# The New Cairo Capital Mega Development Project from Geodetic and Environmental Perspectives

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**Abstract**

The Egyptian government has recently announced the starting of a mega development project to establish a new administration capital. The proposed site is located about 30 kilometers east of the current capital, and 70 kilometers approximately west of Red sea and Suez canal. The project is likely be finished within five years. As a contribution of the academic and research communities in this pioneer national mission, this paper describes and analyzes the overall spatial location of such a massive development activity from geodetic and environmental points of view. Several geospatial databases have been compiled and evaluated within a Geographic Information System (GIS) environment. It is recommended that the accomplished results, the developed maps and spatial databases being taken into consideration by decision makers in the undergoing development phases of this national mega project.

**Keywords:** Cairo Capital, GIS, Spatial Databases, Environmental planning, Egypt

## 1. Introduction

Often, a capital of a country is a very populated city where much history has been made due to high-level political and economic activities that occur there. However, sometimes governments decide to move the capital from one city to another or build a new capital due to tremendous changes in terms of population growth and urbanization. Capital reallocation has been done hundreds of times throughout history. Examples of such countries include: Nigeria in 1992, Myanmar in 2005, Russia in 1918, Pakistan in 1959, Brazil in 1955, Kazakhstan in 1997, Tanzania in 1985, and Ivory Coast in 1983.

City, community, and regional planning deal with spatial information to monitor multiple urban and regional indicators, forecast future needs, and plan accordingly to help improve the quality of life in a community. Objectives of urban planning include, for instance, promotion of sustainable development, achieving integrated planning, developing appropriate planning tools, and integrating plans with budgets. Proper planning is a major key to make cities inclusive, environmentally friendly, economically vibrant, culturally meaningful, and safe for all (Un-HABITAT 2010). Within the activities of city and regional planning, GIS has proven to be an effective technical tool and has been utilized for a wide range of applications worldwide, with Egypt being of no exception. Examples of such GIS applications include: transportation planning (e.g. LA-DCP 2014), flood management (e.g. Dawod et al. 2011), land use planning (e.g. Mohammed and Al-Jenaid 2012), urban growth monitoring (e.g. Al-Ghamdi et al. 2012), optimum site selection for dams (e.g. Salih and Al-Tarif 2012), soil mapping (e.g. Labib and Nashed, 2013), groundwater mapping (e.g. Abdalla 2012), monitoring social conditions in slum areas (e.g. Khadr et al. 2010).

This paper aims to utilize GIS to develop and analyze geospatial databases regarding the new Cairo Capital mega project from geodetic and environmental perspectives.

## 2. The Cairo Capital Mega Project

Traditionally, Cairo has been the Egyptian capital for almost 1000 years. However, the Greater Cairo metropolitan area, has a population of almost 18 million people, and is expected to grow to 40 million people by 2050. Thus, it is considered one of the most densely regions all over the world. That fact might be an important motive for the Egyptian government to think about constructing a new capital. On March 2015 during the economic development conference, the government has announced the Cairo-Capital large-scale development project. It aims to built a national spirit, foster consensus global city with smart infrastructure for future. The project area, Figure 1, located east of Cairo outside the second greater Cairo ring road, halfway to the sea port of Suez. It is anticipated that the new city would become the new administrative and financial capital, housing the main government departments and ministries, as well as foreign embassies.

The new capital will take advantage of the sustainable technologies of today as well as be adaptable to future technologies, further enhancing its resource-efficiency. The main features of that mega project comprises (Cairo Capital, 2015):

- 700 $km^2$ gross land area
- 490 $km^2$ land available for development
- 5,000,000 population
- 250,000 city center's population
- 21 residential districts
- 5.6 $km^2$ central business district
- 16 $km^2$ airport area
- 4,200,000 $m^2$ large retail malls
- 91 $km^2$ energy farms
- 4 $km^2$ theme park
- 140 $km^2$ major and minor streets
- 1,100,00 residential units
- 1250 religious buildings
- 700 kindergartens
- 1,750,000 permanent jobs
- 40,000 hotel rooms

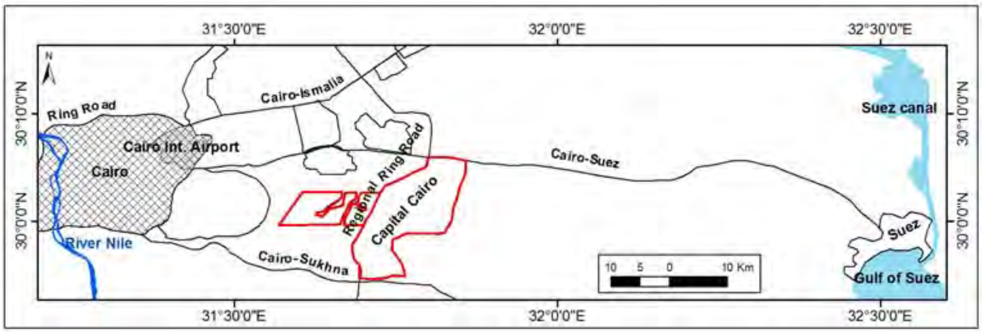



**Figure 1: General Location of the Cairo Capital Project**

### 3. Data and Processing Strategy

In the current study, it has been focused only on the area of the first phase of that mega project. That region (Figure 2) has a total area of approximately 245 square kilometers. Several datasets have been acquired and analyzed. Firstly, a Digital Elevation Model (DEM) representing the topography of the study area has been downloaded from the SRTM3 global DEM website (e.g. http://srtm.csi.cgiar.org). Secondly, two geological maps of scale 1 : 500,000 (namely: Cairo and Beni-Suef) have been obtained, scanned, georeferenced, digitized, and clipped in order to construct a digital geological database for the study area. Additionally, meteorological data for four stations around the study area (namely: Cairo Airport, Helwan, Ras Seder, and Ismalia) have been acquired, and then utilized to create spatial environmental data. Moreover, a map of the proposed transportation networks has been acquired and digitized.

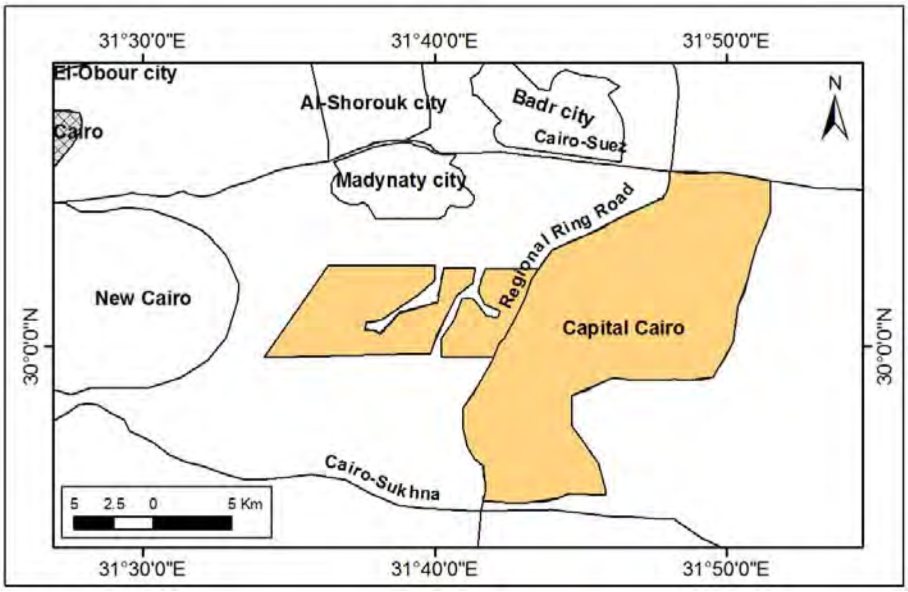



**Figure 2: Phase 1 of the Cairo Capital Project**

The Arc GIS 10 software has been utilized as the main tool for developing and analyzing digital geospatial databases. The processing has consists of several procedures as represented in Figure 3. The DEM has been processed in two separate stages: to create spatial representations of the topography in several forms, and to delineate the hydrological basins existed in the study area. The metrological data have been converted to raster format in order to clip the metrological characteristics of the study area. Additionally, the geological maps and the transportation network have been vectorized. Based on that procedures, several geospatial databases have been developed. Such datasets enable performing an integrated analysis for the Cairo Capital project from geodetics and environmental points of view.

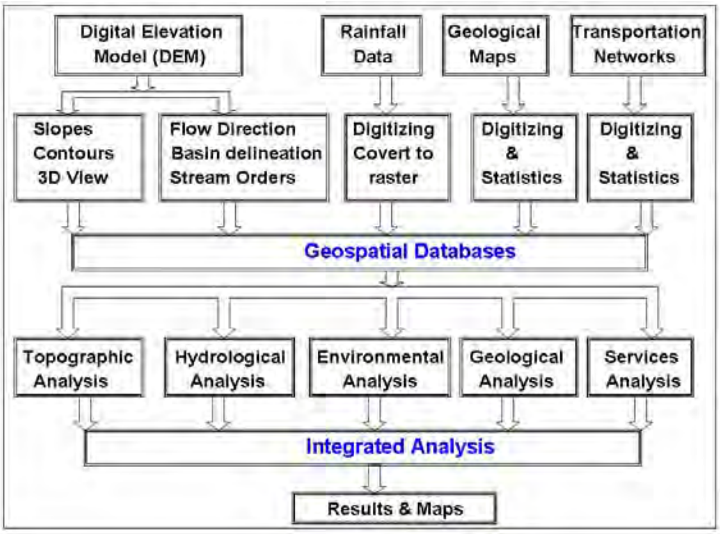



**Figure 3: Workflow of Data Processing**

## 4. Attained Results

### 4.1 The Topographic Analysis Results

The topography of the study area has been depicted in several forms as presented in Figures 4 to 7. It can be seen that the terrain elevations range from 216 to 451 meter, with an average of 314 meter. The highest elevations exist only in the southern and south-western borders of the area, while the majority of the elevations are less than 360 meter. Concerning the terrain slopes, it has been found that slopes vary from 0 to 17.8 degree, with a mean of 1.4 degree. Also, in units of percentage the slopes range from 0% to 32.1%, with an average of 2.4%. Accordingly, it can be concluded that the topography of the study area is almost of gentle slopes, except few locations mostly in its western edges. From an economical point of view, that is an important remark since it will significantly reduces the construction costs in this national project.

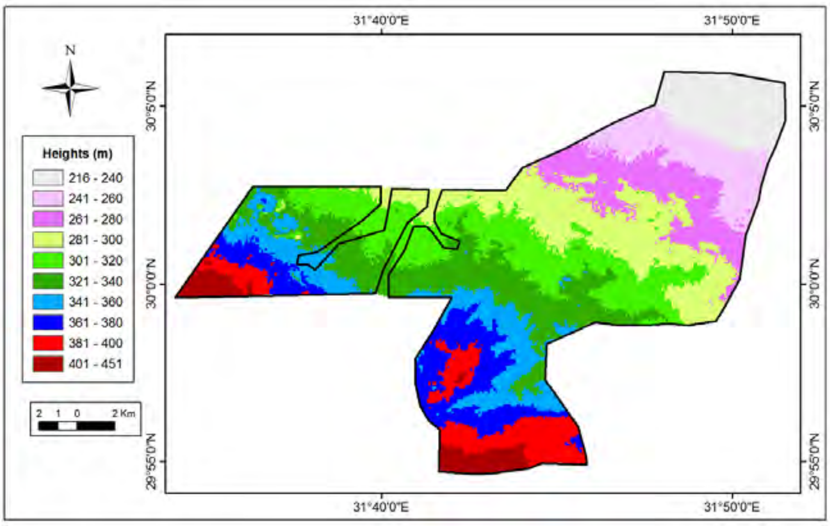



**Figure 4: Topography of the Study Area**

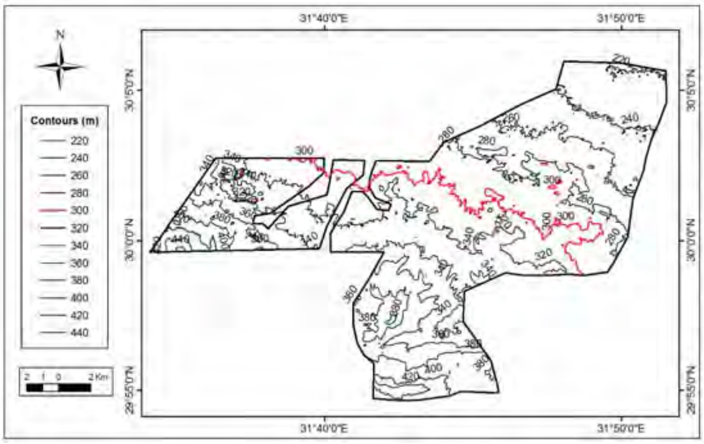



**Figure 5: A Contour Map of the Study Area**

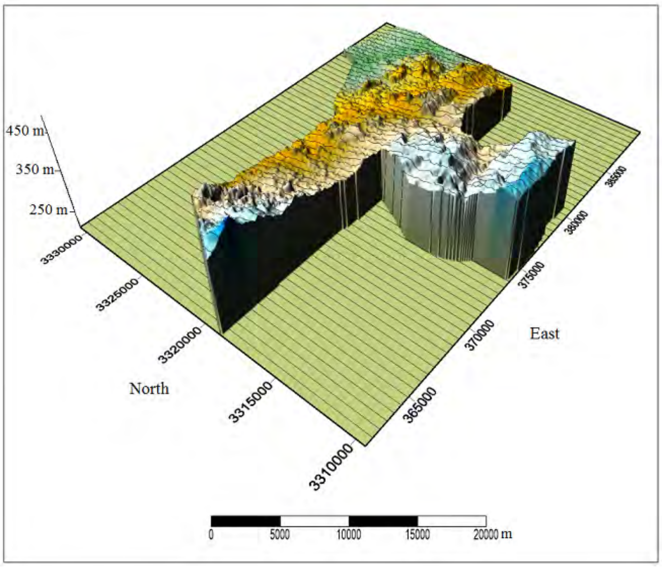
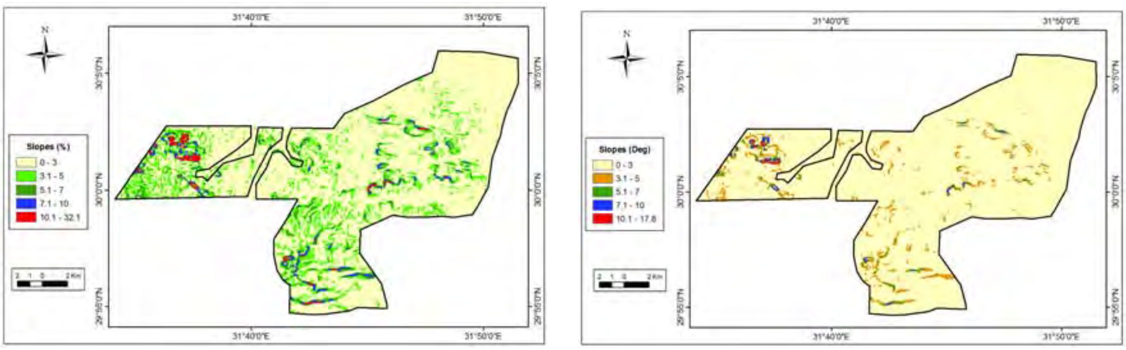



**Figure 6: 3D View of the Study Area**




**(a) slopes percentage** **(b) slopes in degrees**

**Figure 7: Terrain Slopes of the Study Area**

## 4.2 The Hydrological Analysis Results

The Hydrology toolbox of the Arc GIS package has been utilized in order to construct a hydrological geospatial database for the study area. Flow direction, flow accumulation, basin, and stream orders functions have been carried out. Eight main hydrological watersheds, that cover the study area, have been extracted. Table 1 summarizes these basins' characteristics, while Figure 8 depict them spatially. It can be realized that almost two thirds of the study area is covered by basin no. 1, with a total area of almost 167 square kilometers.

**Table 1: Hydrological Basins Statistics**

| Basin | Area ($km^2$) | Area% |
|---|---|---|
| 1 | 167.445 | 68.4 |
| 2 | 33.984 | 13.9 |
| 3 | 12.434 | 5.1 |
| 4 | 16.328 | 6.7 |
| 5 | 8.46 | 3.5 |
| 6 | 1.142 | 0.3 |
| 7 | 1.381 | 0.6 |
| 8 | 3.78 | 1.5 |
| | | |
| Sum | 245 | 100% |

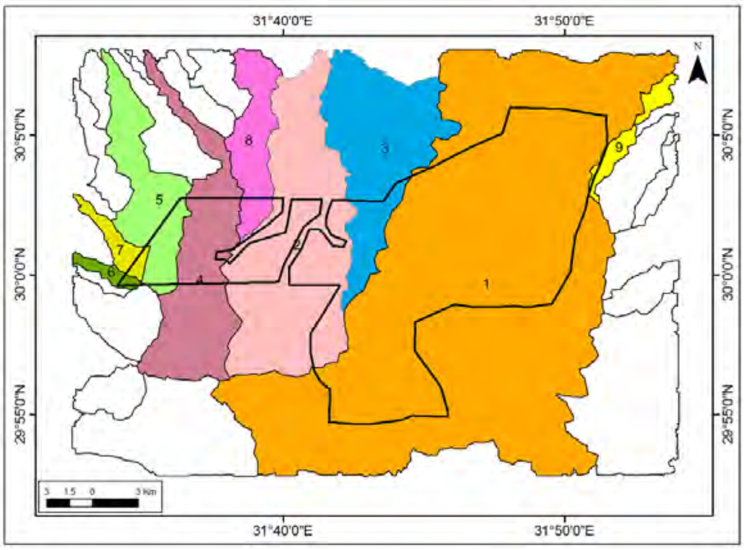



**Figure 8: Hydrological Basins of the Study Area**

Next, the stream orders of the surface drainage networks have been computed based on the Stralher method. It has been found that the streams have orders from 1 to 4, with a total length of 219.2 kilometer approximately (Table 2 and Figure 9). From Figure 9, it can be noticed that the main stream, of order 4, crosses the study area at the north-east border. Therefore, a great care should be taken into account in the design stage of the Cairo Capital landscape. This path should not have any infrastructure or surface utilities on its path, since it might be the most hazardous location in case of surface water runoff.

**Table 2: Stream Orders Statistics**

| Stream Order | Count | Length (m) | Length% |
|---|---|---|---|
| 1 | 96 | 117228.4 | 53.5 |
| 2 | 42 | 54510.6 | 24.9 |
| 3 | 38 | 39716.8 | 18.1 |
| 4 | 5 | 7713.3 | 3.5 |
| | | | |
| Sum | | 219169.1 | 100% |

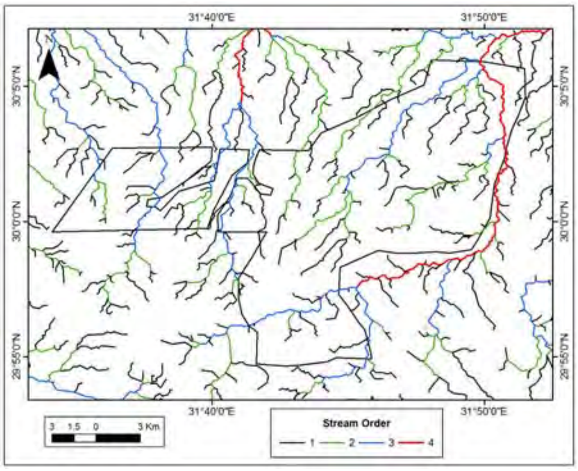



**Figure 9: Hydrological Stream Orders of the Study Area**

## 4.3 The Geological Analysis Results

Concerning the geology of the study area, sex main geological structures exist. The main geological feature is the Hagul formation, that occupies more than half of the study area. The Hagul formation consists mainly from fluviatile sand and gravel, and is locally underline by white limestone with marl. The second main geological structure, Gabel el-Ahmar formation, consists of continental vividly colored sands, quartzite and gravel. Wadi deposits constitutes about 15% of the study area. Therefore, this is an imperative finding from an economical point of view since it will significantly reduces the construction costs in this national development project.

| **Structure** | **Area (km$^2$)** | **Area%** |
|---|---|---|
| Hagul formation | 128.544 | 52.5 |
| Gebel el-Ahmar formation | 48.049 | 19.6 |
| Wadi deposits | 37.765 | 15.4 |
| Maadi formation | 25.157 | 10.3 |
| Mokattam group | 3.235 | 1.3 |
| Basalt | 2.204 | 0.9 |
| | | |
| Sum | 245 | 100% |

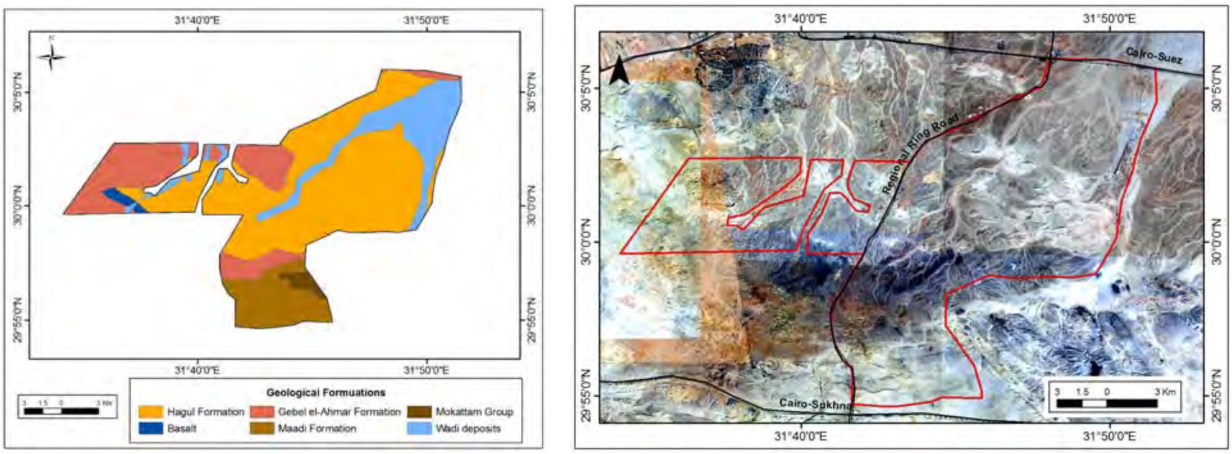



**Figure 10: Geology of the Study Area**

### 4.4 The Environmental Analysis Results

Regarding the rainfall, the study area posses an average annual rain varies from 20 to 39 millimeter/year, with an average value of 28 millimeter/year. It increases northward as can be noticed from Figure 11. It is a matter of fact that the biggest amount of rainfall in Egypt occurs in the autumn and winter sessions (from November to March). Although this can be considered as a small rainfall rate, care should be considered in the design process of the project, particularly for the pathway of surface drainage network of order 4, just to avoid any possible hazardous impacts of surface water runoff.

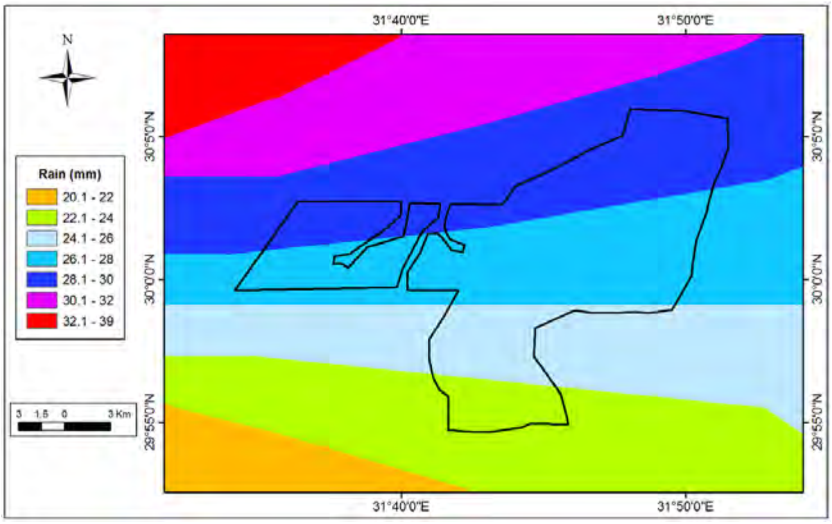



**Figure 11: Average Annual Rains of the Study Area**

### 4.5 The Transportation Analysis Results

Figure 12 depicts the current and future transportation networks in the study area. Currently, the Cairo Capital project area is connected by two highways: Cairo-Suez, and Cairo-Sukhna, that run from the traditional Cairo city to Suez city and Red Sea. Another highway that cross the study area is the regional ring road, which connects several governorates around Cairo. The future transportation road networks in the first phase of the project contains major roads with a total length of 193 kilometer approximately. Also, it has been found that the proposed network of the future expansion phase of the project will include main roads with a total of 158 kilometer length approximately. Furthermore, the transportation network will contain an international airport at the north-east of the project region.

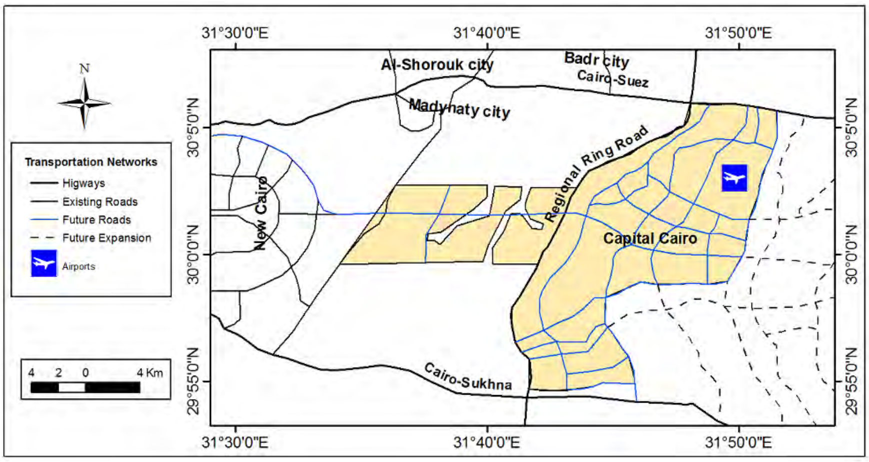



**Figure 12: Transportation Networks of the Study Area**

## 5. Conclusions

A mega development project has been initiated in Egypt to establish a new capital located about 30 kilometers east of the current capital, and 70 kilometers approximately west of Red sea and Suez canal. This research analyzes the overall spatial location of such a massive development activity from geodetic and environmental points of view. The attained topographic results show that the heights range from 216 to 451 m, with an average equals 314 m above sea level. The surface terrain slopes vary between 0 and 18 degrees, with an average equals 1.4 degree, which indicates a gentle-slope pattern. From a hydrologic perspective, the new capital location extends over six hydrologic sub-basins, with stream orders up to the fourth order. It has been found that the main hydrological streams almost run out of the study area expect in few specific locations. In order to minimize the possible flood hazards, it is recommended that such sites should be highlighted in the landscape design of the new capital, and probably left as preserved areas. The developed geological database show that there are six existing geological structures in the study area. The main structure was found to be the Hagul formation, which consists mainly from fluviatile sand and gravel. Several topographic, geological, and hydrological digital maps have been developed for the new capital general location. It is recommended that those maps and spatial databases being taken into consideration by decision makers in the development stages of this national mega project.

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