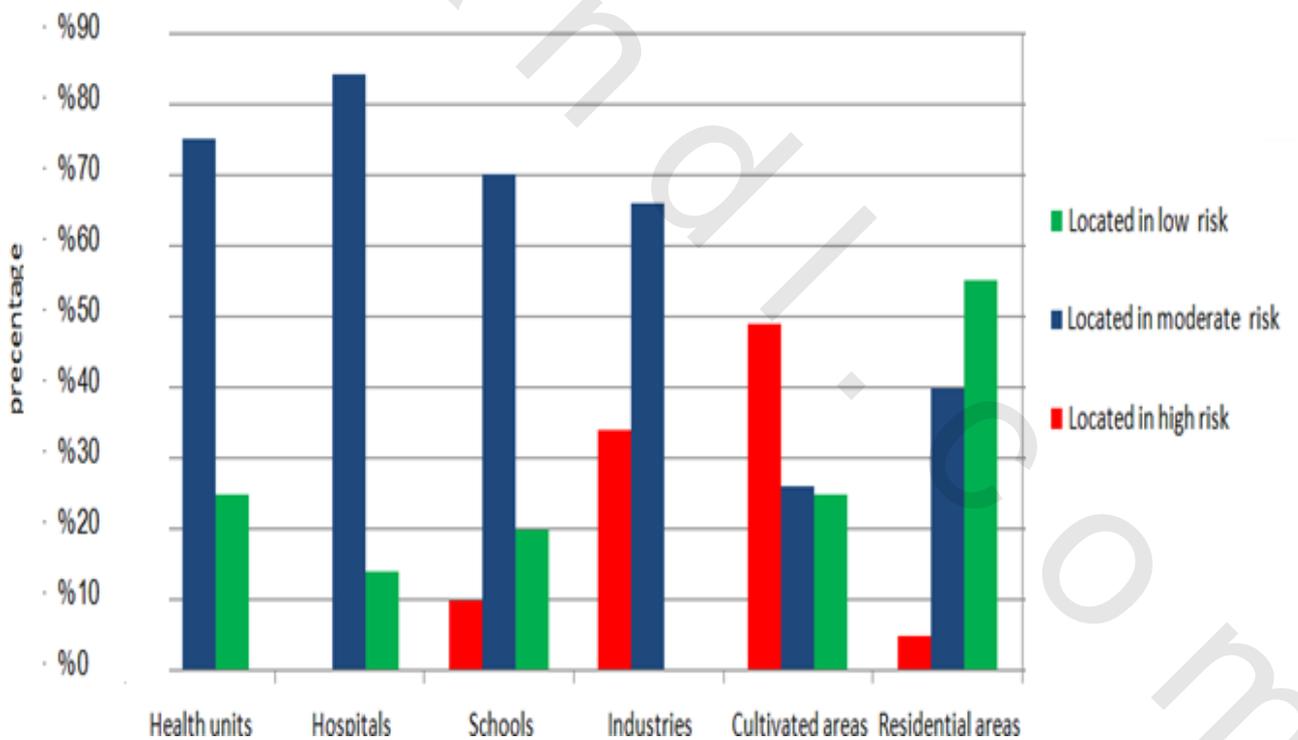


Figure (V -9): Percentage of classification of land use in high, moderate and low risk areas

V.2 Questionnaire analysis and results

We visited the study area more than 13 times over the past two years. During each visit, we took a set of pictures along the coastline and buildings along the coast line and also captured images of factories, schools and hospitals in the area Abu Qir I we did many questionnaires and there were many questions in the form, but my basic goal was to measure the extent of people's awareness of the problem of climate change and sea-level rise and the impact of these phenomena on the economic activities in the region, bearing in mind that potential rising sea level comes in two parts:

1-A sudden rise in the sea level as happened in Alexandria 10/12/2010. This is the most serious because it comes in a surprise and coastal population can't cope with simple tools and escape destruction

2- The second is the rise in the long term this could be coped with through proper proactive planning

Through field studies we detected a number of irregular buildings which have been built on the sand. these buildings are very close to the coast line in Abu Qir bay as a result lack of security due to political events such as the revolution 25/01/2011 in addition to the revolution 30/6 / 2013. Furthermore through filed trip the level of climate change awareness was generally low among the citizens of Abu Qir Region.



Figure (V -10): Pictures shows lack of awareness in study areas



Figure (V -11) Drains discharge in Abu Qir Bay

The study administered a structured questionnaire to elicit information from the citizens of the study area, where 350 valid responses were used for further analysis. The study decomposes various measures of climate change adaptation, the community's perception and level of preparedness.

This study was undertaken in two stages namely:

- (a) A large-scale questionnaire survey of Abu Qir, developed from in-depth interviews and previous research papers,
- (b) Analytical focus groups with adult questionnaire respondents.

The scope of the survey was to learn about perceptions, attitudes and as a response to climate change in Abu Qir, the survey was pre-tested and piloted under one-to-one supervised in-depth interview with 350 people of varied backgrounds and ages. This procedure highlighted any unclear sections of the questionnaire, which were altered to ensure consistency and clarity. Given that it was not practical to survey the whole population within the time limits available, a sampling cluster was adopted.

The questionnaire was subdivided into sections which cover attitudes to life and environmental issues, personal views on climate change, measures on climate change, trust and responsibility, and informational requirements. These were gathered through a mixture of question formats.

Of the 350 adult respondents who completed the question on gender, 25% were females, 75% males, covering a wide range of ages (21 to 30) and socio-economic classes – the rest of the analysis will be in other chapter – We do not claim that this sample is representative of the population of the study area, but this was not our aim. We chose the sample to ensure a large enough range of variation with regard to socio-economic characteristics to make comparisons between different subgroups, and to know about the general knowledge about climate change between the normal people.

A survey is the gathering and analysis of information about a topic, an area or a group of people and our survey is handling all this sides together. Surveys can be an economical and efficient tool for collecting information, attitudes and opinions from many people and we directed ourselves to the internet and fieldwork to insure the best way to get the sufficient information from the residents of the study area themselves.

Climate change is seen as one of the biggest threats facing our world today, and most people agree that changes are needed to avoid disaster. While technical solutions and environmental policies are definitely promising, they can only be successful when accompanied by changes in human behavior (Blanco and Kheradmand, 2011)¹¹⁰. This chapter tries to addresses human behavior in the study area.

The dominant gender in the fieldwork questionnaires was the male by 70 % against 30% to female.

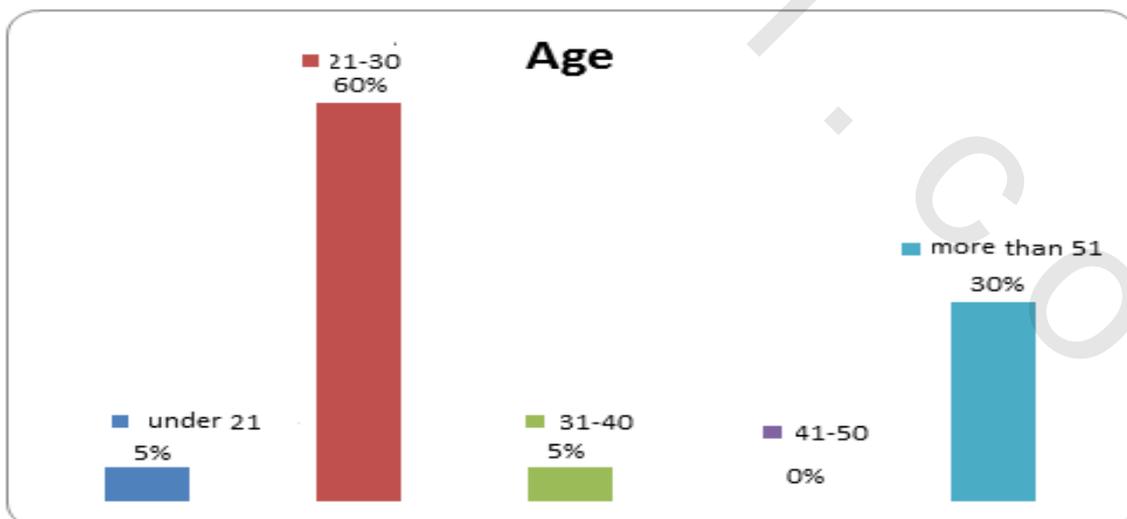


Figure (V -12) Age classification of administered questionnaire in Abu Qir region

In the extra job question 80% mentioned that they don't have any other jobs.

About the marital status there were 20% married person, and 80% single, we didn't meet divorced or widowed people in our field work.

The percentage of people who can read and write was 30%, and who can't read or write was 25%, while the university degree were 45%.

In the question which asked about the number of family members residing in the same house the answers were the same so that 90 % of the respondents said they are "5" people , while the other 10% said they don't know the right number but they are so many.

Question: Is there anybody in the family who works abroad?
Answer: The answers were 40% yes and 60% no.
Question: How many people do they work in the family?
Answer: This answer ranged from 2 at the minimum and 3 at the maximum rate
Question: Is there any work for women at the house?
Answer: 60% of respondents said no.
Question: Does the region need any public services? What are they?
Answer: 100% percent of them said of course.
Question: What are the Types of schools that are needed in the region?
Answer: They said they don't know the type of school, and all they really know is they Want good education.
Question: Is there any nearby medical center?
Answer: The percentage of people who answered yes was 75%, while 25% answered no.
Question: Does the community suffer from any source of environmental pollution?
Answer: 50% drinking water, 30% garbage and sewage and 20% noise
Question: Do you have any problems with roads?

Answer: The percentage of people who answered yes was 85%, while 15% answered no.

Question: Are there any tourists in this region?

Answer: The percentage of people who answered yes was 35%, while 65% answered no.

Question: Does the rate was the same even before the revolution?

Answer: 90% answered no, while 10% answered yes.

Question: Do you know or hear anything about the problem of Climate Change? What is the extent of your knowledge?

Answer: 90% said no and most of them said they care About more important problems than atmosphere or air. Indicating to the low awareness level of population according to the very low activity of NGOs.

Do winter storms affect any of the following?

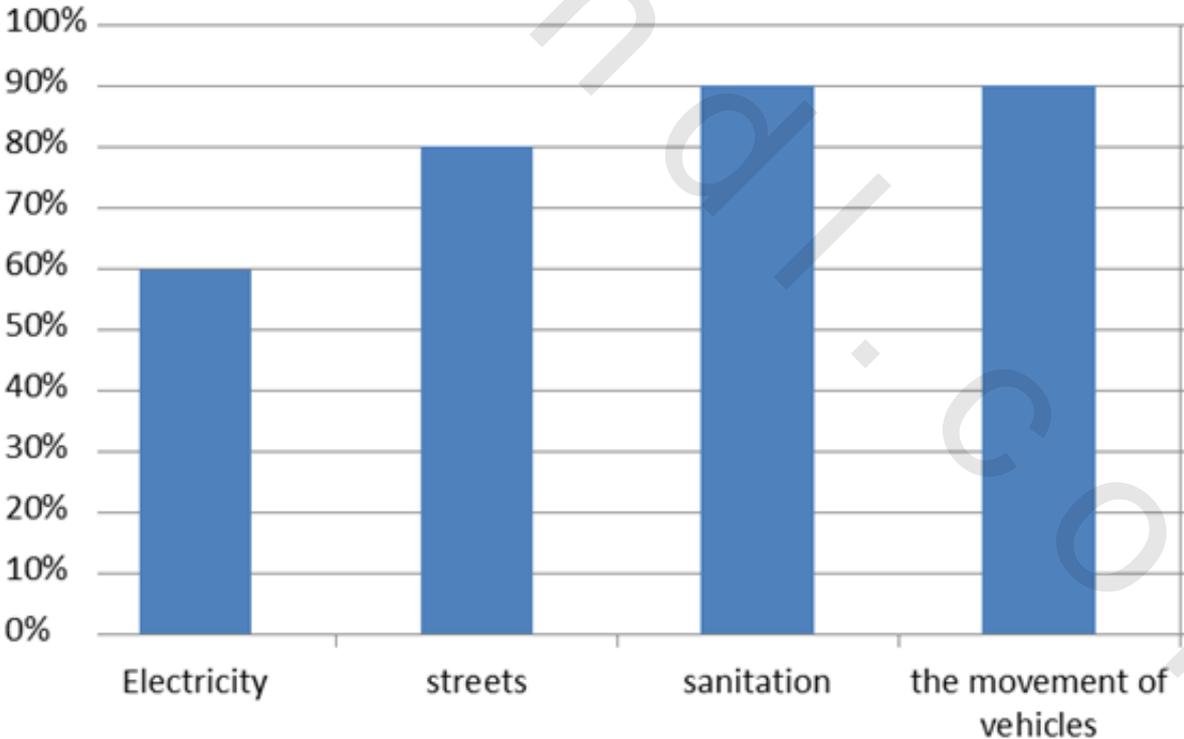


Figure (V -13): Service affected by SLR in Abu Qir region

Question: Can you do any other job if your career affected by climate change?
Answer: 80% said no, while 20 said yes they could work other jobs.
Question: Does the rise of the sea level could effect on the activities and crafts? And how?
Answer: Most of the answers (95%) were it could affect the fishing and the navigation.
Question: What are the areas that most affected by the sea level rise from your view point?
Answer: Alexandria as a whole, Abu Qir especially
Question: Do services work with its full strength in severe winter storms?
Answer: About 80% said no.
Question: Do you expect a Tsunami like what happened in Japan, taking into consideration the difference between the ocean and the Mediterranean Sea?
Answer: 80% of the respondents said NO there will never be a Tsunami in any part of Egypt, not just the study area.20% said yes because there are remembered in 1936 happened storm wave and all people climb on the mountain
Question: From your point of view do you think that there are any procedures or adequate preventive preparations to face these risks?
Answer: 80% No, 20% Yes
Question: Do you believe that there is sufficient awareness of these risks and how to deal with it or face it?
Answer: Nearly 90% answered No.
Question: Where do you get your information?
Answer: The answer was 90% T.V 60% Internet, 20% radio and 10% others.

The Field Work Perspective (Recommendations according to questionnaires)

- Communities in developing nations are especially vulnerable to sea level rise and storm surges.
- Improve public participation and improve environmental awareness among residents in Abu Qir.
- Encourage, enforce and activate the role of NGOs. Low levels of public participation and weakness of NGOs in the area can be attributed to fear, poverty, and frustration in despite of in Abu Qir found 21 NGOs.
- The study area needs a comprehensive sustainable development plan and need to development public services such as roads, hospitals, health units and schools.
- Create a tourist city through the working out of a special booklet of the city, its history, illustrative maps and tourist destinations.
- Improve adaptive management techniques through better education and upgrading awareness.
- Improve monitoring, data collection, analysis and evaluation system

V.3 Policy tools for adaptation strategies

the process of adaptation broken down into concrete goals and frames of reference (e.g., land use planning, infrastructure, conservation, etc.), if begun now provides policy-makers and local communities time to agree upon goals and feasible actions. For example, even the high global estimates of Sea level rise that means there is yet time for communities to adapt to sea level rise. They already have a number of tools in hand to begin this work: land use planning, coastal development rules, ecosystem conservation plans, public facilities, infrastructure investments and post-disaster redevelopment planning for illustrative purposes. Furthermore these may include the facilities or development at the lowest elevations, infrastructure that is critical for meeting the needs of the community, (such as sewage lines or pumping stations), or structures or infra -structure that are closest to eroding bluff or cliff edges. Note: It is also important to conduct careful re -views of existing local policies and regulations in order to identify how to best incorporate adaptation plans when dealing with measures that will control development. In some cases, regulations or policies may already be in place and will simply need to be modified or strengthened. Most coastal communities in Abu Qir region already have Local

Coastal Programs (LCPs), which are basic planning tools that are used by local governments to guide development in the coastal zone in partnership with the Abu Qir region Coastal Commission. Teams should revisit and revise their LCPs as necessary when including new sea level rise adaptation measures. There are found general principles for adaptation planning: human life must be protected; development and protection of the coast should be governed by the principles of sustainability (i.e., meeting the needs of the present without compromising the needs of future generations); consideration should be given to equitable distribution and apportionment of costs and benefits of adaptation measures; and adaptation strategies should account for the distinct vulnerabilities of potentially affected sub-populations. After priorities (such as reducing risks to critical infrastructure from future sea level rise) are clearly identified, a Team can define its adaptation goals. Goals should establish desired endpoints by stating the preferred long-term outcomes of adaptation to sea level rise. Some examples of goals include the following:

- 1- a plan or time line for phased relocation of existing infrastructure or public facilities away from vulnerable areas,
- 2- site and design all future public works projects to take into account projections for sea level rise,
- 3- prioritize critical public infrastructure for retrofitting/protection (storm water/wastewater systems, energy facilities, roads, bridges, ports),
- 4- develop strategic property acquisition programs to discourage development in hazard-prone areas; encourage relocation; and allow in land migration of coastal habitats,
- 5- discourage placement of shoreline armoring and encourage alternatives, and encourage sustainable forms of development (such as clustered or higher density development in low-risk areas)

V.3.1 Local comprehensive land use plans

Land use planning and sea level rise in Abu Qir are intricately linked. Current growth plans and development projections have the majority of residents clustered near the coast or in flood plains, reinforcing current growth patterns. By state law, every county and incorporated in Abu Qir is required to have a local

comprehensive land use plan to guide “the orderly and balanced future economic, social, physical, environmental, and fiscal development in Abu Qir region. State law does not explicitly require consideration of sea level rise in local comprehensive land use plans. However, the plan requires several elements that increasingly need re-examination in light of sea level rise projections. These include the location of land development, provision of public facilities and infrastructure for residential, commercial and industrial purposes, conservation, use and protection of natural resources, housing, recreation and open space, capital improvements, a future land use plan, and coastal management measures (for coastal counties and cities). Zoning, building codes and other local land development regulations are the implementation tools for the policies adopted in the local comprehensive plan. Local plans provide a significant overarching tool for implementing strategies to deal with sea level rise as part of overall growth management currently done for sustainable development. Local governments are required to update their local comprehensive plans on a multi-year basis. these processes provide a natural opportunity for beginning to integrate sea level rise adaptation in all sectors of the plan, including future land use plans and maps to reflect those areas and ecosystems most vulnerable to sea level rise and in assessing risks from sea level rise to essential services, functions and infrastructure.

It is well known that without adaptations, the consequences of global warming and sea-level rise would be disastrous. The study area suffering from lack of financial resources, weak institutions, inadequate or inappropriate planning; poor infrastructure, low developed transportation systems, weak social support systems, and low access to adaptation options so it is very vulnerable (Hafez, 2014)^[124].

Building adaptive strategy requires a strong and scientific understanding of the problems, and developing some solutions, while the lack of trained and skilled personnel can limit a society's ability to implement these adaptation strategies.

V.3.2 Additional adaptation strategies to sea level rise:

Conventional beach protection structures such as groins and revetments are becoming increasingly unpopular, principally due to their adverse impact on beach amenity and aesthetic considerations. In contrast, submerged structures are widely perceived to be capable of providing the necessary beach protection without a loss of beach amenity

or negative aesthetic impact (Ranasinghe et al., 2006)^[97]. The submerged breakwaters have only recently been adopted for beach protection. (Black et al., 2001)^[98]. mentions that there are relatively few reported. Investigation of shoreline response to submerged structures during the past 20 years, alternative solutions was adopted for shore protections of Alexandria city. There was no clear strategic plan for the protection of Alexandria coastline and for that each zone of Alexandria shoreline has been protected by different type of structure. In the following section, summary of these shore protection structures is presented and illustrated (El-Sharnouby, 2010)^[99]

Before we carried out the evaluation of adaptation measures, we identified the most important options for adaptation in the vulnerable areas based on expert's discussions. These are considered below in details:

Increasing development and rising property values along the coast, coupled with rising sea levels and other climate-related impacts are expected to significantly increase coastal-hazard risk over the twenty-first century. Uncertainty around the future rate of sea-level rise, questions about the response of coastal processes to large amounts of sea-level rise, and institutional and social barriers make responding to and coping with future sea-level rise and its impacts a major challenge for coastal management (Cutter, 2008; Ministry for the Environment, 2008)^[100](Blackett, et al., 2010)^[101]; (Cayan et al., 2009)^[102]; (Titus, et al., 2009)^[103] .

The sustainability of the integrated natural systems would ^[99](1) barrier island and shoreline restoration (2) hydrologic and vegetation restoration of coastal lagoons, and (3) relocation of development in highly vulnerable areas require (El-Sharnouby et al., 2010). Such adaptation planning and restoration projects will require a major undertaking by national governments and international institutions. Joint research projects between international organizations such as: USA research centers (NOAA, Corps of Engineers 2007) ^[104], EU sponsored project groups, EU coastal marine centers as well as other worldwide coastal research institutes (Cori, Alexandria) are encouraged to advance the state of the art on managing coasts to adapt to sea level rise employing cost-effective coastal protection technologies. (Ismail, et al, 2013)^[105]