Assessment of Urban Geomorphological Hazard in the North-East of Cairo City, Using Remote Sensing and GIS Techniques

G. Albayomi

Geography Department, Faculty of Arts, Helwan University, Cairo, Egypt
Gehan_albayomi@arts.helwan.edu.eg

Abstract: This study aims to assess the geomorphological hazard of urban area in the north eastern side of Cairo City, based on analyses of remote sensing and GIS. In addition the objective of this study is to develop a GIS-aided urban geomorphological hazard zoning in the north-east of Cairo city. The main landforms of the area were delineated by using remote sensing and land surveying data, applying multi criteria decision analysis to evaluate it. This criterion includes geomorphic factors and sub factors such as: urban site location, urban morphology, Slope gradient, Digital Elevation Models, Gully Density. The research methodology focused on the analysis of those variables factors to indentify urban hazards areas. The results indicate that most of lands with grad (1) which is about 62% are in low risk area, and about of land 26% of the total area is in moderate hazard, and >12% in high hazards of the study area is in high risk hazards.

[G. Albayomi. **Assessment of Urban Geomorphological Hazard in the North-East of Cairo City, Using Remote Sensing and GIS Techniques.** Life Sci J 2012;9(2):398-402] (ISSN: 1097-8135). http://www.lifesciencesite.com. 61

Key words: GIS, Remote Sensing, Hazard, Urban, Geomorphology

1. Introduction

Remote sensing technology has greatly facilitated investigation of land use/cover changes. For example, Sultan et al. (1999) used the Landsat Multispectral Scanner (MSS, 79 m resolution) and TM images to study the urbanization process on the Nile Delta during the 70s and 80s. They found that urban areas increased 58% in 18 years since 1972. Another study, Fahim et al., (1999), found accelerated urban growth at the expense of agricultural land during 1987–1995 as compared to the period 1950–1987. There has long been an urgent need for land use management and policies should be based on an accurate understanding of current land use conditions to ensure future sustainable growth, Hefny, (1983).In addition Diae Chengta, (1996) have been presented a new approach of urban geomorphological, taking an elevation about catastroability of the geomorphological environment in Chongqing City.

This study uses image processing and analysis integrated in a geographic information system (GIS) to assess spatial analysis in north eastern area of Cairo city. Spatial patterns of urban land use and population distribution were compared quantitatively. Such analyses would shed a light on the overall impact of political-economic environment and policy changes on urbanization processes for Cairo, a large city of a developing country, which can be used effectively in geomorphological hazard mapping of urban location.

The objectives of the study are as follow:

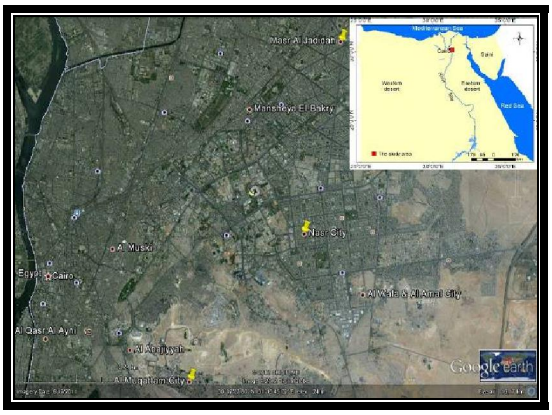
1. To assessment the geomorphological hazard of urban area in the north eastern sector of Cairo City, based on analyses of remote sensing and GIS.
2. Application of GIS methods of urban geomorphology to determine the hazard degree of the buildup in study area.
3. Extracting geomorphological hazard map of the area of study according to physical parameters

The study area

Cairo is located in northern Egypt- Lower Egypt- near Delta Apex, 165 kilometers (100 mi) south of the Mediterranean Sea and 120 kilometers (75 mi) west of the Gulf of Suez and Canal. Cairo City Coordinates are 30°3′29″N 31°13′44″E. Figure (1).The study area located in the north -east sector of Cairo City, the major towns of the study area are, Masr Aljididia, Naser City, Manshyit Naser, and Al Mouqattam City which are located in the eastern bank of River Nile.

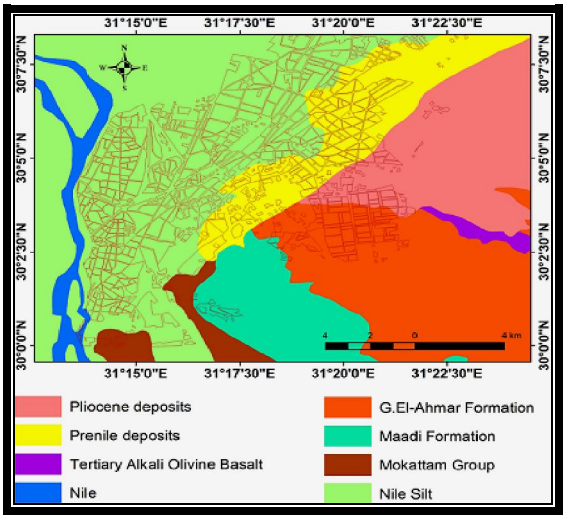
Geology and Geomorphology features:

The area belongs to the late Pleistocene which is represented into the Valley by the deposits of the Neonile which lowering its course at a rate of 1m/1000 years Said,R.(1967).and represented in the margin of eastern desert by rock formation belong to Eocene, Pleistocene and Holocene Figure(2).These rocks are the most wide spread covering the eastern part of Cairo City. In general the Eocene rocks are composed of bedded Carbonates and Calistics with varying proportion, alternating with marl and shale .The fractures ,joints and falts and bedding planes are great planes are of great important in the frequencies of rock fall in this area.



Source: Google earth2012, Topographic map Scale 1:25000

Fig (1): location map of Cairo City Geology and Geomorphology



After :CONOCO 1984,Scale 1:50000

Fig(2): Geological formation in the area of study

The Geomorphology features of area noted as:

The structural plateau in the east of River Nile is underline essentially by limestone rocks belong to Eocene and dissected by a number of faults running mainly in the north west-south east direction, such faults affect the morphology of the surface,the plateau of Mouqattam is the most important physical features in the area of study . **The edges** of this plateau are marked by a variety of slopes some of which are fault determined and consequently developed into steep escarpments. **The narrow piedmont plain** occupies the strip lying between the cultivated land and the foot slopes of the structural plateau. **The flood plain** is related to the River Nile. **Drainage lines** from conspicuous basin which follow mainly plain in the west, the fault lines of weakness, (Armanious, G, M,1990).the main features in the study area represents in Mokattam hill, it is a small limestone plateau lying to the south east of Cairo, rising to about 300 m above sea level, the bedrock of Mokattam plateau is highly fractured, resulting in the collapse of huge blocks from free faces in several sites particularly at the entrances of cave ceiling at the edges of what is called the power plateau at the sides of the road, that leads to the new town (Mokattam town)which has been build atop the upper plateau. The rock fall and rock sliding reflect the negative human interference such as miss use of swage water (sanitation) which absorbed in shale's through fractures causing hazards of mass wasting.

2.Materials and Methods

Input data:

The collected is based on field work in the north eastern of Cairo City. Over 100 points were located using Global Position System (GPS) receivers and described for the land use/cover conditions. Topographic maps of 1:50,000 scales were collected, scanned, digitized and Land sat thematic mapper (ETM) of 2009 was selected as it covers the study area, DEM of 20 m resolution was interpolated using Top grid module in Arc GIS. Geomorphological map descriptions were classified as table (1).

Table (1) illustrates the main data set in the study area

Class Name	Description
Built-up	All types of man-made surfaces, including residential, commercial, industrial, transportation, etc
Geological Map	After CONOCO 1984,Scale 1:500000,presented the main formation in the area of study
DEM	Digital elevation model is used to describe a digital representation of the terrain surface
Slope	Slope map is expressed as a change in elevation over a certain area
Gully density	Gully density applied to define the hydrological parameter of the study area to asses hazards
Relief degree	The relief degree of land surface is an important reference factor of geomorphologic form classification used to describe and reflect the macroscopic characteristics of topography of the surface in a large area

Data processing

The present work involves to establishment of data base in a digital format for the study area.

The flow chart summarizing the methodology that has been used in the study area as shown in figure (3). The processing of data input are geometrical analysis of urban –build up –area, surface analysis and spatial analysis. GIS application have been carried out to produce map of different factors controlling geomorphogical hazard in order to produce hazard map of the study area.

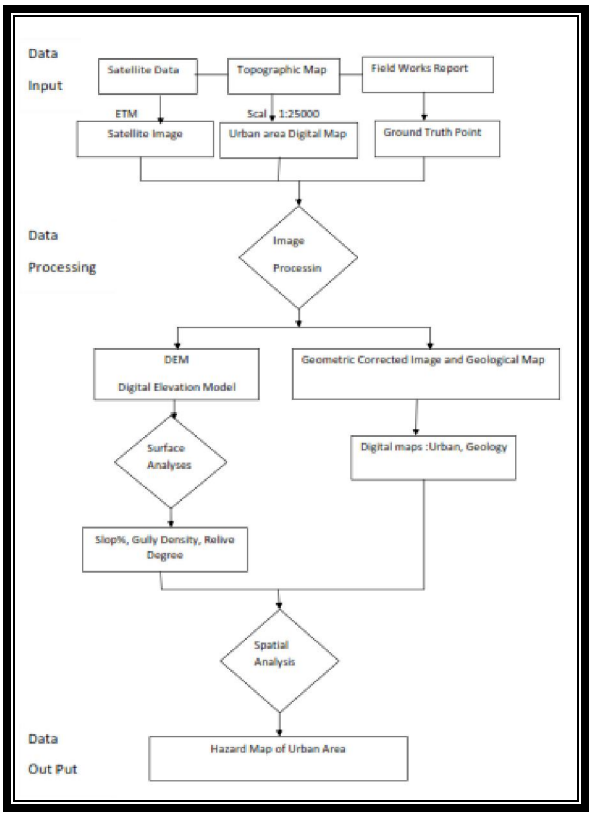
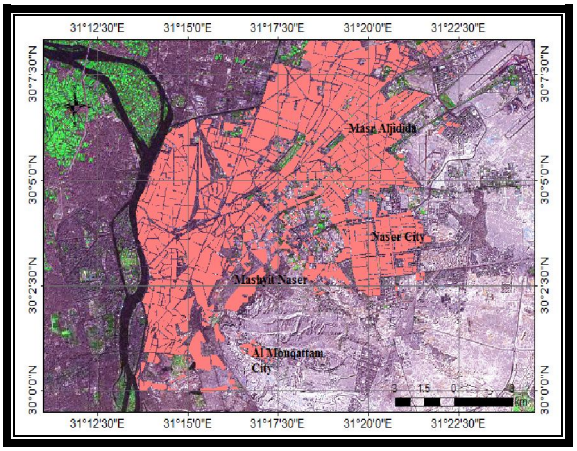


Fig (3): Model constructed in urban geomorphological hazard map

3. Results and Discussions

Mapping of geomorphological units and urban location:

From landsat image ETM, and topographic map Scale 1:50 000 the urban map of the study are presented in figure (4). Each united are characterize by particular spectral characteristics (i.e. color, pattern, and boundary).



Fig(4): The build up area in the north eastern sector of Cairo City

The physical parameter of study area:

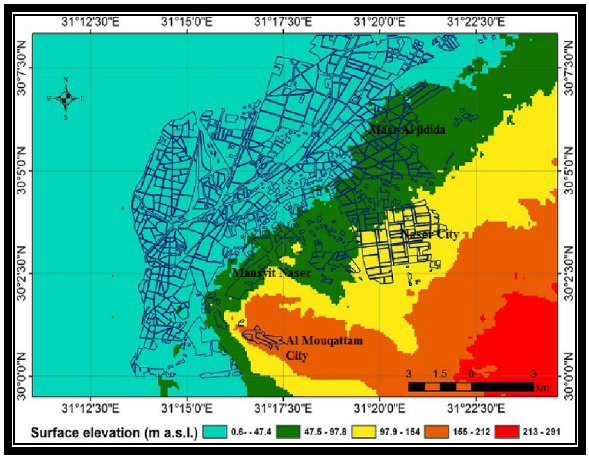
Based on the Land sat ETM images, the physical evaluation index of parameter are presents in table (2).

Table (2) Evaluating index of parameters

Evaluating index	1 Low	2 Moderate	3 High	4 Very High	5 Dangerous
Elevation(m)	<47.4	47.5-97.8	97.9-154	155-212	213-291
Slope gradient(%)	<2	2-4	4-6	>6	
Gully density Km.Km2	<1.25	1.25-5	5-10	10-15	>15
Relief degree(m)	<1	1-5	5-10	10-15	>15

1. The Digital Elevation Model (DEM)

The Digital Elevation Model (DEM) ,Masr Al jidida and Manshit Naser City are located between 47.4m and 97.8m,Naser City is located between 79.9m and154m,and Al Mouqattam 155m and 212m. Figure (5)



Fig(5) Digital Elevation Model of the study area

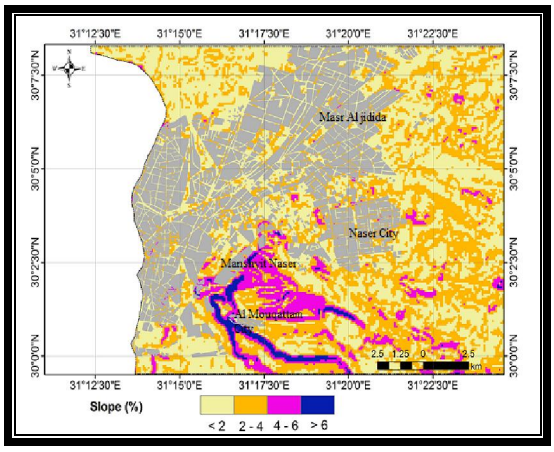
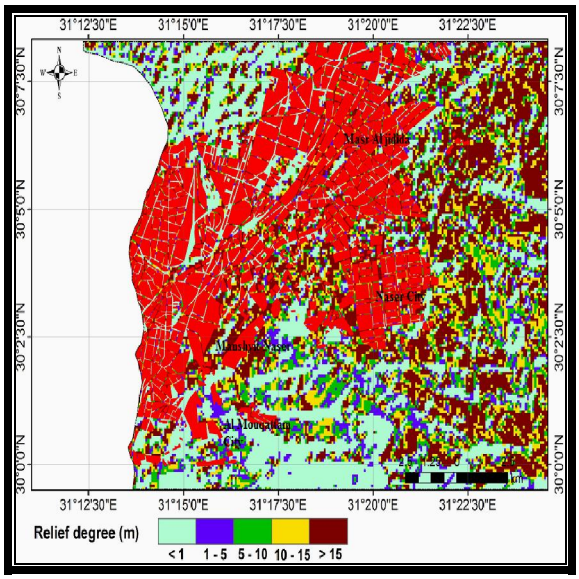


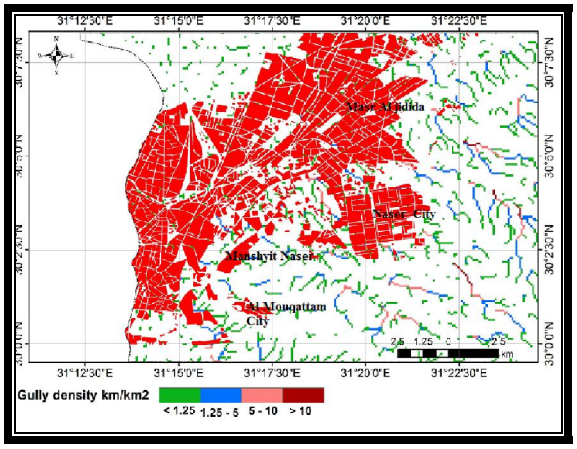
Fig (6) slope degree in the study area

The percentage of slope are ranging from 2% and 6%,Masr Al jidida and Manshit Naser , meanwhile Al Mouqattam town is ranging between 4% and 6% of slope figure(6).

The relief degree of land surface of the study area, based on DEM. Based on the extraction, classify the national geomorphologic form slow undulation, low undulation, moderate undulation, and mountainous undulation. According to classification the land surface degree of relief degree is ranging of <1. 25m, 1.25-5m, 5-10m, 10-15m and >15m.The results show that there is a very good correlation between the relief degree of land surface and the urban susceptibility, with the increase of the value of relief degree of land surface, its information content gradually increases up to >15 m.figure(7).the gully density <1.25 figure(8).



Fig(7) Relief degree in the study area



Fig(8) Gully density in the study area

The result indicates that 62% of urban build up are located in low hazard location, such as Masr Al jidida 25% in moderate hazard Such as Nasr city ,10% in high hazard in Al Mouqattam City, and Mashyiat Naser >1% in very high hazard location there are outside the area of study figure(9).

Table (3) the percentage of urban geomorphological hazards In the north eastern side of Cairo City.

	Low	Moderate	High	Very high	Total
Number of units	24158	9898	4072	233	38361
Area(km^2)	195.68	80.17	32.98	1.89	310.72
Areal percentage(%)	62.98	25.80	10.61	0.61	100.00

Note: Unit area = 90 * 90 m

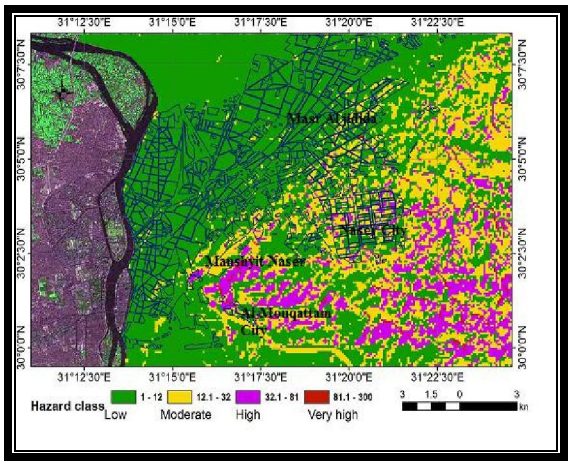


Fig (9) hazard map degree of urban-build up- area of the study area

4. Conclusion

- The use of satellite data proved to be useful in mapping the geomorphic land types.
- The urban extend are firmly related to geomorphology.
- Combination of field observation and Remote sensing analysis with satellite image, interpretation may provide valuable information about geomorphological sitting.

The study area is characterized by geomorphological features, each combines with urban distribution. The use of combined FCC of several band rendered in different colors for the same area is necessary for the discrimination between land units due to the fact that every feature has a unique spectral response with every band. Multi-band concert of satellite images was confirmed to be useful in discriminating features of similar spectral characteristics.

Corresponding author
G. Albayomi
Geography Department, Faculty of Arts, Helwan University, Cairo, Egypt
Gehan_albayomi@arts.helwan.edu.eg

Reference

1. Sultan, M., Abdel Hady, Y., El Araby, H., Mahani, A., Mehanee, S., Mecker, R., Fiske, M., Stein, T., &Gamal, M. (1999). Monitoring the urbanization of the Nile Delta, Egypt. Ambio, 28, 628–631.
2. Fahim, M. M., El-Mowelhi, M. N., Pax-Lenney, M., Khalil, K. I., Hawela, F., & Zaki, H. K. (1999). Identification of urban expansion onto agricultural lands using satellite remote sensing: Two case studies in Egypt. Geocarto International, 14(1), 45–48.
3. Hefny, K. (1983). Land-use and management problems in the Nile Delta (Egypt). Nature and Resources, 18(2), 22–27.
4. Said,R.(1967).Geology of Egypt.
5. Armanious,G,M,1990:Geoelectrical and Geological studies at greater Cairo area" M.SC Diae Chengta 1996" a new approach to theory and methods of urban geomorphological" China Geographical sciences ,VOLUME 8 NO1Beijing ,China
6. Diao Chengtai 1996,An Approach of urban geomorphology, Chinese Geographical Scince,Vol 6,No 1,pp88-95.Beijing,China.

3/28/12