Land Use Mapping For Path Selection of Strategic Road Using EgyptSat-1 Imagery

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ABSTRACT

The Egyptian government plans for establishing a set of free ways to relief the traffic congestion and support the development projects in and around the Nile Delta. For example, the project of this research, the proposed path between Ashmoun city and Cairo-Alexandria desert road. Establishing these corridors requires an up-to-date and use and land cover maps to determine the various constraints for selecting the most suitable path. On top of these constraints are the residential areas, the industrial areas as well as the linear features such as the irrigation networks, the road networks, and the utility networks. The key constraints is that the proposed path must be away from the residential areas, the industrial areas and to minimize the intersections with wide irrigation channels (i.e. wider than 25 meter) and both highways and railways. Unfortunately, there is no an official up-to-date land use and land cover map with appropriate scale for this particular area. Therefore, using Egyptsat-1 satellite is a potential source of information to generate and update such maps at the appropriate scale. The availability of EgyptSat-1 satellite imagery together with other source of information helped the research team define and map the various landuse elements in the northwest region of the Six October Governorate for the purpose of determining alternative scenarios of the proposed free way between Asmoun City (El-Monofia Governorate) and Cairo-Alexandria Desert Road. All the details of these maps, techniques and scenarios are fully discussed in this paper.

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INTRODUCTION

Roads are constructed for various purposes. For instance, in the desert environments, roads function for accessing remote areas, developing new regions rich in natural resources, or flourishing trade activities. In the highly populated regions such as the Nile Delta, relieving traffic congestion within and between big cities is the main objective for road constructions. Aligning with these objectives, a road had been proposed in the northeast region of the Six October Governorate. This road will function to, 1) sustain and maintain the agricultural and the industrial development projects located in the northeast region of the Six October Governorate, and 2) link the Six October Governorate with the other governorates in the middle of the Nile Delta. The road is supposed to extend form Ashmoun City in the west of El-Monofiyya Governorate to Cairo-Alexandria Desert road (Figure 1). However, selecting a path for the proposed road requires developing a well concise approach and comprehensive geo-database in particular in the areas of intensive land use.

The Geographic Information Systems (GIS) have a wide variety of applications in the different fields of urban planning (Hanzl 2007, Durieux et al. 2008, Langford et al. 2008, Baz et al. 2009). One of these fields is the least cost path selection for identifying the most suitable routes for constructing roads (Mainguenaud 2000, Frank et al. 2000, Matisziw et al. 2006, Bielli et al. 2006, Bonvicini and Spadoni 2008). GIS is wealth by various functions and operations for performing site selection analysis especially the path selection for proposed roads in different environment. However, the potential of GIS for performing such types of analyses is always restricted by the quality of the geo-spatial data sources. One of the most reliable sources of developing and organizing the GIS layers that eventually form the geo-spatial database is the remote sensing imagery. Both are always integrated for mapping and analyzing the geo-spatial database in order to solve the real world problems (Mason et al. 1997, Thomson and Hardin 2000, Montoya 2003, Kong et al. 2006, Yang et al. 2008). From this perspective, the objectives of the current research had been performed. In the absence of the fine resolution and the up-to-date topographic maps that can identify and the map the complex reality either within or along the borders of the Nile Delta, the satellite imagery
became the natural alternative. Among these satellite imagery is the EgyptSat-1 which has technical specification capable to identify and organize the various GIS layers that are necessary for proposing various paths for the proposed rods between Ashmoun City and Cairo – Alexandria Desert road.

The availability of the EgyptSat-1 satellite image provided the capability of developing and organizing a comprehensive geo-database for the study area (Figure 2). The EgyptSat-1 satellite image dated September 15, 2009 along with the field work were used to organize and establish the up-to-date comprehensive geo-database required for performing the main objective of the study which was proposing various scenarios of the proposed road extending from Ashmoun City to Cairo-Alexandria desert road.

**METHODOLOGY**

An integrated methodology was proposed and conducted for the accomplishment of the main objective of this research. This methodology includes the followings:

**A. Digital image processing**

The EgyptSat-1 satellite imagery was geo-referenced using the Universal Transeverse Mercator (UTM) projection with unit meters, spheroid WGS84, datum WGS84, and zone 36N parameters. The median filters along with histogram contrast stretching enhancement techniques (Sabins 2007) were applied to facilitate the visual interpretation of the various land use features in the study area.

**B. Establishing an updated geo-spatial database**

Using the EgyptSat- satellite image, it was possible to identify and map a wide set of geo-spatial database. This database includes polygon GIS layers such as the residential areas, the industrial areas, the agricultural areas, the Nile River, and cemeteries (Figure 3). In addition various linear GIS layers were identified and automated such as the irrigation networks, the drainage networks, the road networks, and the various utilities networks (Figure 4). Along with the polygon and linear GIS layers, the point GIS layers were also identified and automated such as the scattered buildings and the base of the electric power lines. Given this geo-database, various GIS analytical functions and operations were followed.
Figure 1: Location map of the study area.

Figure 2: EgyptSat-1 satellite image that was used to identify and map the various landuse features in the study area.
C. GIS analysis for establishing various scenarios of the proposed road

❖ Path definition

Defining a path between Ashmoun City and Cairo-Alexandria Desert road occurred according to the following steps

- Define various paths that avoid the residential and the industrial areas along with the holy places such as cemeteries,
- Modifying these paths to avoid the scattered residential buildings,
- Relocate the proposed paths to cross the Rosetta Branch of the Nile River at various widths, and
- Relocate and adjust the paths to be perpendicular on both the Rosetta Branch of the Nile River; and the irrigation and drainage channels that have widths more than 25 meters.

Figure 3: Residential, industrial, and agricultural areas extracted from EgyptSat-1 satellite image.
Figure 4: channel and road networks extracted from EgyptSat-1 satellite image.

Path Analysis and assessment

The intersection analysis was carried out for the purpose of

- Assertion that the paths did not intersect with the residential and industrial areas along with the cemeteries, and
- Calculation of the number of the intersections with the linear features such as the irrigation, irrigation, and road networks.

RESULTS AND DISCUSSION

Applying the previous approach, five paths were deduced. Each has its own length and spatial characteristics such as relative locations with the major cities, Rosetta branch of the Nile River, and other linear features. In addition, each is characterized by its number of intersections with the various land use features located in the study area. In the following sections, a description of each path will be presented:
The first path

The total length of the first path is 21.03 km. It starts from the western borders of Ashmoun city and continue crossing the Rosetta Branch where the width is 200 m. It continues passing in the western direction until it crosses El Behari and ElNasseri Canals and then gently bend in the southwest direction until it intersect with Cairo – Alexandria Desert road. Along the whole path, there are no intersections with the residential, or cemetery areas. It rather intersects with an industrial farm (Table 1). Regarding the intersection with the linear features, the path intersect with 1.0 highway, 8.0 paved road, 106.0 unpaved road, 1.0 railway, 2 channels of width more than 25.0 m, 1.0 channels of width ranging from 10.0 m to 25.0, and 8.0 channels of width less than 10.0 meters (Table 1). The buffer zone of 60.0 meters of the path will result in losing ~ 436 feddans of the agricultural and reclaimed areas along the path (Table 1).

The second path

The total length of the first path is 20.87 km. It starts from the western borders of Ashmoun city and continue crossing the Rosetta Branch where the width is 350 m. It continues passing in the western direction south of the first path until it crosses El Behari and ElNasseri Canals at southward location relative to the first path as well. After crossing these canals, the second path continues passing in the westward direction before it gently bends in the southwest direction before it intersect with Cairo – Alexandria Desert road. Along the whole path, there are no intersections with the residential, industrial or cemetery areas (Table 1). Regarding the intersection with the linear features, the path intersect with 1.0 highway, 8.0 paved road, 102.0 unpaved road, 1.0 railway, 2.0 channels of width more than 25.0 m, 1.0 channels of width ranging from 10.0 m to 25.0, and 6.0 channels of width less than 10.0 meters (Table 1). The buffer zone of 60.0 meters of the path will result in losing ~ 538 feddans of the agricultural and reclaimed areas along the path (Table 1).
The third path

The total length of the first path is 21.03 km. It starts from the western borders of Ashmoun city and then heads up in the southwest direction until it crosses the Rosetta Branch where the width is minimal reaching 150 m. It continues passing in the western direction south of the second path; and north Abu Ghaleb City until it crosses El Behari and ElNasseri Canals at the same location of the second path (Figure 5). After crossing these canals, the third path continues passing in the westward direction following the location of the paved road located in the middle of the study area until it intersects with Cairo – Alexandria Desert road (Figure 5). Along the whole path, there are no intersections with the residential, industrial or cemetery areas (Table 1). Regarding the intersection with the linear features, the path intersect with 1.0 highway, 8.0 paved road, 108.0 unpaved road, 1.0 railway, 2.0 channels of width more than 25.0 m, 1.0 channels of width ranging from 10.0 m to 25.0, and 10.0 channels of width less than 10.0 meters (Table 1). The buffer zone of 60.0 meters of the path will result in losing ~ 436 feddans of the agricultural and reclaimed areas along the path (Table 1).

The fourth path

The total length of the first path is 21.02 km. It starts from the western borders of Ashmoun city and then heads up in the south western direction until it crosses the Rosetta Branch where the width is minimal reaching 150 m. It continues passing in the western direction similar to the third path. At a point north Abu Ghaleb city this path diverts from the third path in the southwest direction to intersect with El Behari and ElNasseri Canals at different location than the third path (Figure 5). After crossing these canals, the fourth path continues passing in the westward direction following the same location of the second path until it intersects with Cairo – Alexandria Desert road (Figure 5). Along the whole path, there are no intersections with the residential, industrial or cemetery areas (Table 1). Regarding the intersection with the linear features, the path intersect with 1.0 highway, 8.0 paved road, 110.0 unpaved road, 1.0 railway, 2.0 channels of width more than 25.0 m, 1.0 channels of width ranging from 10.0 m to 25.0, and 9.0 channels of width less than 10.0 meters (Table 1). The buffer zone
of 60.0 meters of the path will result in losing ~ 436 feddans of the agricultural and
reclaimed areas along the path (Table 1).

❖ **The fifth path**

The total length of the first path is 21.00 km. It starts from the western borders of Ashmoun city and then heads up in the south western direction until it crosses the Rosetta Branch where the width is minimal reaching 150 m. It continues passing in the western direction similar to the third and the fourth paths. At a point north Abu Ghaleb city this path diverts from the third and the fourth paths in the southwest direction to intersect with El Behari and ElNasser Canals at different location than the previous paths (Figure 5). After crossing these canals, the fourth path continues passing in the westward direction before it heads up in western direction in a straight way for a short distance. Then, the path bends in the southwest direction until it intersects with Cairo – Alexandria Desert road (Figure 5). This path is the only path that is located south of the paved road located in the middle of the study area (Figure 5). Along the whole path, there are no intersections with the residential, industrial or cemetery areas (Table 1). Regarding the intersection with the linear features, the path intersect with 1.0 highway, 9.0 paved road, 91.0 unpaved road, 1.0 railway, 2.0 channels of width more than 25.0 m, 1.0 channels of width ranging from 10.0 m to 25.0, and 9.0 channels of width less than 10.0 meters (Table 1). The buffer zone of 60.0 meters of the path will result in losing ~ 436 feddans of the agricultural and reclaimed areas along the path (Table 1).

**CONCLUSION**

From the above approach, results, and discussions, it is possible to conclude the followings considerations:

❖ EgyptSat-1 satellite imagery could be a potential source for extracting and constructing a comprehensive geo-database in order to potentially identify, map, and analyze the various land use features,

❖ There are no considerable variations in the lengths of the whole paths, and
The relative locations of the five paths to the Rosetta Branch along with the number of the intersections in particular with the wide linear features could be valuable parameters to differentiate and select the most suitable path for the proposed road that will links Ashmoun City and the Cairo – Alexandria Desert Road.

Figure 5: the five paths developed from studying the complicated land use features in the study area.
Table 1: The main characteristics of five paths of the proposed road between Ashmoun City and Cairo – Alexandria Desert road.

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<th>The path</th>
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<th>Intersection with the Polygon features</th>
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REFERENCES


