CATRINA (2008), 3 (3): 65 - 78

Geo-Hazards Assessment of Western Adabyia Port Area, Gulf of Suez, Egypt

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ABSTRACT

The aim of the present study is to assess the present geo-hazards, both flash flooding and seismic activity at the western part of Adabiya Port area, Gulf of Suez. Assessment of include Remote Sensing technique was applied using satellite images, topographical, geological and other geological data through GIS technologies. GIS data integration, including the morphometric; local seismic activity and the structural data analysis, indicated that the area is threatened by two types of geo-hazards. The morphometric analysis strongly supported the high probability of flash flooding in different sites within the study area. The structural lineaments, extracted from enhanced ETM+7 image, showed that the major of seismic activity are related to the segments of the fault system of the Gulf of Suez and Gulf of Aqaba. The seismic activity hazard was taken into consideration through identification of the sources of events. The seismic activity in the study area markedly increases from north to south. The distribution of seismic activity pattern and data analysis for the study area clearly exhibits the urgent need for an assessment and rehabilitation program to mitigate geo-hazard along the existing structures.

Key words: Gulf of Suez, geo-hazards, remote sensing, GIS, flash flood, seismic activity.

INTRODUCTION

Sustainable development of the Gulf of Suez is accentuated in the last three decades for relieving population pressure in the narrow Nile Valley and Delta. Nowadays, the northwestern part of the Gulf of Suez region is considered as the most important area. It has the national project that called "Development of North Western part of Gulf of Suez project" which supports the sustainable development and largely contributes to the national income. The project includes many major infrastructures areas such as roads, ports, national industrial development, power stations, mineral exploitation, beaches and tourist villages. The sustainable development of these projects are in essential needs to carry out the basic geo-environmental studies to evaluate the resources and geo-hazard assessment from the geological point of view. To achieve the sustainable development of an area, a comprehensive of risks assessments of natural hazards should be conducted. Risk assessment is required step for the adoption of adequate and successful disaster reduction policies and measures. Risk assessment encompasses the systematic use of available information to determine the likelihood of certain events occurring and the magnitude of their possible consequences. As a process, it is generally agreed that it includes: identifying the nature, location, intensity and probability of a threat; determining the existence and degree of vulnerabilities and exposure to those threats; identifying the capacities and resources available to address or manage threats; and determining acceptable levels of risk. Both hazard and vulnerability capacity assessments utilize formal procedures that include collection of primary data, monitoring of hazard and vulnerability factors, data processing, mapping and social survey techniques. The increasing use of computer-assisted techniques such as Remote Sensing and geographic information systems (GIS), may widen the breach between the information produced by technical risk assessments and the understanding of risk by people. Therefore, acceptable levels of risk may vary according to the relative views on objective risk versus perceived risk. In the case of hazard assessment, where technical means are often employed for monitoring and storing data of geological and atmospheric conditions, the assessment activities typically involve scientific specialists. The study area is located between Latitudes 29°:45'– 30°:00' N and Longitudes 32°:19'– 32°:30' E (Fig. 1). It is bordered by Adabiya Port, Gulf of Suez from the east, Ataqa plateau from the North, and Suez – El-Sokhana highways from the south. Also it includes nearly most of the western part of Adabiya Port, Gulf of Suez. It's considered as one of the most important portion of Egypt, because it comprises a lot of Economical industrial plants, mining activates tourist villages, and the newly developed industrial zones. It comprises the main downstream of several Wadis, including W. Abou Syeala, W. El Maghra El Bahry and W. El Maghra Hadyera. These wadis run from NNW and E-W and debouch into the Gulf of Suez. In general, the area under investigation is characterized by arid climate conditions, dominated by long hot rainless summer and mild winter. Most precipitation occurs as heavy showers with short duration especially in the period from December to April /year (Omran, 2006).

Geoenvironmental hazards such as flash flooding and seismic activity represent the major natural hazards, resulting in loss of life and economic losses due to damages of building, industrial project and businesses. For the people who live in such areas risk management decisions need to be taken. Examples of such decisions include the level of the determination of a seismic design whether or not the structural upgrading of building is appropriate based on some prediction of

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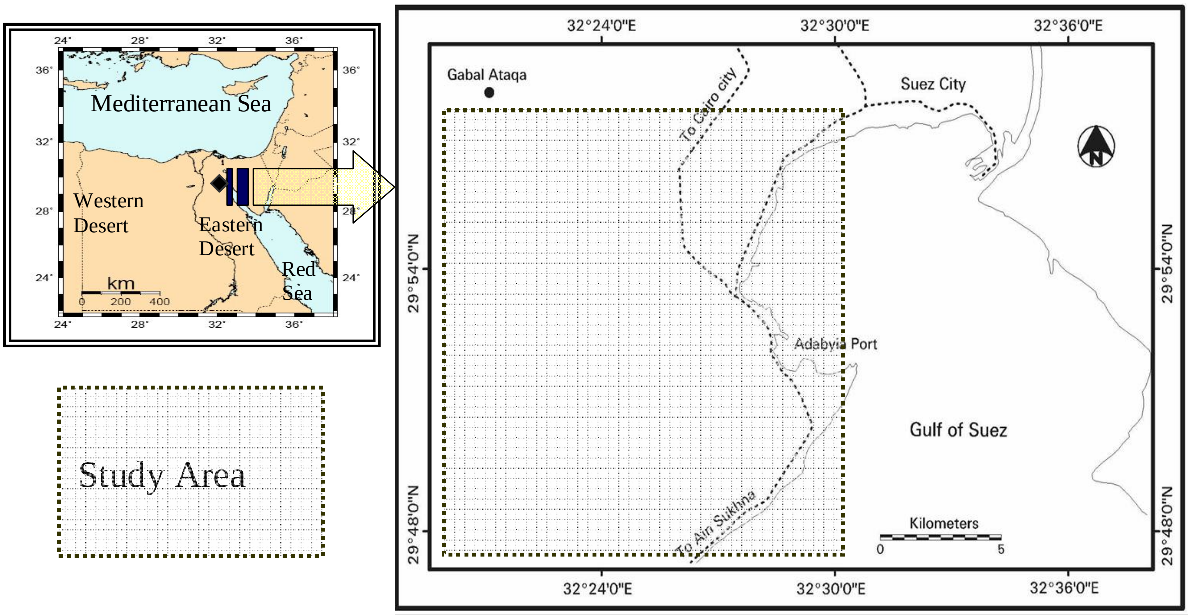

Figure (1): Location map of the study area.

future geo-hazard events. However, existing technology does not enable the direct predication of future events, and must use the historic events time series instead. The aim of this work is to assess the environmental geo-hazards including, flash flooding and seismic activity.

General Geology

The area under investigation is located along the western side of the Gulf of Suez region which situated within the stable belt of Egypt (Smith, 1984). To understand the general geology of the study area, knowledge of background geology of the Gulf of Suez region is essential. A simplified general tectonic and geology of the study area and its surroundings is shown in Figure (2). A brief summary of the regional geology of the study area and its surrounding is given:

Regional geologic setting

The main feature that characterises the geologic setting and tectonic of the study area is attributed to the regional tectonic framework of the Gulf of Suez and Red Sea rift (Steckler *et al*., 1988). The extensive previous geological studies led to important models for the formation of this and other rifts around the world (Moustafa 1976; Moustafa and Abdellah, 1991; Colletta *et al*., 1988; Martinez and Cochran, 1988; Moustafa, 1993, and Bosworth, 1995).

The Gulf of Suez is well defined part of the western boundary of Sinai subplate. It forms the offset northwestern termination of the Red Sea. This structure was considered the tectonic boundary between the Africa and Sinai subplate by Mckenzie *et al*. (1970) who noted that the Dead Sea shear did not correspond to a small circle cantered on their Red Sea opening pole. Freund (1965) suggested that the trend of the open, plunging folds, with axial trace NE-SW (Syrian arc system) in the Suez area implies some left-lateral strike motion along the Gulf of Suez. Adel-Gawad (1970) proposed that this type of Left-lateral motion along the Gulf of Suez could fit the entire difference between the total slip on the Dead Sea rift and the opening of the Red Sea. Garfunkle and Bartov (1977) and Chenet *et al*. (1985) find only limited evidence for left-lateral strike-slip motion along N-S trending faults. The structure of the Gulf of Suez rift is dominated by normal faults with sinuous trends that strike roughly parallel to the rift and delimit many tilted blocks (Said, 1962). The dominant tectonic movements, especially along the southern portion of the rift, have been extensional. Northward, the rift bends to attain a more northerly strike and pronounced rift valley disappears, showing that the extension is decreasing markedly. Salah *et al*. (2006) and Tewfik (1988) suggested tectonic is dominated by vertical movements. Mckenzie *et al*. (1970) combined the opening of the Gulf, similar in sense with the opening of the Red Sea, although with a smaller amount. Youssef (1968) and Lyberis (1988) suggested, based on the geometry of the shoreline, which the Gulf of Suez consists of WNW-ESE trending ridge segments perpendicular transform faults with right-lateral motion. Moreover, the interpretation of landsat images shows that the more recent normal faults mainly strike N-S along the eastern side of the Gulf as suggested by Tapponnier and Armijo (1985). The dominant trend of normal faults within the Suez Rift are N 135° E and N 150° E, parallel to the rift axis (Colletta *et al*., 1988). The Suez rift considered to be the only well defined part from the western boundary of the Sinai subplate as

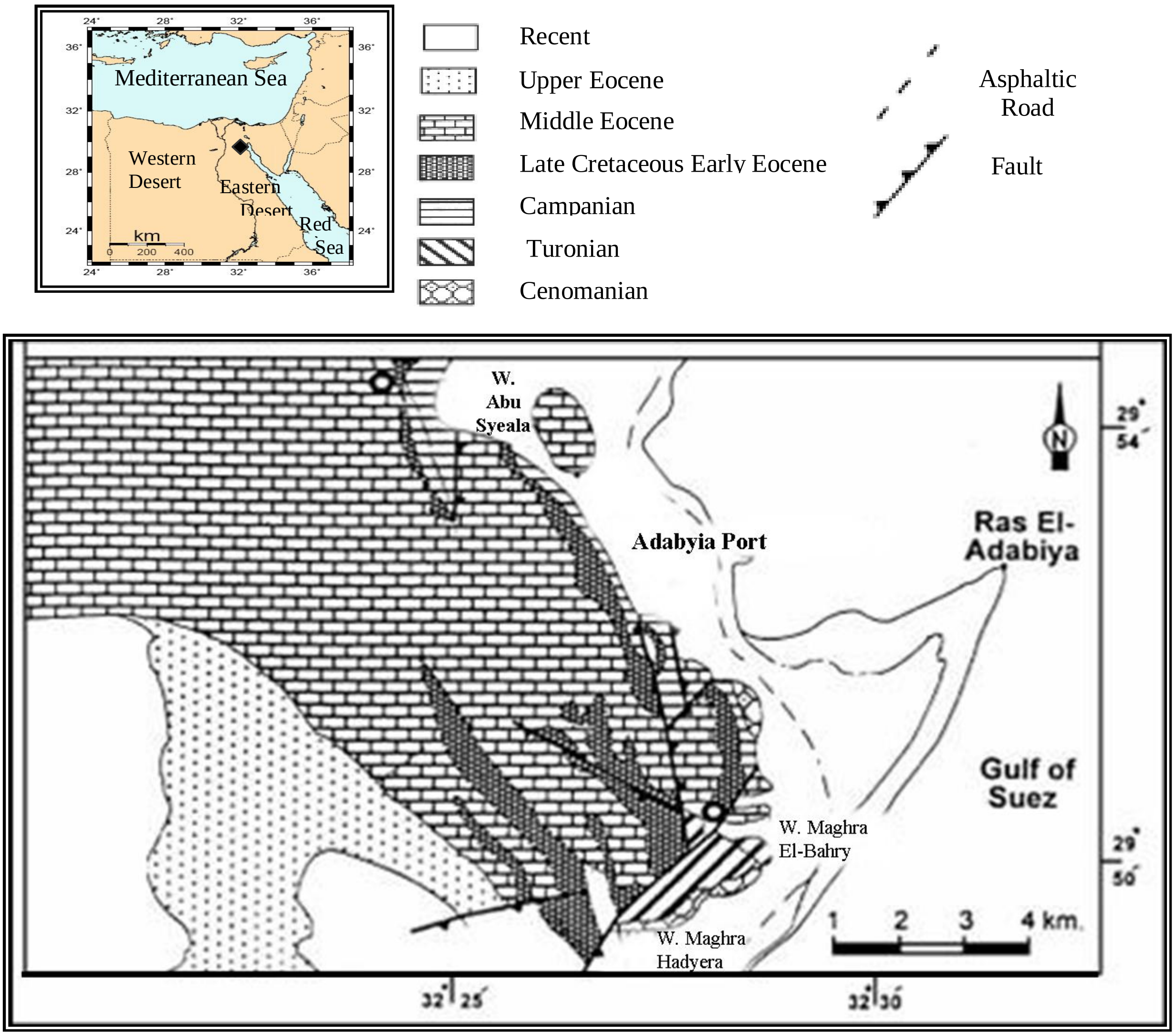

Figure (2): Simplified tectonic and regional geology of the study area and its surrounding. (Compiled from Said, 1962; El-Akkad and Abdallah, 1971; Hussein and Abd-Allah, 2001).

suggested by Robson (1971), and Badawy and Horvath, (1999). According to the above suggestions facts, the western side of the Gulf of Suez is believed to have a geologic setting which is remarkably similar to that the Gulf of Suez region as a whole and other part of Great Rift Valley. Abdel El-Rahman and El-Etr (1979) considered the western side of the Gulf of Suez as an expression of graben series of positive and negative fault blocks bounded by ENE faults. Abdallah (1993) and Youssef and Abdallah (2003) reported that faults exist in the western side of the Gulf of Suez have three main sets including NW, E-W, and NNW. These faults are affecting the Eocene and Miocene rocks in the western side of the Gulf of Suez and form several zigzag fault systems. It is extending from the north eastern of the Western Desert to the west-central part of Sinai Peninsula as suggested by Moustafa and Khalil (1995), and Abdellah (1993).

Regional tectonic activity

The tectonic activity in a region is not independent phenomena, but it depends greatly on the structures present within the region "mainly fault system", and on the situation of the region within the framework of geotectonic of Egypt. Regionally, it is well known that the tectonic activity in Egypt is controlled by active rifting in the Red Sea-Gulf of Suez - Left lateral strike slip motion along the Gulf of Aqaba and Levant transform, and the convergence between Africa and Eurasia in the eastern Mediterranean (Maamoun *et al*., 1984; Ben-Avraham *et al*., 1987). From neotectonic view, the area under investigation is situated within one of the most interesting tectonic activity regions in Egypt due to the presence of shallow and significant intermediate magnitude earthquake activity. Kebeasy, (1990); Abou Elenean (1997); and Mahmoud (2003) proposed that the Gulf of Suez trend – Cairo - Alexandria seismic active trend represents the major active trend that extends along the Mediterranean Sea. The recorded activity along this trend has increased in recent years due to the increasing number of the highly sensitive seismographic stations installed in Egypt. Moreover, the area coverage of this trend is highly populated and has large economic activities. During the last 2000 years, many destructive earthquakes strucked the region and caused much catastrophics. Therefore, the study area is expected to be one of the much active areas in northwestern Gulf of Suez, Egypt.

METHODS AND TOOLS

The current work includes the applications of remote sensing, digital elevation models (DEMs) and GIS to the assessment of geohazards at the western part of Adabyiea Port. The collected data set of remote sensing including a Landsat ETM+7 data (Path 176 – Row 39 of WRS-2), dated 2000, and a 30 m SRTM DEM utilized for structural lineament extraction, drainage network, geomorphic features and seismic validation and field observations collected. These data are geo-referenced to the UTM coordinate system, zone 36 north based on 1: 50000 scale topographic map (Military survey of Egypt, 1986). The panchromatic band of the ETM+ at 15 m spatial resolution was merged and resample to 30 m by a bi-cubic convolution Method. This was to allow unbiased comparison with the lineaments; geomorphology and drainage pattern extracted from the DEM data. The DEM of the study area was prepared from SRTM and using digitized spot height from 1: 50000 scale topographic map. Furthermore, tabular data such as seismic intensity and climatic data are used, ETM+7 satellite image was enhanced by using different processing techniques such as spatial filtering, principal components analysis, histogram equalization and ratios techniques to extract and delineate the structural lineaments and drainage network patterns. Remote sensing and GIS techniques were used respectively for the above purposes using ERDAS Imagine version 9.1, ARC GIS version 9.1 software. The area under investigation was surveyed by reconnaissance field trip, using topographic map at scale 1:50000 and ETM+7 image to the entire length of the area (Figs. 3, 4, 5, and 6). The data collected from the field observations and satellite image were used to derive the different morphometric drainage network and to trace the main structural lineaments in the area. In order to gain better understanding of the tectonic activity and to evaluate the seismicity, it is important to extend our historical and recent knowledge of earthquakes and timing their occurrences. The seismicity distribution overall the study area during the period 1904 - 2005 has been obtained from the National Earthquake Information Centre (NEIS), the International Seismological Centre (ISC) and the Egyptian National Seismic Network (ENSN).

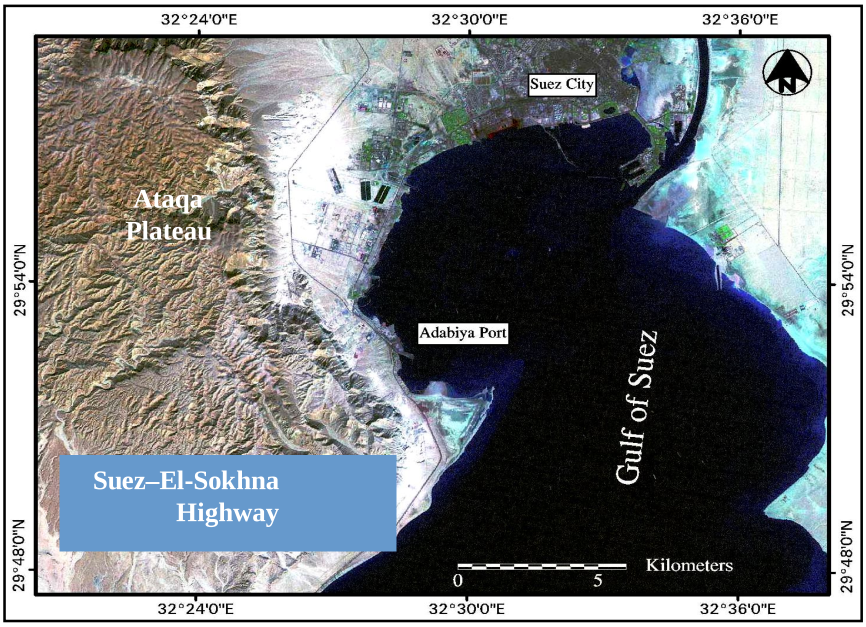

Figure (3): ETM+7 image of the study area.

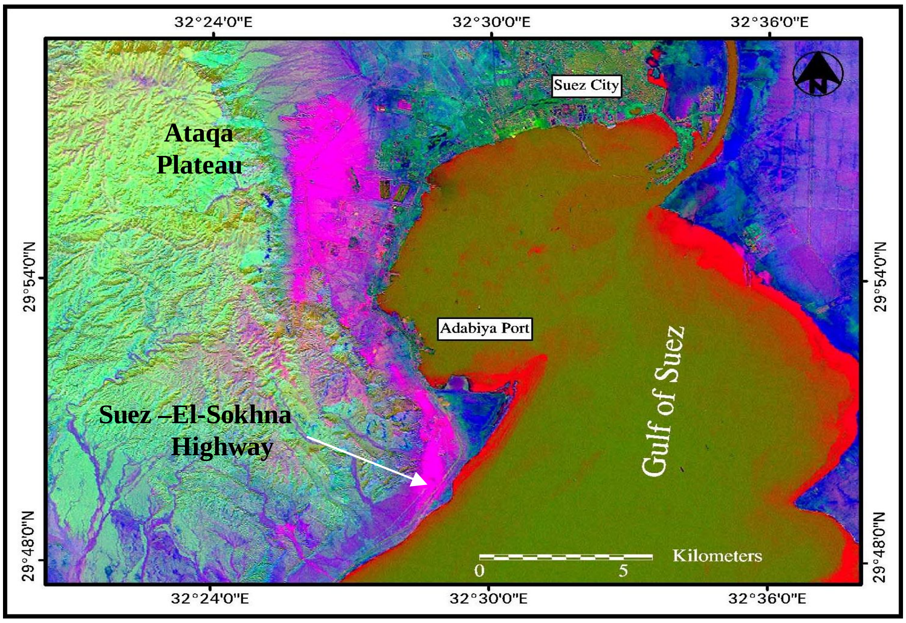

Figure (4): Enhanced PCI ETM image of the study area.

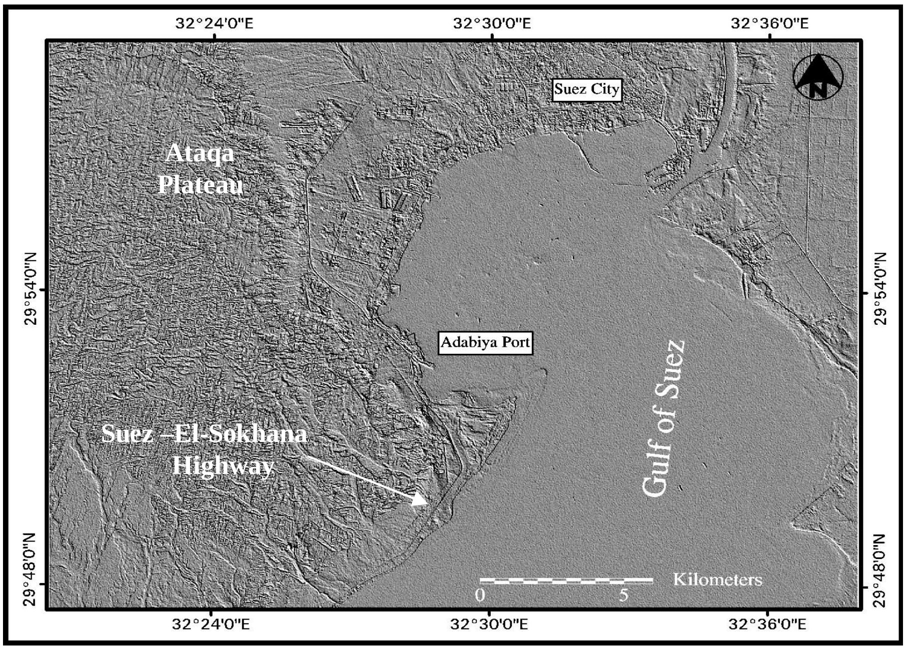

Figure (5): Spatial filtering enhanced ETM image of the study area.

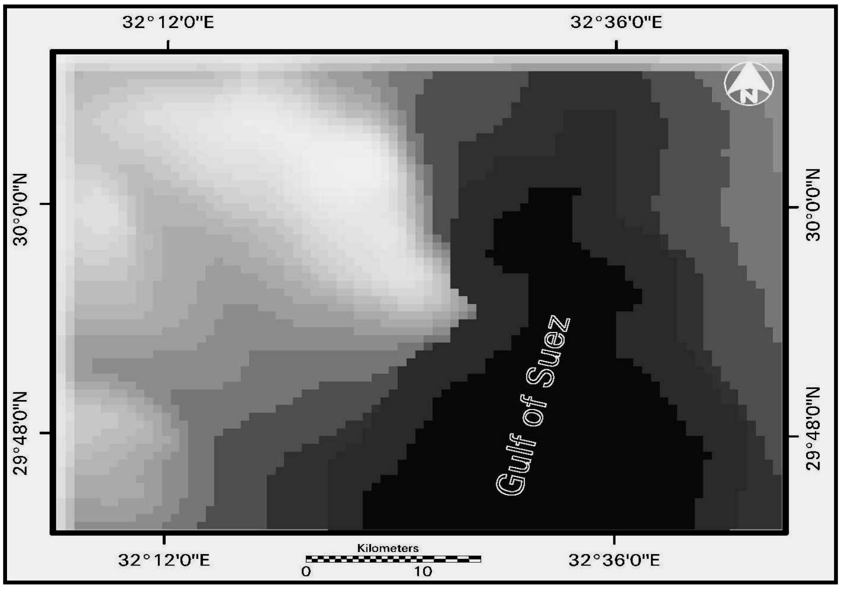

Figure (6): DEM image of the study area extracted from SRTM image.

GEO-HAZARDS

The objective of a geo-hazard assessment is to identify the probability of occurrence of a specific hazard, in an expected future time period and its intensity. Multi-hazard assessments are difficult to be accomplished due to the different approaches in assessing individual hazards. The use of Remote sensing and GIS techniques has broadened the possibilities to undertake multi-hazard assessments. The present case study exemplifies the potential for multi-hazard assessment seismic activity and flash flooding using GIS and Remote sensing techniques.

Seismic Activity

The local seismicity reflects the tectonic activity of surface structural lineaments of an investigated area (Fig. 7). Historical and recently earthquake data set are used to construct a more complete earthquake catalog, in an attempting to gain a homogeneous coverage of the investigated area and extracted the characteristics its seismic activity. The earthquake data set file includes two parts:

(A) The recently recorded earthquakes

Recently, the International Institute of seismology and Earthquake Engineering (IISEE) and National Research Institute of Astronomy and Geophysics (NRIAG) have collaborated in seismological studies of the northern and southern parts of Egypt since August (1994), in which the seismic activity of this parts has been monitored by permanent instrumentally telemetric network, installed on both sides of the Red Sea. According to the progress in the installation of the seismological stations overall region of the Egypt, the recently recorded earthquake is classified into different intervals according to the quality of gathered earthquakes data as shown in Table (1). Data for the period 1974 - 1993 AD was taken from the bulletins of the National Research Institute of Astronomy and Geophysics (NRIAG), National Earthquake Information Centre (NEIS), and the International Seismological Centre (ISC), while Data of the period 1994 - 2005 AD was taken from the Egyptian National Seismic Network (ENSN). Figure 8 shows the epicenters for the recorded recently earthquakes with magnitudes ($3.0 \leq Mb \geq 4.5$) on the study area and its surroundings.

(B) The Historical earthquakes

Information on historical earthquakes is documented in the annals of ancient Egyptian history and Arabic literature. According to Maamoun, *et al*. (1984) and Poirier and Taher (1980), two events were reported to have occurred in the study area and its adjacent, and to have caused damage of variable degrees in different localities overall the study area. The estimated maximum intensity is (VII) in a confined area near the study area. The expected accuracy in the determined focal depths for epicenters historical earthquakes ranges between 10 to 15 km, with magnitude ($Mb \geq 5$). Figure 8 shows the location of epicenter for these events.

Seismic Hazard Analysis

Depending on figures 7 and 8, three seismic clusters zones can be identified and delineated in some places as seismic three clusters areas (I, II, and III). These areas are extended to northwest of the Gulf of Suez and lies between Latitudes 29°:33' –30°:10'N, and Longitudes 32°:17'- 32°:38' E, respectively as shown in figure 8. The first cluster area (I) is located northwest of Suez city and it's characterized by the occurrence of low seismic activity by magnitudes ($Mb \leq 3.0$). The second cluster area (II) is extending to westward and parallel to

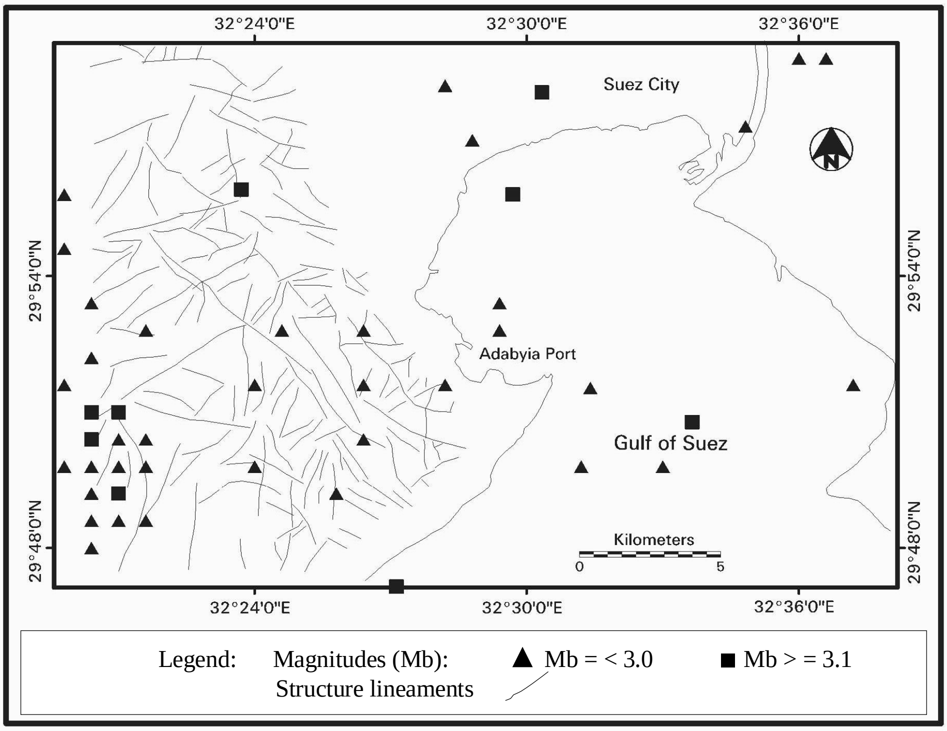

Figure (7): An integrated structural lineaments map extracted from enhanced ETM images with local seismicity of the study area.

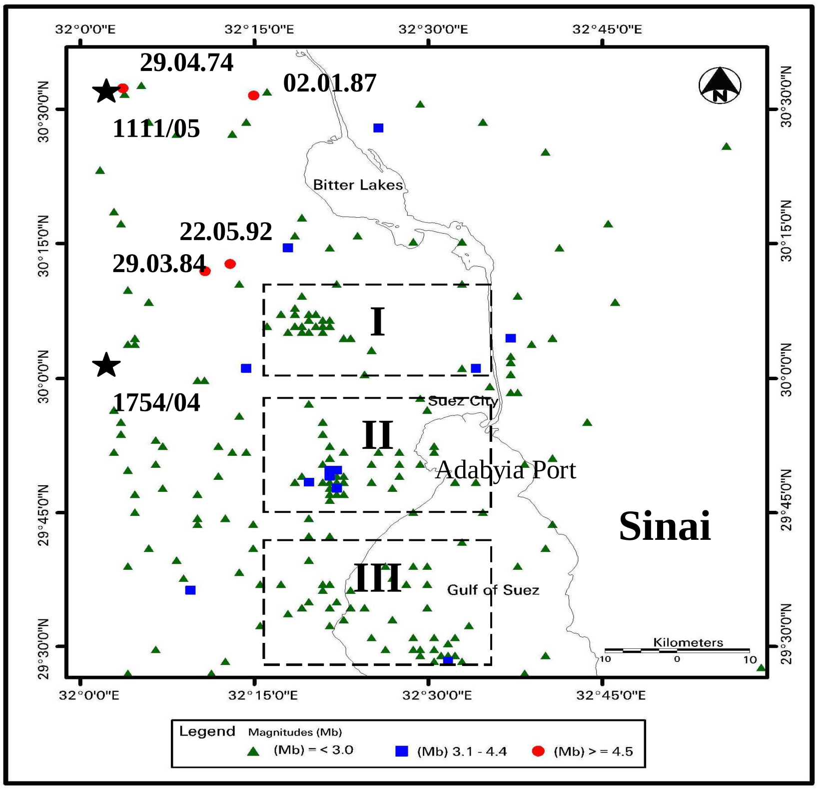

Figure (8): Map showing regional and local recorded earthquakes with magnitude (3.0 ≤ Mb ≥ 4.5) of the study area and its surroundings.

I, **II**, and **III**: Three seismic clusters area determined and used to assess seismic activity.

★ : Epicenter of historical earthquakes with magnitude Mb ≥ 5.

Table (1): Classification of the instrumentally recently recorded earthquakes that occurred within the study area for the period (1974 to 2005) with to the expected accuracy in the magnitude and focal depth.

Period (year)	Magnitude (Mb)	Focal depth (Km)
1974 - 1993	0.1 - 4.5	4.1 - 34
1994 - 2005	0.4 - 5.4	4.1 - 34

Adaybia Port province. It's characterized by the occurrence of low to moderate magnitudes events (Mb ≤ 4.4). Furthermore, the third cluster area (III) is located in souththwest Adaybia Port with seismic activity by magnitudes (Mb ≤4.4). The area was also affected by some historical and recently moderate events (4.5 ≤ Mb ≥ 5.5). These were reported during April 29, 1974 in Abu Hammad; Wadi Hagul, March, 29, 1984; Ismailia earthquake January 2, 1987; and recently one of a moderate shock occurred in May, 22, 1995 in the west Bitter lakes (Fig. 8). The seismic activity in the mentioned cluster areas is conformable and related to wide active major faults and structural lineaments overall study area, which have NW-SE trends that parallel to the Gulf of Suez and also are perpendicular to the Gulf (NE-SW).

Flash Flooding

The drainage network developed in the study area is external and is located within the Gulf of Suez mega basin (El Shazly, *et al*., 1991), where the drainage lines discharge into the Gulf of Suez. The drainage network varies in the drainage density, length of tributaries, and their orientation and furaction angles (Figs. 9 and 10). By using GIS software, the catchments area is delineated. It includes three basins, as part of the Gulf of Suez sub-megabasin. The basin has a cumulative area of 75.63 Km^2. The studied sub-megabasins are basically identified from enhanced satellite images ETM+7 of 1:50000 and SRTM. It includes three small sub-basins (Wadi Maghra El-Bahry, Wadi Abu Syeala, and Wadi Maghra Hadyera). The water divides between the sub-basins and surroundings trends mostly NE-SW or NW-SE. The topographic map and DEM are also used to identify the elevations, slopes, and locations of the settled area. The area is controlled mainly by the faulting of the Gulf of Suez, geologic and geomorphologic characteristics involving lithology, and the range of attitude and altitudes.

Flash Flooding Analysis

Quantitively, the morphometric parameters of each basin were defined in terms of order, weighted bifurcation ratio, frequency, density, slope gradient, basin shape, basin length and overland flow, in order to elucidate their bearing of flash flooding behavior. The morphometric analyses of the hydrographic basins are listed in Table (2). Stream order (U) of each stream segment in each basin was defined following the system introduced by Horton (1945) and slightly modified by Strahler (1952). The stream ordering of the basins and

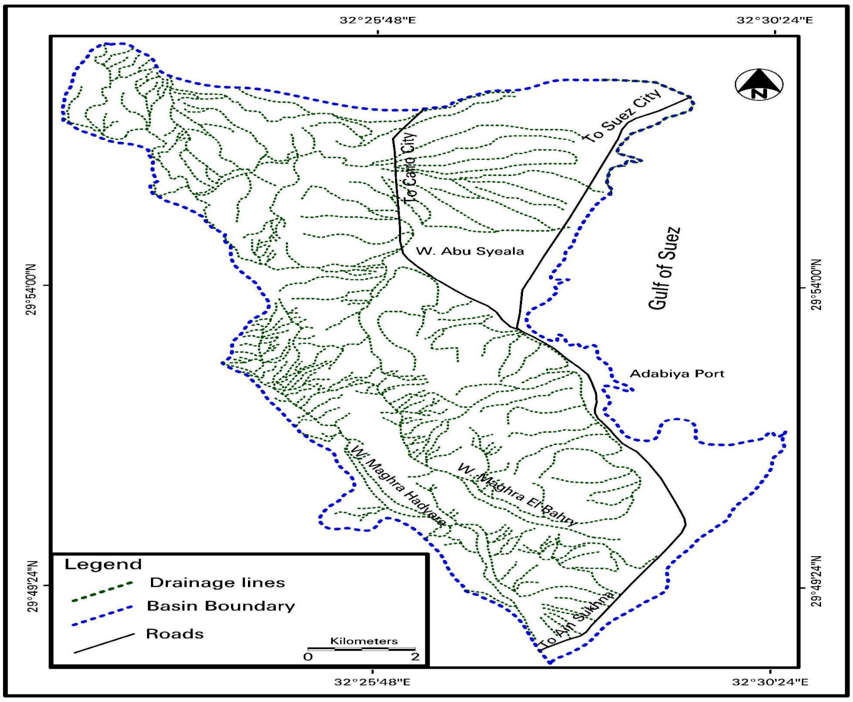

Figure (9): Surface drainage network of the study area extracted from the enhanced satellite ETM+7 image and topographic map.

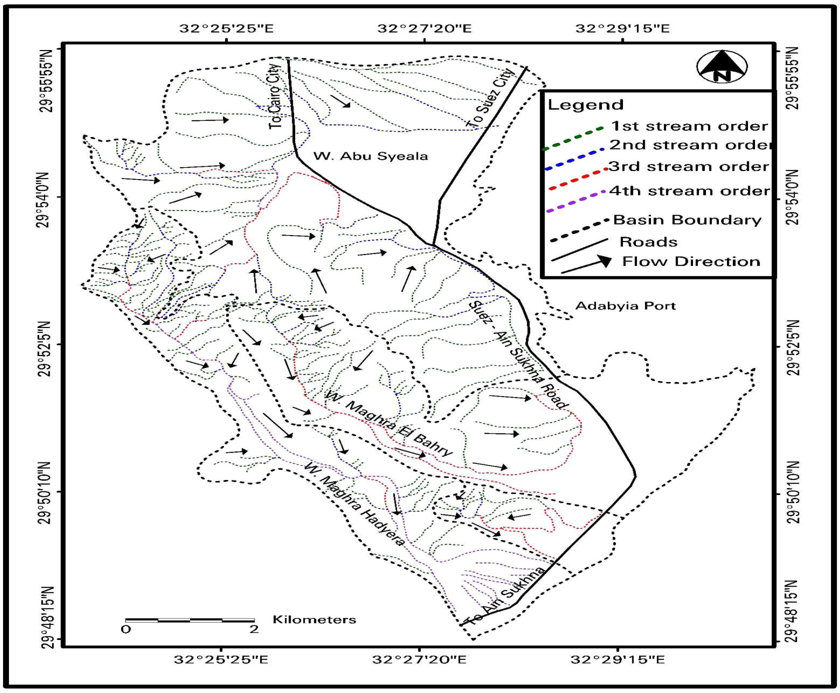

Figure (10): Drainage basins and water flow direction of the study area extracted from the enhanced satellite image ETM+7 and topographic map.

Table (2): Morphometric parameters of the hydrographic basins of the study area.

1. Network parameters

Basin Name	Order	1st	Rb	2nd	Rb2	3rd	Rb3	4th	Total
W. Maghra El-Bahry	Number	47	57	10	27	21			78
	Bifurcation	4.2 267.9		0.476 7.616					275.516
W. Abu Syeala	Number	62	101	39	50	11	16	5	117
	Bifurcation	1.5897 160.5597		3.5455 177.275		2.2 35.2			373.0347
W. Maghra Hadyera	Number	89	124	35	55	20	35	15	172
	Bifurcation	2.5487 316.0388		1.7500 96.2500		1.3333 46.6655			458.9593

2. Network basin parameters

Basin Name	A	P	H	BL	O	Nu	WMBR	F	D	Re	Rc	TL	M.G.	OLF	Categ.
W. Maghra El-Bahry	19.482	24.950	470	7.159	3rd	78	3.7742	4.004	2.402	0.696	0.393	45.789	1.65	0.208	F
W. Abu Syeala	36.426	35.276	520	8.873	4th	117	2.234	3.212	2.151	0.767	0.368	76.683	4.550	0.232	F
W. Maghra Hadyera	19.719776	33.327	620	12.150	4th	172	2.6684	8.722	3.545	0.412	0.223	68.409	6.660	0.141	F

Abbreviation

A: Area of basin in km^2
H: Difference in hight between mouth and water divide
P: Basin perimeter km
BL: Basin Length in km
O: Basin order
Nu: Number of drainage segments
WMBR: Weighted mean bifurcation ratio

Categories:

A: Very large (>1500km^2)
B: Large (1500->600km^2)
C: Medium (600->300km^2)
D: Small (300->100km2)
E: Very Small (100->50km^2)
F : Minute (<50km^2)

D: Density
Re: Elongation ratio
Rc: Circularity ratio
TL: Total length of segments in km
M.G.: Mean gradient
OLF: Overland Flow and **F:** Frequency

number of stream segments of all orders for all basins, also the total lengths of stream segments and bifurcation ratios between each two successive orders (Table 2).

The relation between stream order and both stream numbers and stream lengths are considered in the interpretation. Basins of W. Maghra El-Bahry has third order, while basins of W. Abu Syeala and W. Maghra Hadyera have fourth orders. The Weighted mean bifurcation ratio (R_{bw}) is obtained by multiplying the bifurcation ratio R_b of each successive pair of orders by the total number of streams involved in the ratio and taking the mean of sum of the values (Strahler, 1952). R_{wb} values of the studied basins are ranged between 2.2340 and 3.7742. Drainage density (D) measures the cumulative length of all streams of a drainage basin to its total area (Horton, 1932). It can be also calculated by applying the experimental relation of Melton (1958), (F=0.694/D2). Table (2) lists both the calculated density (CD) and the measured density (MD). The CD values range between 2.151 and 3.545. Basin shape controls the stream discharge from a watershed and is numerically expressed in the form of circularity and elongation ratios. Circularity ratio (R_c) is the ratio of basin area to the area of a circle with the same perimeter as the basin (Miller, 1953). The R_c values range between 0.223 and 0.393. Elongation ratio is the ratio of the diameter of a circle equal in area to the basin to maximum basin length parallel to the main stream (Strahler, 1958). Basins of the study area have elongations ratio values range between 0.412 and 0.767 (Table 2). The hydrogeomorphmetric relations are used for the hydrologic assessment of hydrographic basins (El-Shamy, 1992). The drainage basins are classified into three categories A, B, and C. The hydromorphmetric analysis of (Fig. 11) indicates that these basins are of high flooding probability, where they lie in domain B referring to low groundwater potentialities and relatively high flooding possibilities (Fig. 12). Overland flow across the ground surface to the nearest channel is the surface runoff (Linsley *et al.*, 1992 and Yehia, *et al.*, 2002). Basins of long overland flow induce high infiltration rate and have low risk of flash flooding. The calculated overland flow of the study area ranges between 0.141 and 0.232 as shown in Table 2. Integration of morphometric parameters could be used to characterize the risky flash flooded sites map. Delineate the vulnerable sites for flash flood along the main Suez- El-Sokhna highways and settlement areas were done by GIS techniques and presented in Figure 12.

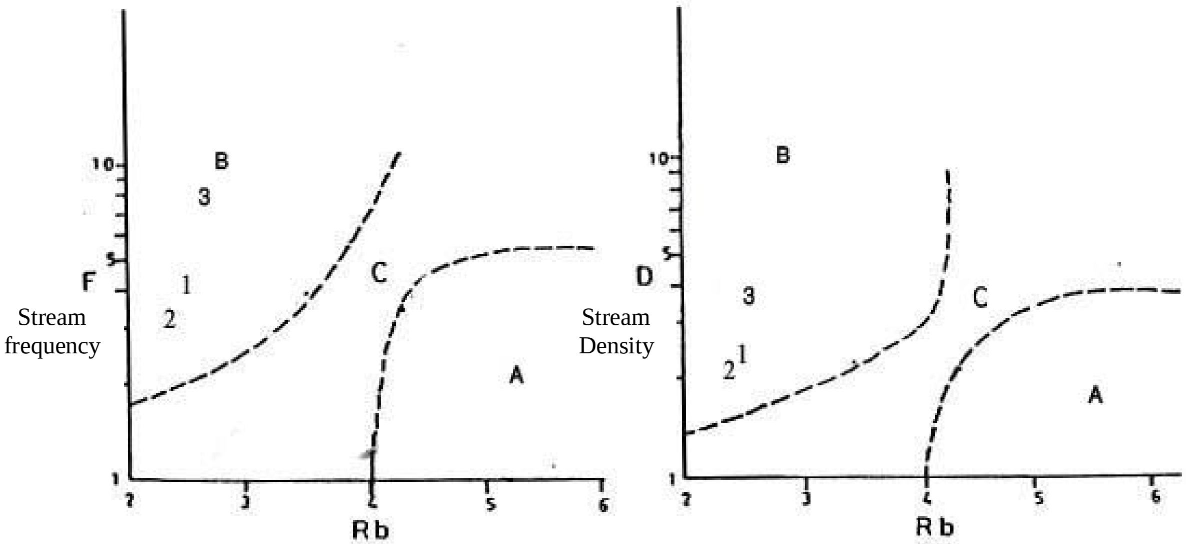

Figure (11): Basin assessment of the study area using some hydromorphometric parameters. **A**: low flooding risk basin, **B**: high flooding risk basin, **C**: intermediate flooding risk basin, **D**: stream density, **F**: stream frequency, $\mathbf{R_b}$: bifurcation ratio, **(1)**: W. Maghra El-Bahry basin; **(2)**: W. Abu Syeala basin; **(3)**: W. Maghra El-Bahry basin

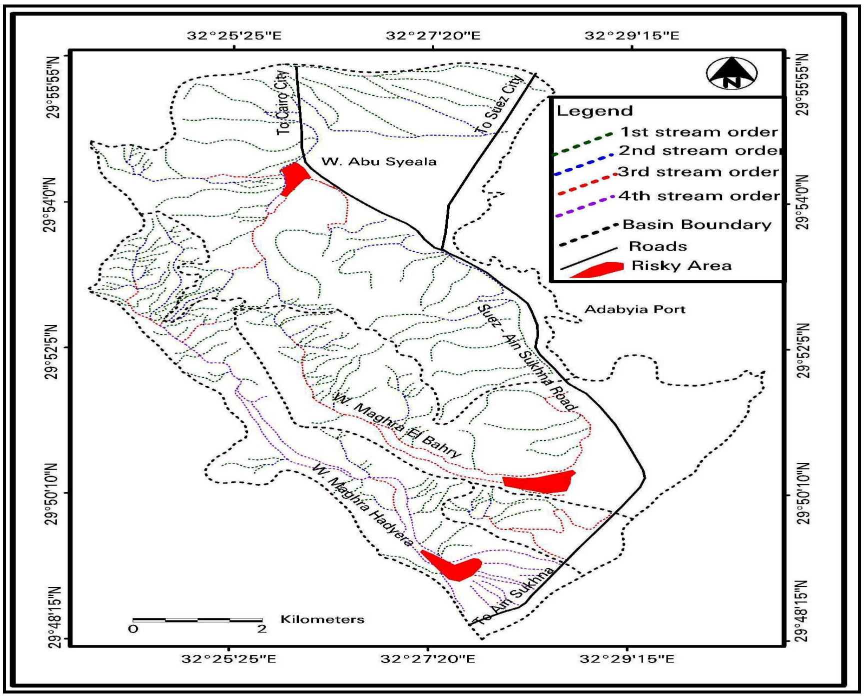

Figure (12): Risky flash flood sites map of the study area.

DISCUSSION

Geo-hazard assessment methodology is used in the present study to determine the nature and extent of risk by analyzing the potential hazards and evaluating existing conditions of vulnerability that could pose a potential threat or harm to people, property, livelihoods and their environment. Seismic activates at the southeastern part of the Risk assessment map were prepared for the study area to verify threatened area by flooding, tectonic and seismic activities. GIS techniques are able to define the vulnerable sites to flash floods and seismic activities along the main Suez - El-Sokhna Highway and settlements. The distribution of seismic activity pattern, structural lineaments data and morphometric network drainages analysis for the study area clearly showed the urgent need for rehabilitation program to mitigate geo-hazard environmental in existing structures. According to the previously recorded climate conditions, the study area may exhibit flash flooding hazards in the future. The result of integration showed that flood hazard sites are located in the end of main trunk of Wadi Maghra Hadyera at longitude 32°:27':29" E and latitude 29°:49':13"N and W. Maghra El-Bahry located at longitude 32°:28':17" E and latitude 29°:50':19" N. While, W. Abu Syeala at longitude 32°:25':58": E and latitude 29°:54':15" N. Furthermore, three seismic clusters area can be identified and delineated. These areas are extended to northwest of the Gulf of Suez and lies between Latitudes 29°:33' – 30°:10'N, and Longitudes 32°:15'-32°:38' E. This information is necessary to undertake a reliable evaluation of geohazard risk in the investigated area as well as the entire region west of Gulf of Suez. Moreover, the satellite images, Risky flash flood sites, seismicity, geologic and topographic maps were used to categorize land-use/land-cover at study area; these data were verified by field investigation to satisfy human needs in the study area. Unsupervised classification of the satellite data used to discriminate between the land cover features recognized at the area of study, including urbanization; industrial and Quarrying areas; and barren land required for development activities to construct the Land use/land covers as shown in Figure 13. Finally, resulting from the above discussion, it can be concluded that, this study is great importance for decision makers and designers regarding different construction projects in the area, such as power plants, dams, industrial centers, and pipelines.

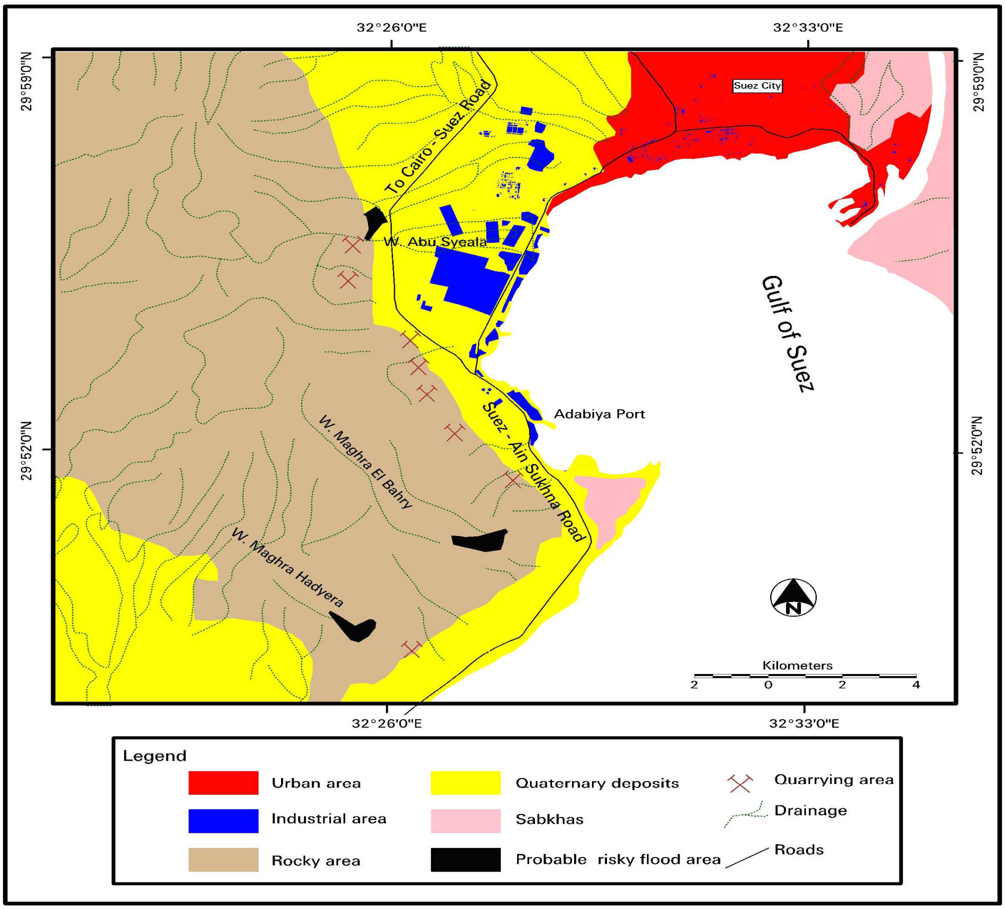

Figure (13): Land use/land cover map of the study area.

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Received June 15, 2008
Accepted December 21, 2008

تقييم المخاطر الجيولوجية للقطاع الغربى لمنطقه ميناء الأدبية - خليج السويس - مصر

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الملخص العربـــى

تهدف الدراسة إلي تقييم المخاطر الجيولوجية متمثله في المخاطر التكتونية والزلزالية ومخاطر السيول علي القطاع الغربي لميناء الأدبية- خليج السويس- مصر. وفي هذه الدراسة تم تطبيق واستخدام البرامج والتقنيات الحديثة كنظم المعلومات الجغرافية والاستشعار عن بعد وذلك بمعالجه الصور الفضائية وتحليلها وتفسيرها لاستنباط البيانات وبناء نماذج الارتفاعات الرقمية والخرائط الطبوغرافية، علاوة على تحليل البيانات والمشاهدات الحقلية وبناء قاعدة بيانات جغرافية وتكاملها من أجل تحديد وتقييم المخاطر الجيولوجية التي تؤثر على عمليات التنمية و منظومة المشروعات القومية في منطقه الدراسة.

أوضحت عمليات التحليل الوصفي والكمي الإحصائي المورفومترى لأحواض شبكة الوديان المستنبطة من تحليل الصور الفضائية ونماذج الارتفاعات الرقمية على احتمال تعرض هذه المناطق لسيول خطيرة برغم من صغر مساحتها فى حالة التغيرات المناخية المحلية الحالية نظراً لطبيعة الصخور والعوامل التركيبية والجيوموفولوجية للمنطقة وما حولها وذلك بسقوط كميات كبيرة من الأمطار مما يؤدى لحدوث سيول، وبتكامل الخرائط الرقمية لكل من النشاط الزلزالي والمخاطر التركيبية التكتونية ومخاطر السيول أمكن التوصل لخريطة المخاطر الجيولوجية التي تهدد عمليات التنمية بمنطقة الدراسة.

دلت نتائج دراسات التوزيعات المكانية للزلازل التاريخية والحديثة، أن العديد من الهزات تميزت بقوتها المتوسطة والتي تبلغ (3-4.5) بمقياس ريختر و تقع على الأطراف الشمالية والجنوبية للمنطقة وما حولها. و بشكل عام فان الفوالق التركيبية المميزة في هذا الركن تأخذ الاتجاهات الشمال الغربي – الجنوب الشرقي وأيضا الاتجاه من الشرق – الغرب ، وهذه الفوالق تسهم في زيادة النشاط الزلزالي في المنطقة .