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THE POTENTIALS OF SATELLITE IMAGES FOR MAP UPDATING WITH EMPHASIZES ON EGYPT SAT-1 IMAGES

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The lack of adequate maps is one of the critical issues to be handled in developing countries. The main problem is the rapid development of urban areas, so that maps are out of date very fast. Consequently, nearly all these maps have to be revised and updated as soon as possible. Recently, due to the improvement in satellite technology, remote sensing data is applied for mapping and map updating at different scales. On April 17, 2007 the first Egyptian earth observation satellite Egypt Sat-1 was launched. The available images from Egypt Sat-1 satellite provides valuable source of remote sensing data in Egypt. This paper aims to evaluate the potential of Egypt Sat-1 images versus other satellite images for maps updating. Data used in this study are satellite images from Egypt Sat-1, SPOT 4, IKONOS and topographic map at scale 1:25,000.

The methodology focuses on visual comparison of the images over the test area for specific features such as roads, railways, watercourses and boundaries of urban areas. After that an investigation is carried out for the potential of the information content in Egypt Sat-1 images, for updating 1:25,000 map. The results of these evaluations show that Egypt Sat-1 images, from the point of geometric accuracy, have the capability of 1:25,000 scale maps revision. Also, from the point of information content, it have the capability of revision of the main features such as building blocks, roads and vegetation cover. Revision of other objects in Egyptian 1:25,000 scale maps that are problematic in their identification and extraction from Egypt Sat-1 images can be completed using other mapping methods.

KEYWORDS: *Egypt Sat-1, Information Content, Feature Extraction, Map Revision.*

1. INTRODUCTION

Map updating is the process of bringing the information on a map up-to date. Nowadays map updating becomes a very important and major task for mapping agencies, as topographic maps must be as up-to-date as possible. Furthermore, there is increasing demand to use maps for planning and development. The economic development of a country or a region is highly dependent on up-to date information. The rate at which maps go out of date varies and is related to the rate of development of the area. Revision of mapping can be made in three main alternative ways, which are (Jamebozorg, et al. 2003):

1. Cyclic revision, which aims to revise the whole series over a fixed period of years.
2. Selective revision, which try to achieve revision of individual maps by an order of priority that is governed by rate of change or urgency of demand and not by fixed periods.
3. Continuous revision, which relies on a continuous inflow of information, to maintain maps in an up-to-date condition.

In addition to the three updating methods given above, map updating programs have to distinguish how much of the changed data will be included in updating. This can be done through quick updating, partial updating and complete updating. Quick updating aims to update the most important features of the map such as, roads, watercourses, boundaries of urban areas, etc. While, partial updating aims to update some preselected parts or some particular elements of the map. Finally, all the changed elements in the maps could be updated in complete updating program.

Rapid changes in the ground activities require acquisition of information in the shortest time and the cheapest way. However, the real possibility of using satellite images for cartography depends on several factors such as; the possibility of providing planimetric and altimetric accuracy as well as information content with respect to detection and identification of features (Sadeghi et al, 2004). Under usual conditions the geometric accuracy is not the limiting factor. The main factor is the information contents, which depends upon various factors such as spatial and radiometric resolutions. This is in addition to spatial scale of the features to be imaged, radiometric contrast between different target types and the final application for which the image has been acquired (Narayanan et al, 2002). The available images from Egypt Sat-1 satellite, open new possibilities for mapping and map updating in Egypt. The main aim of this research is to evaluate the use of Egypt Sat-1 images for map revision according to its geometric accuracy and information content.

2. METHODOLOGY

In order to achieve the objective of this study, the following steps were performed and their results are evaluated.

- The images used in this study (from Egypt Sat-1, SPOT 4 and IKONOS) are geometrically corrected in order to match the corresponding pixels of the images being compared.
- Applying different enhancement techniques to the images to highlight features of interest. Then choosing the technique giving the best visual improvement.
- Extraction of map features using manual on-screen digitizing in order to investigate the features that can be updated from Egypt Sat-1 images.
- Comparing the potential of Egypt Sat-1 images, with two of the most widely used satellite images for mapping, SPOT and IKONOS satellite images. The methodology focuses on visual comparison of the images over the test areas. During this investigation specific features are taken into account such as roads, railways, watercourses and boundaries of urban areas.
- Investigation of the potentials of the information content in Egypt Sat-1 images, for updating 1:25,000 Egyptian maps. The evaluation is entirely based on assessment of field control (collection of ground truth data), the image itself and on general experience of the area.

3. STUDY AREA AND DATA USED

3.1. Study Area:

This study is applied on part of the governorate of Assiut that covers Assiut city and the surrounding villages with longitudes 31° 79 300 to 31° 159 000 E and latitudes 27° 79 300 to 27° 159 000 N. Governorate of Assiut is one of the oldest governorates in Egypt and it is the capital of Upper Egypt. Its total area is about 25926 km^2. It is situated about 375 Km south of Cairo (the capital of Egypt). Assiut is one of the fastest growing urban areas in Egypt (Farrag and Moustafa, 2006). The study area consists of various land covers such as, urban, rural, water, mountainous and agriculture.

3.2. Satellite Images Used:

Three satellite images are used in this study from Egypt Sat-1, SPOT 4 and IKONOS.

3.2.1. Egypt Sat-1 Images:

On April 17, 2007 NARSS (National Authority for Remote Sensing and Space Science, Egypt) in cooperation with Yuzhnoye State Design Office (YSDO), Ukraine, launched the first Egyptian earth observation satellite Egypt Sat-1. It orbits the Earth once every 98 minutes at an altitude of approximately 668 km in a sun-synchronous path. The satellite payload includes 4 spectrum optical camera (3 in spectral bands and one in panchromatic band) and mid-infrared camera. The image swath for optical camera and Mid-infrared camera are 46 km and 55 km respectively. It can capture a vertical image for any location in Egypt once every 75 days. Also it can be tilted to capture images for location at both sides of satellite path (tilting capability 35 deg), capture stereo images, or re-capture images for the same location within periods of less than 16 days (NARSS, 2011). In this study multispectral image from Egypt Sat-1, captured in August 26, 2009, level 1A with 7.8 m spatial resolution is used.

3.2.2 Other Satellite Images Used:

The two other satellite images used in the study are multispectral satellite image from SPOT 4 satellite, captured in March 26, 2000, level 1A with 20 m spatial resolution and high resolution satellite image from IKONOS satellite, captured in February 17, 2006. IKONOS image is acquired as 1m resolution panchromatic (Pan) and 4 m resolution Multi-Spectral (MS). Table 1 summarizes the main characteristics of satellite images used in this study.

Table 1: Main characteristics of satellite images used.

Sensor	Number of bands	Spatial resolution	Temporal resolution	Swath width	Radiometric resolution	Cost in (USD) per Km^2	Company	Launch
	Pan/MS	Pan/MS	days	Km				
Egypt Sat-1	1/4	7.8/7.8	75	46	8 bit	0.36	NARSS	2007
SPOT 4	1/4	10/20	26	60	8 bit	0.7	SpotImage	1998
IKONOS	1/4	1.0/4.0	2.9	11.3	11 bit	18	GeoEye	1999

3.3. Map Used:

There is no available large scale map for the study area, only topographic map compiled from aerial photographs at scale 1:25,000 (No. NG36M3a4) is obtained. The map produced in 1991 by the Military Survey Department (MSD) covering the study area and it is used as a basis for comparison and assessment.

4. DATA PREPROCESSING

Data preprocessing include the tasks required for presentation of the satellite images in a more suitable form that can lead to better interpretation and extract maximum information from these images. This carried out through the following steps:

4.1. Image Geo-Referencing:

Satellite images were geo-referenced to Egypt transverse Mercator (ETM) projection using a total of 19 Ground Control Points (GCPs) and 5 check points well distributed and well defined on the images. The coordinates of the GCPs and check points were determined from the field observation applying Global Positioning System (GPS). Second order polynomial transformation and nearest neighbor resampling techniques were adopted. The images were rectified with Root Mean Square (RMS) error in the check points as 5.59 m for Egypt Sat-1, 10.7m for SPOT 4 and 1.2 m for IKONOS.

4.2. Image Enhancement:

Before image interpretation, different enhancement techniques were applied to Egypt Sat-1 and SPOT 4 in order to find image composition that improve the visual interpretation and highlight features of interest. Best result were obtained by radiometrically enhanced both images using contrast stretching plus an edge enhancement through a kernel size of 3 by 3. In IKONOS the lower resolution of multispectral image does not allow extraction of objects with the same level as the higher resolution panchromatic image. Pan-sharpening technique merge the advantages of low-resolution multispectral and high-resolution panchromatic images to improve the visual quality of the image for better object identification. This means that a pan-sharpened image combines the spatial and spectral characteristics of both images (Siachalou, 2004).

5. INFORMATION EXTRACTION

The complexity of digital image data, makes the approach to their interpretation and analysis very distinctive. Extraction of information from satellite images can be categorized as being a manual, semi-automated and fully automated process. Manual extraction is performed through interactive interpretation by a human operator. The operator only sees intensities, hues, edges, patterns and textures in the image. In this case recognition of objects like roads, watercourses, boundaries of residential area etc., depend on the personal experience in visual perception and the background knowledge of the interpreter. While, semi-automated extraction requires some human input to guide a set of automated processes. Finally, automatic feature extraction process requires no human input. This method takes into account the form, texture and spectral information. Its classification phase starts with the crucial and initial step of grouping neighboring pixels into meaningful areas, which can be handled in the later step of classification. Such segmentation and topology generation must be set according to the resolution and the scale of the expected objects. By this method, not single pixels are classified but homogenous image objects are extracted during a previous segmentation step.

Manual extraction has more reliable results compared to the automatic extraction (Marangoz et al. 2007). However, the experience of the operator is very important, and the time spent has to be considered. Automatic extraction can be quite faster. But, there are no fixed parameters for segmentation of the images and the experience of the operator is still important (Topan, et al. 2009). In practice, a feature should not be captured solely from images unless there is some additional supporting information, which confirms the existence of the feature, and provides its attributes. Satellite image is generally used to position new features, and other information is used to attribute the features (Forghani et al., 2003).

Forghani 2002 has carried out an assessment of KOMPSAT-1 Versus SPOT-2/4 satellite image for maintenance of Geoscience Australia topographic databases. In this study an assessment of the sharpness, clarity and reliability of information with respect to mapping of urban features was carried out on the images. It was found that the visual interpretation is best suited for urban mapping.

6. INFORMATION CONTENT OF EGYPT SAT-1 VERSUS IKONOS AND SPOT 4 IMAGES

SPOT is a series of earth observation imaging satellites designed to be a commercial provider of earth observation data. They have been studied by many researches and considered one of the most widely used satellite data for mapping. Also the availability of the new generation of high resolution satellite images have provide valuable data source for producing and updating digital maps (Samadzadegan et al, 2004). Higher resolution images such as IKONOS, as expected, provided greater spatial detail. Since, when the resolution of remote sensing images approaches 1 m or less, most small objects on the ground such as houses, vehicles and so on can be seen clearly. In this section information content in Egypt Sat-1 image is compared with that in IKONOS and SPOT 4 images. Egypt Sat-1 has nearly the same bandwidths as SPOT 4 in green, red and near infrared bands of the image that are used in comparison as shown in table 2. Egypt Sat-1 and SPOT 4 images have 8 bits (256 grey values) radiometric resolution. IKONOS have 11 bit (2,048 grey values) which improves visualization and provides more information to discern subtle differences among objects.

Table 2: Bands wave length and resolution of images used in this study.

Bands	IKONOS		Egypt Sat-1		SPOT 4	
	Wave length (μm)	Resolution (m)	Wave length (μm)	Resolution (m)	Wave length (μm)	Resolution (m)
Blue	0.45 - 0.52	4	-	-	-	-
Green	0.52 - 0.60	4	0.51 - 0.59	7.8	0.50 - 0.59	20
Red	0.63 - 0.69	4	0.61 - 0.68	7.8	0.61 - 0.68	20
Near Infrared	0.76 - 0.90	4	0.80 - 0.89	7.8	0.78 - 0.89	20
panchromatic	0.45 - 0.90	1	-	-	-	-

6.1. Verification of Urban and Rural Features:

Visual analysis of images with concomitant display of source material was done to observe the level of sharpness, clarity and reliability of information in Egypt Sat-1 image compared with IKONOS and SPOT 4 images. ERDAS imagine 8.4 software was utilized, where qualitative and quantitative evaluations were performed for the informative content. The following features exist in the study area and represented in 1:25000 map are considered and evaluated:

A. Hydrological features:

Hydrological features include rivers, streams, canals and drainage. On the images it is clearly visible that, with IKONOS, Egypt Sat-1 and SPOT 4 the whole section of River Nile and main canals such as Ibrahimia canal can be mapped (Figure 1). In IKONOS image branch canals are quite easy to be detected and identified. Also, they can be identified and delineated in Egypt Sat-1 image, but in SPOT 4 image, their edges are hazy. Swimming pool in Assiut university is clearly visible and it can be mapped with IKONOS image and Egypt Sat-1 image, whereas in case of SPOT 4 image, it is not visible (Figure 3 - *E*). Holland et al, 2003 mentioned that capturing of rivers from IKONOS images is acceptable for 1:10,000 mapping and smaller, but streams require field completion to get a true picture of the topographic feature.

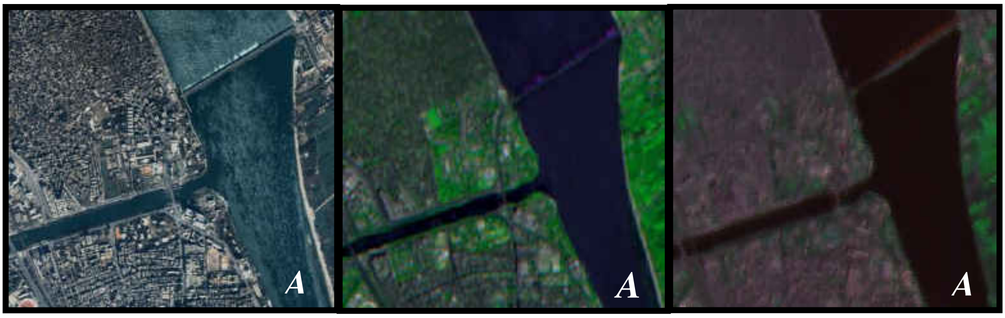

Figure 1: River Nile and Ibrahimia main canal. *A1* (KONOS image), *A2* (Egypt Sat-1 image) and *A3* (SPOT 4 image).

B. Cultural features:

Cultural features present in study area include residential areas, stadium, diesel cisterns, etc. Residential areas are divided into low density, medium density and high density. Boundaries of individual buildings in low density residential areas can be identified and delineated with Egypt Sat-1 image. In case of SPOT 4 image, the boundaries of various polygons are not so precise and somewhat hazy at most places (Figure 2 – *B2* and *B3).* In medium density areas, boundaries of individual buildings are hazy in Egypt Sat-1 image. But in case of SPOT 4 image, it is difficult even to identify the individual buildings or determine its boundaries (Figure 2 - C*2* and C*3*). Boundaries of individual buildings in low density and medium density residential areas are quite easy to be detected and delineated in IKONOS image (Figure 2- *B1* and *C1*). In high-density areas, all images have their own limitations and it is not possible to identify individual buildings, only boundaries of high residential area can be delineated (Figure 2 - *D*).

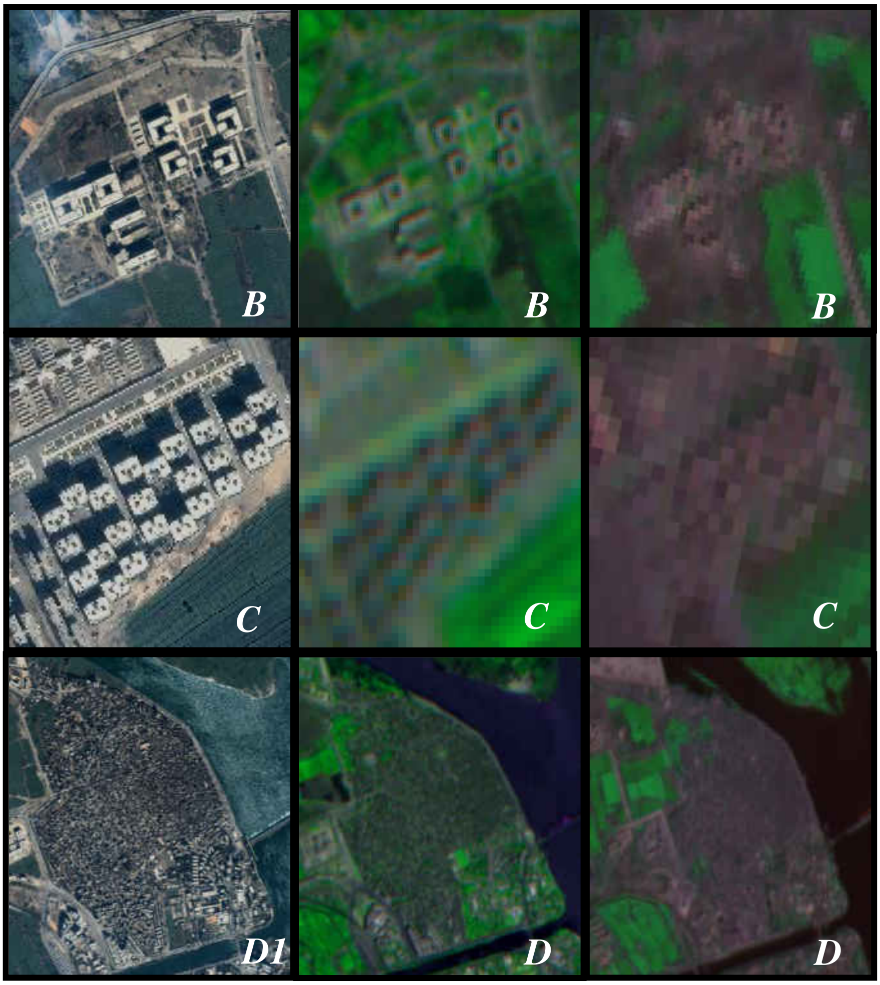

Figure 2: Images of residential areas of different densities. ***B:*** boundaries of individual buildings in low density residential area. ***C:*** boundaries of individual buildings in medium density residential area. ***D:*** boundaries of high residential area. *B1, C1, D1* (IKONOS image), *B2, C2, D2* (Egypt Sat-1 image) and *B3, C3, D3* (SPOT 4 image).

There are some urban features presented in the 1:25000 map and can be identified in the image such as track and playground in Assiut university. They can be identified and clearly delineated with IKONOS and Egypt Sat-1 image. Whereas, in SPOT 4 image, They are detectable but are not clearly identified (Figure 3 - *E*). Another example of urban features are diesel cisterns in Wallidia power station. It has best clarity of delineation in IKONOS image, good clarity in Egypt Sat-1 image and fair delineation in SPOT 4 image (Figure 3 - *G*). On other hand, the difference in contrast between agriculture and manmade features make it easy to extract features surrounded by agriculture. Also it leads to more easy definition of the borders of the built up areas of the village in satellite images.

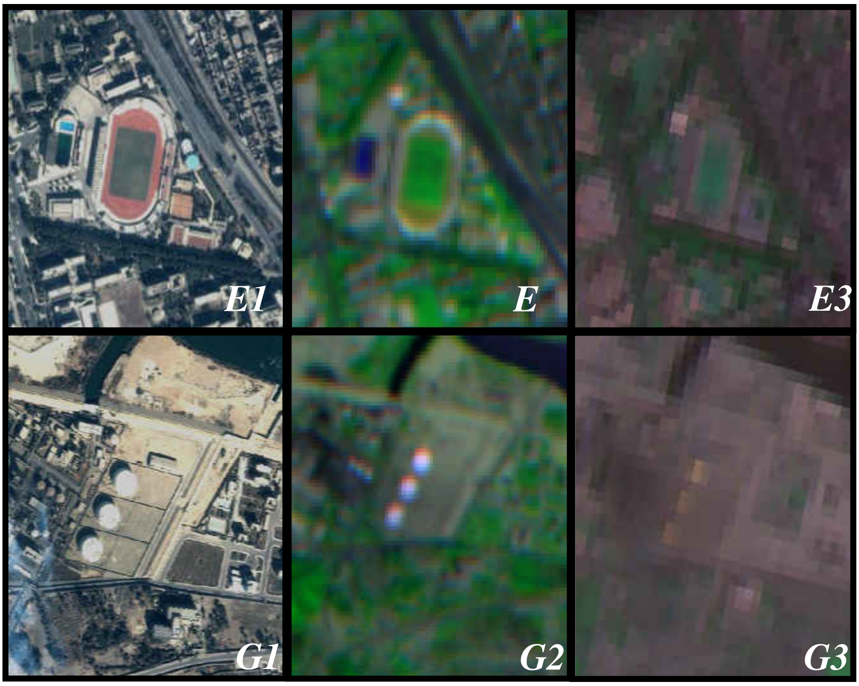

Figure 3: Images of various urban features for visual comparison. ***E:*** the playgrounds in Assiut university. ***G:*** diesel cisterns in Wallidia power station. *E1,G1* (IKONOS image), *E2, G2* (Egypt Sat-1 image) and *E3,G3* (SPOT 4 image).

Features such as the overhead power transmission lines cannot be seen in all images. In IKONOS image, high voltage power lines towers are identified by shadows caused by the shallow sun angle as shown in figure 4. Subsequently, by tracing of these towers, power lines can be mapped.

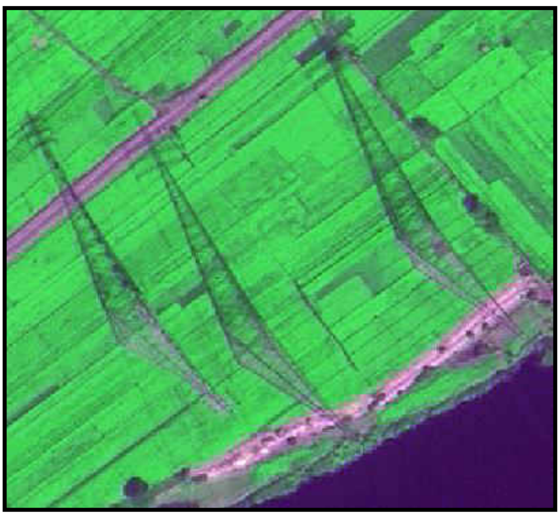

Figure 4: High voltage electricity towers in IKONOS image.

C. Transportation network:

Transport network present in study area are roads, bridges railways, etc. The road network of the city is categorized into major roads and secondary roads. There are some distinct characteristics that can be applied in the identification of roads. Minor roads are often built along the length of feature such as canals and drainages, which are also visible on image. This allow to measure the function and importance of the road, if required to classify it without additional source material. Background contrast of roads in rural areas is often not as strong as in urban areas. Major roads can be clearly visible in all images. Secondary roads can be identified and delineated in IKONOS image and Egypt Sat-1 image, but their edges are hazy in SPOT 4 image. Figure 5 - *F* shows curvature and junction of roads clear and prominent in IKONOS image and Egypt Sat-1 image, whereas they are not clear and it can be delineated only with assistance of ground knowledge in SPOT 4 image. Unpaved roads are detectable, but are not clearly identified, in Egypt Sat-1 image and SPOT 4 image, where they can be detected and identified in IKONOS image. Abd Elwahed, et al. 2011a evaluated the potential of IKONOS image for large scale mapping purpose. Results of feature extraction using on-screen digitizing method showed that the accuracy of extracting district and village roads is approximately 100%.

The general alignment of the railway can confidently be depicted. This was helped by the educated knowledge of how railways would usually appear in an image (i.e. constant alignment with no sudden curves). However, the actual rails could not be seen and railway furniture (e.g. signals, points) was certainly not visible.

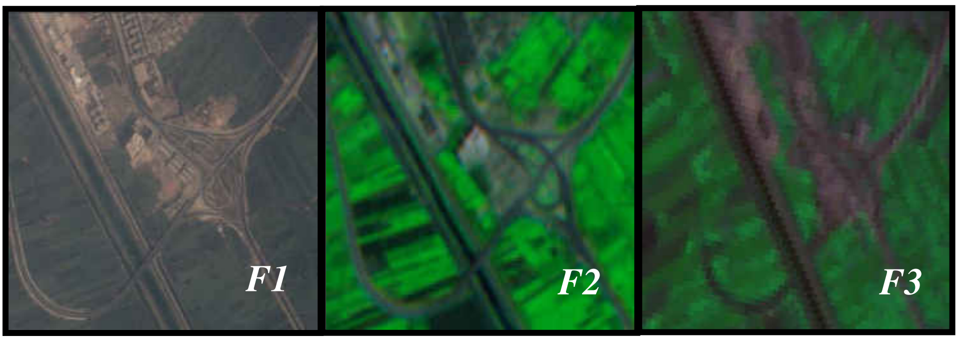

Figure 5: Images of roads junction and curvatures. *F1* (IKONOS image), *F2* (Egypt Sat-1 image) and *F3* (SPOT 4 image).

D. Vegetation land cover:

Most of the study area is dominated by vegetation surrounding the city and villages. Boundaries of vegetation area are often connected to features such as canals and drainages which allow to delineate them. It appear from figure 6 - ***H*** that Egypt Sat-1 image gives clear boundaries compared with SPOT 4. General vegetation is easy to depict in IKONOS image although the actual nature of the vegetation is not easy to be identified. Also boundaries of vegetation area are very easy to capture in IKONOS image.

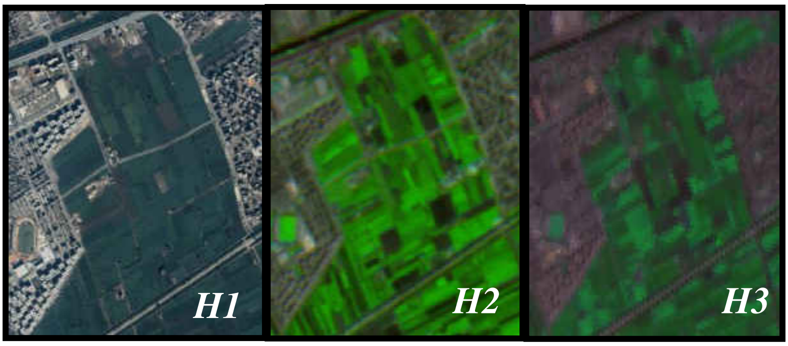

Figure 6: Boundaries of agricultural fields. *H1* (IKONOS image), *H2* (Egypt Sat-1 image) and *H3* (SPOT 4 image).

7. EVALUATION OF EGYPT SAT-1 FOR UPDATING 1:25,000 MAPS

The factors influencing mapping from satellite images are the geometric accuracy and the information content. As mentioned in section 4.1., the planimetric geometric accuracy of the extracted features from Egypt Sat-1 is 5.59 m. This meet the required accuracy for 1:25,000 map which is 0.3 mm at map scale according to the National Map Accuracy Standards (NMAS). So an investigation of information content in Egypt Sat-1 image is carried out to evaluate its suitability for updating topographic maps at this scale by visual inspection. The required information content for 1:25,000 scale map may be divided into four main categories (as shown in table 3); hydrological features, cultural features, transportation network and vegetation land cover. As shown in table 3 objects are classified based on their level of detection and identification under four categories as follows:

• Good: if the object is detected or identified easily and with high level of certainty.
• Medium: if the object is detected or identified but with a lower level of certainty,
• Poor: if the object is almost detected or identified,
• Not Available (NA): if the object is not appeared in the image.

Table 3 shows that there is no difficulty to detect or identify linear features such as roads, bridges, watercourses network, etc from Egypt Sat-1 images. Also, there is no difficulty to detect or identify boundaries of area features such as isolated buildings, high residential area, vegetation area, etc. Table 3 also demonstrates that not all features that presented in the 1:25,000 Egyptian map can be captured from Egypt Sat-1 image such as the overhead power transmission lines and railways in desert area. Also there is some features are detectable but cannot be clearly identified such as unpaved road.

Table 3. The results of features detection and identification on IKONOS, Egypt Sat-1 and SPOT 4 images:

Feature name	Feature is detected												Feature is identified											
	IKONOS				Egypt Sat-1				SPOT 4				IKONOS				Egypt Sat-1				SPOT 4			
	N A	Poor	Medium	Good	N A	Poor	Medium	Good	N A	Poor	Medium	Good	N A	Poor	Medium	Good	N A	Poor	Medium	Good	N A	Poor	Medium	Good
Hydrological features																								
River				X				X				X				X				X				X
Main canal				X				X				X				X				X				X
Branch canal				X				X		X						X				X		X		
Cultural features																								
Individual buildings in low density residential areas				X				X			X					X				X		X		
Individual buildings in medium density residential areas				X		X				X						X		X			X			
Boundaries of high density residential areas				X				X				X				X				X				X
Swimming pool				X				X	X							X				X	X			
Stadium				X				X			X					X				X			X	
Cisterns				X			X			X						X		X				X		
Overhead power transmission lines	X				X				X				X				X				X			
High voltage power lines towers			X		X				X						X		X				X			
Transportation network																								
Major roads				X				X				X				X				X				X
Secondary roads				X				X			X					X			X			X		
Unpaved road				X			X			X						X		X				X		
Bridges				X				X			X					X				X			X	
Railways			X				X			X					X			X				X		
Railways in desert area		X			X				X				X				X				X			
Vegetation land cover																								
Boundaries of vegetation areas				X				X				X				X				X				X

7.1. Information Content in Egypt Sat-1:

In this work measurement of information content was made through subjective visual interpretation supported by background knowledge for the extraction of urban features. Screen digitizing was made through ERDAS imagine 8.4 for linear and polygonal features. After that, fieldwork was carried out to obtain important information about the verification of some features such as roads and railways. The updated features were compared with the features in the original map and the result of comparison are summarized quantitatively in table 4.

Table 4: Length and area of features compared with original map.

Type of Feature	Old Features on Topographic Map	New Features	% of Updated Features
Urban Areas	8,463,571 m²	5,277,485 m²	62 %
Paved Roads	201,325 m	46,543 m	23 %
Watercourses	414,508 m	4536 m	1.1 %
Railways	22,650 m	22,650 m	0 %

Table 4 shows that there is a large quantity of information that can be added to the original map. There is about 18 years difference between the map and the image. Since the image is acquired on August 2009 and the map is produced in 1991. Rapid population increase in this time has led to expansion of cities and villages. Most of this expansion is in residential area on the expense of vegetation area surrounding the cities and villages (Abd Elwahed, et al. 2011b). Also the comparison between length of roads, given in table 4, shows a significant difference in the extent of roads. The increase in length of roads is due to the presence of new roads and the change from some unpaved secondary roads to paved roads in the last 18 years. Extraction of road network outside the urban area is easy compared to that inside the urban area where the contrast between roads and background was relatively low. Major roads and bridges through canals can be delineated precisely.

About watercourses, relatively small changes are noted because the study area is an old vegetation area. Watercourses can be presented as polygon feature, such as banks of River Nile, Ibrahimia Canal and also in small canal such as El Malah Canal. Finally, table 4 shows that there is no change in length of railways. In vegetation area railways can be clearly detected. It was possible to confirm some portions of railways in urban area while, it was difficult to identify this category in desert and it has been delineated with ground knowledge.

8. RESULTS AND DISCUSSION

- From visual comparison, the superiority of Egypt Sat-1 image over SPOT 4 image is quite appeared. Linear features in case of Egypt Sat-1 image demonstrates better clarity compared with that of SPOT 4 image. In case of major roads the difference is comparatively less between both images. Whereas, in case of secondary roads the difference in the extent of mapping from both images is much more significant. Contrast of road intersections with the surroundings are more precise on Egypt Sat-1.

In places where watercourses tend to be more polygon features, there is less difference between both images. When watercourse become small feature there is a considerable difference in the extent of watercourse mapped from both images. In delineation of boundaries of high density residential areas, there is no significant difference between both images. But in delineation of the boundaries of individual buildings, Egypt Sat-1 image provide more accuracy. Boundaries of agricultural fields are found to be more precise when mapped with Egypt Sat-1 image.

- Using high resolution satellite images such as IKONOS images shows that much more information can be extracted. Features such as unpaved road which are not clearly identified in Egypt Sat-1 image can be clearly detected and identified with IKONOS image. Also features such as the overhead power transmission lines is impossible to be detected from Egypt Sat-1 images. Where the detected towers from IKONOS image can be used as guide for the power lines. Railways lines in desert area in IKONOS image can be detected and cannot be identified. Using IKONOS image indicates that higher resolution images may not completely solve all problems associated with the identification of problematic features but it can reduce the required field work. However, one of the limiting factors in the high resolution satellite images is the high price which can influence on the total coast of map updating. For example, the total cost of Egypt Sat-1 image covering 46346 km (about 2216 km^2) is about $US 800. Whereas, the same area will cost about $US 39888 if covered by IKONOS images (about 50 times the cost of Egypt Sat-1 image).
- The evaluation of information content of Egypt Sat-1 images for updating maps at 1:25,000 scale showed that; linear features (roads, watercourses network railways,…etc) are extracted accurately, except in some places where the contrast between the features and background is relatively low. There is no difficulty to detect and identify boundaries of area features (high residential area, villages, isolated buildings, boundaries of vegetation area,…etc). However, there are features that can be detected but they are difficult to identify such as unpaved roads. Also, there are some features that are impossible to be detected and identified on the image such as overhead power transmission lines and the railway extension in desert area.

9. CONCLUSIONS

Comparative assessment of information content between Egypt Sat-1 image and SPOT 4 image shows the superiority of Egypt Sat-1 image. The geometric accuracy of Egypt Sat-1 meet the requirement of 1:25,000 map according to the National Map Accuracy Standards (NMAS). It also provides a large amount of information that can be used for updating the main features of 1:25,000 Egyptian maps. However, there are difficulties in extracting some features from Egypt Sat-1 such as overhead power transmission lines and the railway extension in desert area. The comparison of information content of Egypt Sat-1 image with IKONOS image shows that; although high resolution images improve the identification and delineation of most of problematic features in Egypt Sat-1; still there are some features that remain impossible to be detected or identified from IKONOS. Some of the features that have problems in their detection and identification from Egypt Sat-1can be due to its limited resolution. On the other hand, high resolution images are more expensive and this can influence the total cost of map revision process.

Even thought there is some difficulty in the information content of Egypt Sat-1 image to fully update maps at these scales the acquired information content are good enough to be used for updating of the main features of 1:25,000 Egyptian maps. The remaining features may be inferred from other mapping methods such as ground survey.

10. REFERENCES

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إمكانيات صور الأقمار الصناعية في تحديث الخرائط

مع التركيز علي صور EGYPT SAT-1

استخدام مرئيات الأقمار الصناعية في تحديث الخرائط يعتمد بشكل أساسي على دقة التصحيح الهندسي للمرئية وكذلك على محتوى معلوماتها. في الأحوال العادية يمكن الوصول ألي دقة التصحيح الهندسي المطلوبة بينما يصبح العائق الأساسي هو محتوى المعلومات المطلوب. يعتمد محتوى المعلومات على عدة عوامل مثل قوة تمييز التصوير، المدى الطيفي، شكل ونوع الهدف ومدي التباين بين الأهداف وكذلك على التطبيق الذي تستخدم من أجله المرئية. الغرض من هذا البحث هو تقييم إمكانيات مرئيات Egypt Sat-1 في تحديث الخرائط مقارنة بالأقمار الصناعية الأخرى. تم عمل الدراسة باستخدام مرئيات ملتقطة بواسطة Egypt Sat-1, SPOT 4, IKONOS توضح مدينة أسيوط وما حولها، و كذلك خريطة طبوغرافية للمنطقة مقياس 1 :25000. تم دراسة محتوى المعلومات الموجودة في Egypt Sat-1 و مقارنتها بمحتوى معلومات مرئيات ملتقطة بواسطة القمر SPOT 4, IKONOS. حيث تعتبر هذه المرئيات الأكثر انتشاراً و التي تم دراستها في كثير من الأبحاث في هذا المجال. تمت المقارنة بين المرئيات بصريا لعدد من المعالم الحضارية مثل الطرق والمجاري المائية، والسكك الحديدية وحدود المناطق الحضرية. كما تم دراسة ملائمة محتوى المعلومات التي يمكن استخلاصها من مرئيات Egypt Sat-1 لتحديث الخرائط مقياس 1 :25000.

أوضحت نتائج مقارنة محتوى معلومات Egypt Sat-1 و SPOT 4 أفضلية محتوى معلومات Egypt Sat-1. كما أظهرت نتائج البحث أنه من حيث الدقة الهندسية في المستوى الأفقي يمكن تصحيح مرئيات Egypt Sat-1 بما يتناسب مع المواصفات القياسية لإنتاج وتحديث الخرائط ذات مقياس 1: 25000. في حين أنه على الرغم من القدرة العالية في التعرف على كثير من الأهداف في مرئيات Egypt Sat-1 إلا أن هناك بعض الأهداف الموجودة بخرائط 1 : 25000 لا يمكن التعرف عليها أو تحديدها في المرئية مثل امتداد السكك الحديدية في الصحراء أو خطوط كهرباء الضغط العالي. وبالرجوع إلي المرئية العالية الدقة من IKONOS نجد أن معظم المعالم التي لم يتم التعرف عليها أو تحديدها في مرئية Egypt Sat-1 أمكن تحديدها والتعرف عليها ولكن لا تزال بعض المعالم يصعب اكتشافها أو تحديدها. وقد خلص البحث ألي أن كمية البيانات التي يمكن استخلاصها من مرئيات Egypt Sat-1 جيدة بما فيه الكفاية بحيث يمكن استخدامها في تحديث المعالم الرئيسية للخرائط مقيـاس 1 :25000. ويمكن تحديث كافة التفاصيل المتبقية بالربط والتكامل مع قواعد البيانات الأرضية الأخرى من خلال نظم المعلومات الجغرافية أو عمل زيارات ميدانية.