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Urban Growth Mapping Using Remote Sensing and GIS Techniques, case study: Darbandikhan, Kurdistan Region, Iraq

ABSTRACT

Abstract: Change in land use and land cover, as one of the most important factors of global-scaled environmental transformations, is considered as heart of the sustainable development debate. It is approved that humans are the main driving force that altering the land cover of the globe. In order to attain substantial development, urban authorities should think of useful tools to monitor how the land is now used to apprise future plan. The apprehension of urban change is crucial for making optimal decision and suitable planning. Satellite remote sensing is known potentially as a powerful way of assessing and mapping land-use/cover change at different spatial and temporal resolution. It also offers lower costs and time than those done using the traditional models. Remote sensing data and techniques are extremely useful because of its flexibility to provide views, repetitive coverage over a single area and real time and near real time data acquisition. land uses change and urban growth in remote sensing compose the analysis of two aerial or satellite image bands of a particular area which is recorded at two different dates. This study aims to a produce urban growth map for the small city of Darbandikhan, in the west of Kurdistan Region-Iraq, using RS-GIS data and techniques integrated with field data from 2003 to 2012. Results revealed that the has town sprawled by 2.7 times, from almost 1.9 km^2in 2003 to 5.3 km^2 in 2012, mainly to the North and West of the city. During this period population has doubled mainly because of migration from rural to urban area. Developed map shows that the distribution of facilities, except schools, trended to maintain around city center and not well distributed all over the town. It is also resulted that approximately 90% of streets were less than 15m.

INTRODUCTION

Environmental conversion is a critical issue the world has been always facing and undoubtedly the expansion of population and development of urbanization has a great effect on the natural behavior of the Erath cycles (Foley et al, 2005). In addition, it inevitably and strongly affects people movement; they actually have a two-way relationship (Miller et al, 2005), Change in land use and land cover, as one of the most important factors of global-scaled environmental transformations, is considered as heart of the sustainable development debate (Hegazy and Kaloop, 2015). The land use change in urban area involves several factors. There are many influencing factors, including both natural and human factors which change this process. It is approved that humans are the main driving force that changing the land cover of the globe. Landscape conversion mostly occur regionally. These

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changes are proved to have substantially changed about 80% of the Earth's land area over the recent centuries (Vitosek et al, 1997). Urban incensement is usually accompanied with the fundamental changes in social and economic factors. In order to attain substantial development, urban authorities should think of useful methods to spot how the land is now used apprise future plan. Th throughout comprehension of urban land change is crucial for decision making and planning (Sivakumar, 2014). Urban growth, especially the movement of residential and commercial areas to the margin of big cities, has always been regarded an index to assess the economic condition of urban area regionally. The accelerated change of land cover/use, especially in developing countries, are accompanied with land degradation, uncontrolled urban sprawling which cause many unenviable environment catastrophes (Sankhala and Singh, 2014). In addition, the land cover change will change biotic diversity, potential and actual efficiency, soil quality, run-off and sedimentation change (Steffen et al, 1992). Furthermore, it is involved hardly by land use change. Consequently, land cover changes play a remarkable role on local and regional environmental circumstance of that specific region and they are also associated to environmental change in global scale (Ramadan et al, 2004). Human originated changes in urban and non-urban area for example, change the atmosphere carbon cycle, and increase CO in Earth atmosphere (Alves and Skole, 1996). Therefore, it seems unavoidable to monitor and assess the changes in land cover, to minimize the effects on ecosystem and to reach a sustainable land use and land cover planning (Muttitanon and Tripathi, 2005).

RS-GIS abilities in urban growth monitoring

Potentially, satellite remote sensing techniques are known as a powerful way of assessing and mapping land-use/cover change at different spatial and temporal resolution. It also offers lower costs and time than those done using the traditional models (El-Raey et al, 1995). Remote sensing data and techniques are extremely useful because of its flexibility to provide views, repetitive coverage over a single area and real time and near real time data acquisition. Saved and provided as the digital, satellite imageries, therefore, would let engineers to compute various land cover/land use types, accurately. It also helps in handling the spatial data which is very fundamental for mapping urban growth and land use conversion (Mukherjee, 1987). Geographic Information System (GIS), as a reliable and powerful decision support system, can be used urban planning project. The use of GIS modeling has today become dominant in researches focusing on urban expansion, as well as, environmental studies. Many researches on urban sprawl uses GIS as an essential tool to characterize the effects of urban sprawl on the natural environment and interplay of urban growth and residential life style. GIS enable us to recognize and map patterns of urban changes spatially by determining distances of current urban growth areas from previously build town infrastructures (Gar-O, Xia, 2001). Since urban development regarded as an irreversible phenomenon, GIS regarded as a priceless tool that widely used to simulates future land development (Lee et al, 1998). The monitoring of Urban growth is known as the process of studying the variations in the state of a phenomenon among an urban area, by observing it at different dates using remotely sensed data. In other words, land uses change and urban growth in remote sensing compose the analysis of two recorded aerial or satellite imkages of a particular area which ar registered at two different dates. Such a process is going to assess the changes that is took places in a particular area between the two times (Radke et al, 2005, Pilon et al, 1988).
In Iraq's neighborhood, countries like Egypt, remote sensing have been used as this technology was developed (El-Baz et al, 1979). In these regions the monitoring of urban growth is a field which considered as the most important major application of RS/GIS. Nevertheless, in some areas like Iraq this modern technology has been rarely used in urban and environmental studies. The basic assumption in using RS data for urban growth assessment is that the process can derive change from two or more dates that is unsimilar. Several researchers have addressed the problem of precisely mapping land cover/change in a wide variety of environments (Shalaby and Tateishi, 2007). Through Maximum- Likehood classification of TM images, in 2004, Elnazir tried to produce a land-use map of Shaoxing and find out how it has been changing in a period of time (Ramadan et al, 2004).

Over the last years, urbanization is a dominant inclination of big urban areas. The major conversion of land use in the big cities can be categorized as changing non-urban areas in to urban land. The classic mapping methods are too time consuming and expensive for the assessment of urban growth. Additionally, those data is not accessible for most of cities especially in developing countries like Iraq. Therefore, today most of research are inclined to use GIS and remote sensing techniques for monitoring of urban growth using.

The aim of this study is to a produce urban growth map for the small city of Darbandikhan, in the west of Kurdistan Region-Iraq, that faced a noticeable rising of rural to urban migration in the recent decades. It supposed to map changes that have happen especially in the urban area and subsequently to map the urban sprawl of Darbandikhan from 2003–2012.

Study area

This research is focusing on Mapping of urban Growth of Darbandikhan city as the study area. Darbandikhan is located in Sulaimani province, at the Southwest of Kurdistan Region which is governed Kurdistan Region Government (KRG). To be more precise, its located between (45°39'6.12"E, 35° 7'24.74"N) as the Northeast of the study area, and (45°41'32.88"E, 35° 6'4.62"N) as the Southwest, respectively (Figure 1). Darbandikhan is resided by almost 42500 residents in 2012. Since the city is considered as a strategical location. The containers carrying raw oil KRG to Iran should pass Darbandikhan to get Parwizkhan border. Furthermore, most of passengers pass this way to go to Baghdad, the capital of Iraq, from Sulaimani and Halabja province. Nevertheless, the passes this city never meet the standards of main and transit ways, which have been always resulted in irrecoverable catastrophes. This city is neighbored with Sirwan River which play a noticeable role in local people socioeconomic condition. The river, at the first place, and the Darbandikhan dam which has been built on Sirwan river, as well as, surrounding mountains, Khoshk, Zmnako, Baranan, Gollan, and Zarda (Figure 2, left), altogether has made this city as an attractive city to call a large number of people to visit it (Figure 2, right). These characteristics, beside attracting ecotourists, has resulted in migration of rural resident to this city during recent decades.

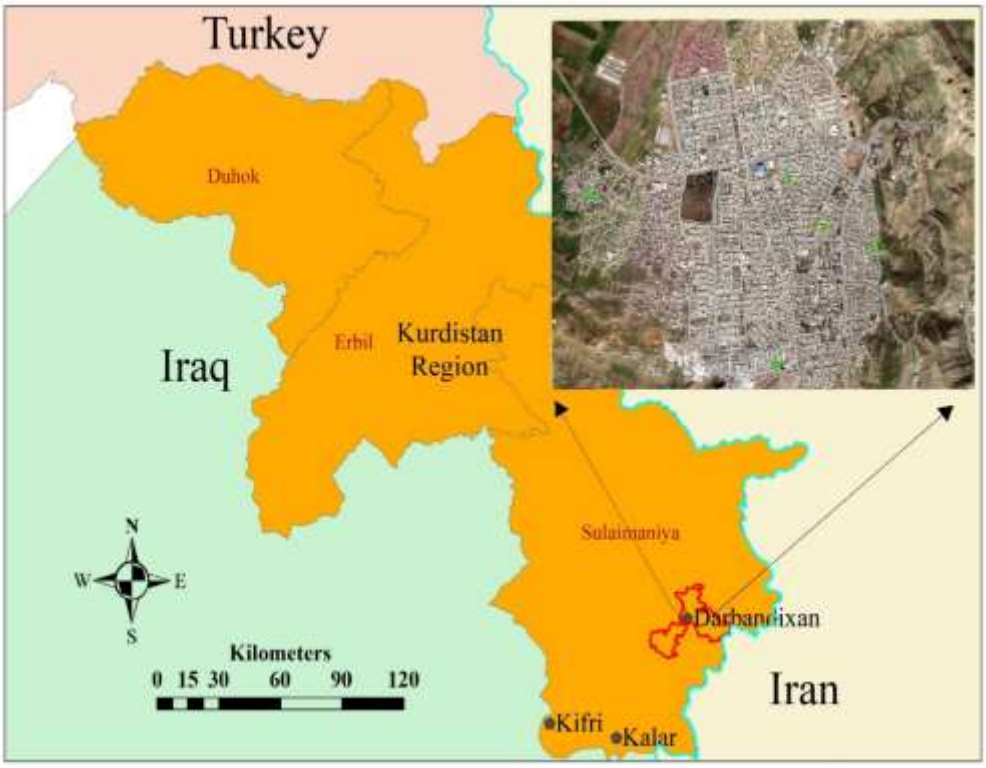

Figure (1): Study area location, at the Southwest of KRG, East of Iraq

Population change in the study area:

During recent decades, a great number of Kurdish people has migrated to urban areas form rural areas.

Figure (2): left: Darnandikhan city surrounded by mountains, **Right**: The Dam of Darbandikhan attracts ecotourist.

Regarding the great social and environmental impact of migration, many researchers have been done in this field, recently. Migration phenomenon depends on several factors, including social characteristics, as well as, political and economic condition (Black et al, 2011). Environmental change regarded as a critical factor affecting migration phenomenon (Boano, 2008). Studies show that the migration combined phenomenon (Black et al, 2011), and environmental change is not regarded as the major factor causing migration (Carr, 2005). However, environmental conversion is important in studying migration phenomena and should be included (Carr, 2005). In 1995 more than 25 million people migrated as a result of environmental changes. This number is estimated to rise by 200 million in (Myers and Kent, 1995).

For Iraqis, totally speaking, and for Kurdish people in this country, particularly, migration, both internal and international, have always been considered as a challenge (Sirkeci, 2005). Kurds residing in the north of Iraq, have face the migration issue several times in the last four decades (Black, 1993). Rural-urban displacement, especially, has become a crucial challenge the Kurdistan resident are involving. Many factors have affected this movement including the war between Iran and Iraq which lasted about eight years, the concentration of facilities in urban areas, and the conversion of life style.

MATERIALS AND METHODS

MATERIALS

Two sets of data have been used in this research. The first set involves the field data including the location of urban items (schools, sanitary centers, mosques, Administrative sites, public and academic institutions etc.), as well as, some basic statistics like population and its change during the studied period.

The second dataset was satellite derived images. The images have been provided by Google and Being companies. They have been downloaded, as georeferenced layers, using Universal Image Downloader which is owned developed by allmapsoft website (http://www.allmapsoft.com/). This software let the users to download panchromatic satellite images provided by official websites. Two images were used. First taken in 2003 which the Iraqi previous regime, Baas, collapsed and new economic condition started. Started from 2003, a new prospering era resulted in developing lots of project especially in the field of infrastructures and building residential area. Unexampled population

growth accompanied with unsupervised developmental activities has led to substandard and nonstandard urbanization, with insufficient infrastructure facilities.

METHODS

The study was started with digitizing satellite image. Its tried to determine the place of schools, administrative sites, mosques, public institution, industrial district, academic institutions, city center, and sanitary center on the satellite image taken in 2012. This process accompanied with field observation to verify the items on the map. Each one, then convert into a shapefile in ArcGIS 10.6.2. Table (1) shows the layers as well as, their symbols as made in ArcGIS. Based on the width of the streets, recorded by field observations and verified by the municipality too, they were classified into 4 classes (Table 1). Using spatial analyzes tools ArcGIS the percent of each classes was determined.

Table (1): Urban items and their symbols on the map

Description	Symbole
2003 boundary	
2012 boundary	
Academic centers	
terminal	
school	
mosques	
Sanitary centers	
Administrative areas	
Public institutions	
City center	
Industrial district	
Road =30 m	
Road =20 m	
Road =15 m	
Road <15 m	

Furthermore, in order to find out the area of the urban area in 2003 and 2012, and its growth during this period, the boundary of the Darbandikhan town for each year was extracted from the satellite image and converted to a layer. Then using geometry Query tools, the areas were calculated in ArcGIS (Figure 3). Table 2 shows the area of Darbandikhan town in 2003 and 2012.

Table (2): The area of the Darbandikhan town

Year	Area (m^2)	Rate of growth
2003	1,942,020	
2012	5,353,470	275% (2.7 times)

Parallel to spatial analyses of the satellite image, the residential statistic also collected. The population of Darbandikhan town, as well as, their rate of growth and sprawl, As reported by periodical report of Sulaimani Statistical Office [26], has almost been doubled during the studied period, from 2003 to 2012 (Table3).

Growth of Darbandikhan area and population

As seen in Figure (3), Darbandikhan town has grown, from 2003 to 2012, mostly to the North and the West. The rate of growth reveals a noticeable change in this period. In 2012 the covered area of the town is 2.7 times greater than 2003. After the invasion of Iraq in 2003, the situation economy of Kurdistan boomed due to security in the region. The KRG Sulaimani administrative offered

mortgage to the inhabitants and a free parcel of land to build a house. The amount of mortgage was sufficient to finish between (30%) to (50%) of the house budget. As a result, the urban expansion doubled from 2003 to 2012. Although the population has also increased but it only doubled (Table 3) therefore, the rate of population and area are not consistent. This non-consistency might be originated from the unplanned urban policies. Additionally, the dominant architecture style, willing to build big hoses, may considered as another reason. Totally, based on the official reports, immigration from rural area to urban area regarded as the main factor to justify the growth population (Table 4).

Table (3): Population of Darbandikhan

Year	Urban Population	Rate of Growth
1977	10360	
1987	15678	51%
2002	21373	36%
2013	42625	100%

Table (4): the percent of town population in Darbandikhan district

Year	Urban Pop.	District Pop.	Urban pop/district pop
1977	10360	21835	47%
1987	15678	46462	33%
2002	21373	30261	70%
2013	42625	47041	91%

RESULTS AND DISCUSSION

Urban structures and infrastructure distribution

The result of digitizing the satellite image is converted to a map (Figure 4). The map reveals the location of all item mentioned in Table (1). Based on the map, except the schools, distribution of almost none of urban structure has followed the growth of the town. As observed, most of facilities, public institutions, sanitary centers have maintained around then city center which have would resulted in concentration of car traffic inside this area.

From 2003 to 2012, almost all administrative offices have not moved away, but the Court and the Polytechnic Institute of Darbandikhan. In addition, they are in the city center which can be regarded as source of heavy traffic.

The results of classifying streets show that the majority of the town streets are less than 15 m, in width. Table (5) shows the result of the analyze.

Table (5): types and percent of streets of Darbandikhan

Road classes	percent	description
30 m	5%	Major roads, a network of 6 streets
20 m	3%	Minor roads, Distributed between major roads
15 m	2%	Minor roads, involves 4 roads between majors
< 15 m	90%	Compose the majority of city transport network

Recommendation

Regarding infrastructure condition of Darbandikhan town, some recommendation seem to be quite helpful. They are mention as following:

- Based on the map (Figure 4), we can find that the land policy is segregated and the neighborhoods has no center. The concept of mix use is marginalized.

- The access and collector roads do not function as they are. The 30m streets are semi-circle and they should have redesigned and getting wider when the diameter from the city center increases
- It is possible to intensify all governmental service building in the city center with providing coherent car parking policy and reliable public transport.
- Some governmental service buildings have been relocated to some other neighborhoods which lead the inhabitants to be car dependent.
- The schools are within a walk able distance and comply with the Iraqi Standard which is 300m
- The other service building and playfield, play sport, cultural center does not fulfill the needs of the inhabitants according to the Iraqi standard which is 800 m.

We are now in 2018, in the next studies we offered to map urban changes from 2012 to 2019 and find out how acceptable have been the changes. For scrutinize even deeper into modelling all urban details in the study area, as we as, getting further information about how urban growth and residents' interplay, it is proposed to do a cooperative study to model socioeconomic aspect of migration.

In addition, it will be quite helpful to use time series satellite images, as well as, high resolution images to do change detection. It can also be a good idea to use multispectral satellite images to modelling land cover changes during these periods.

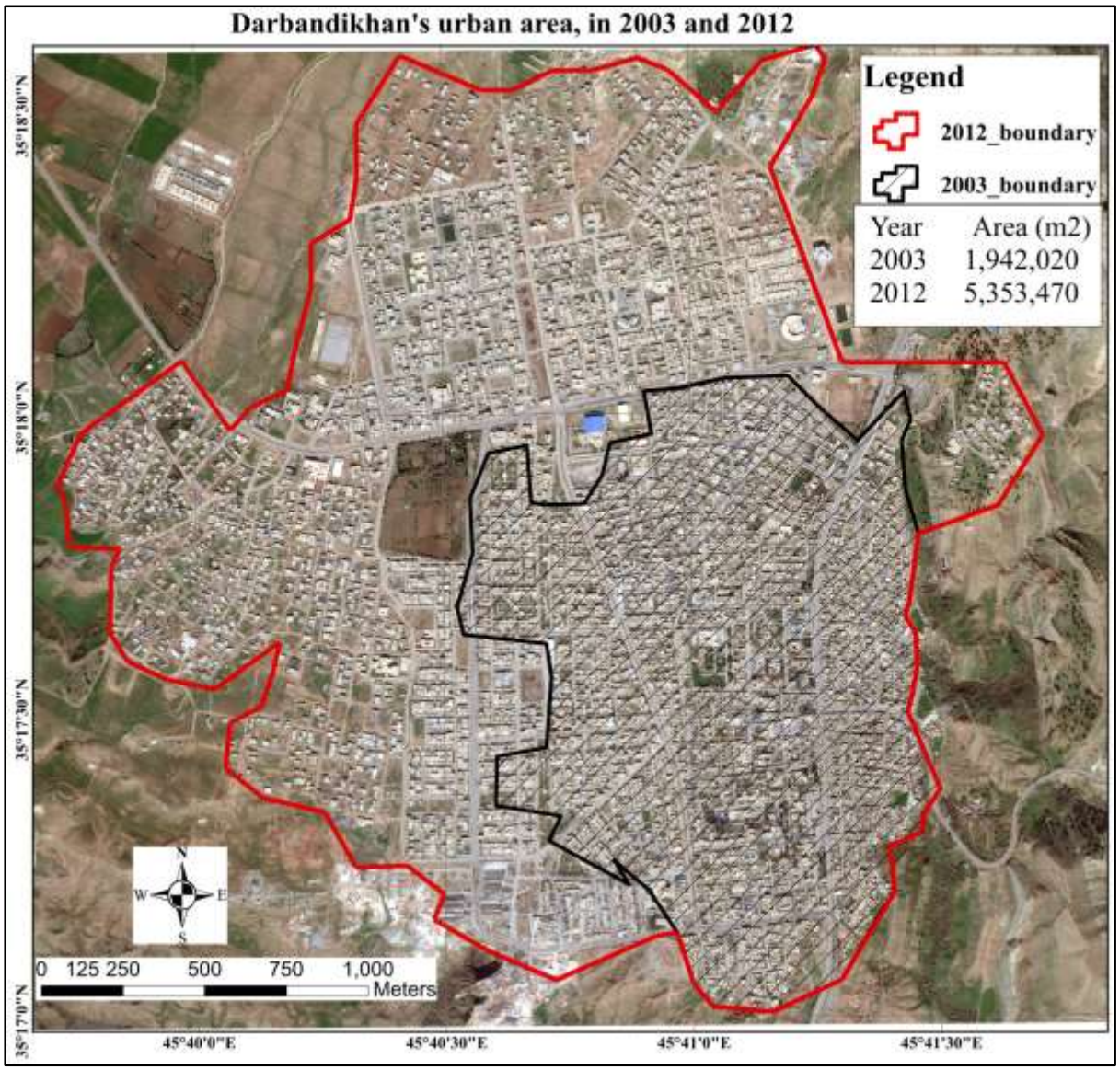

Figure (3): Darbandikhan town boundary in 2003 and 2012. The black arrows show the direction of urban sprawl to the North and the West.

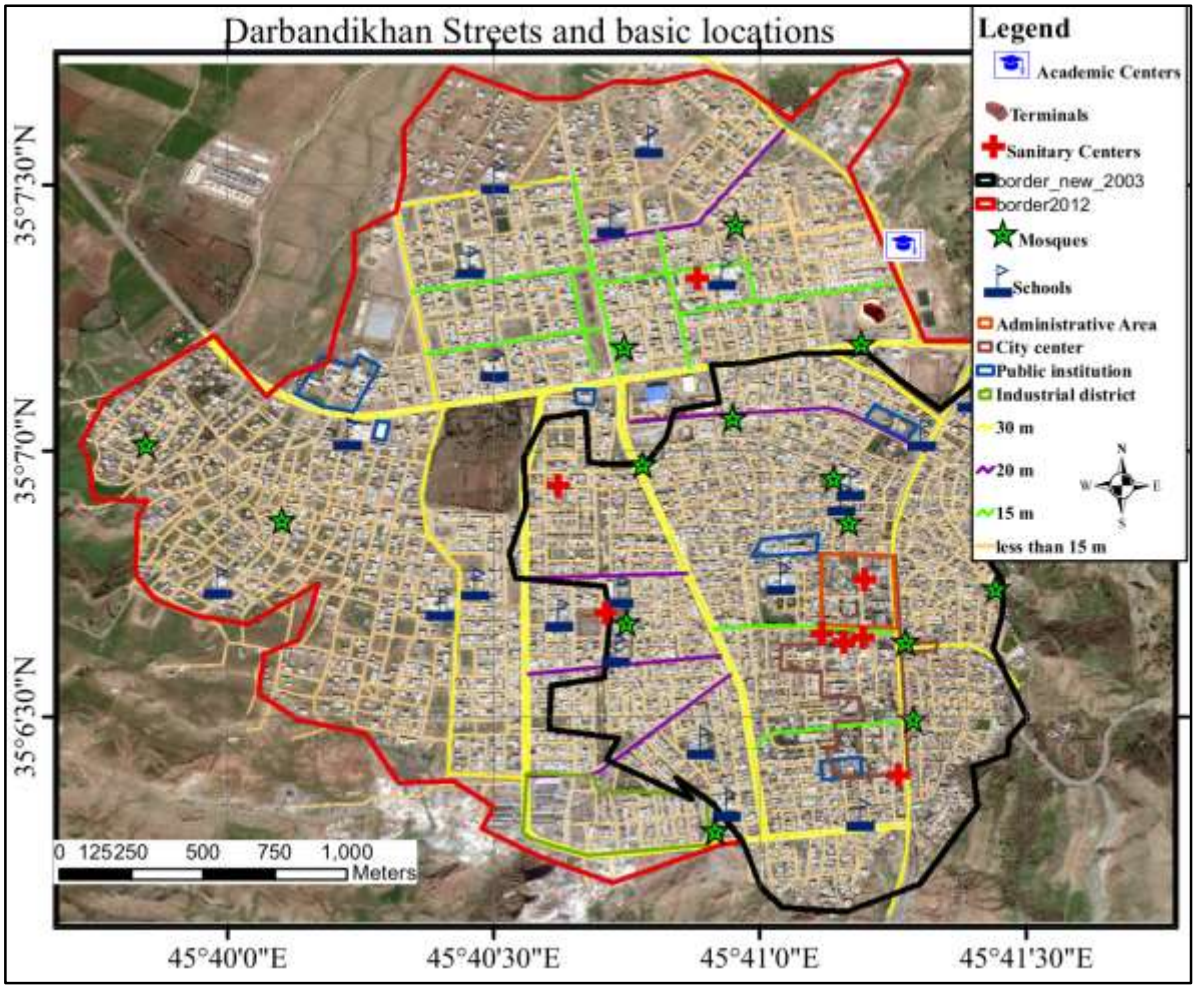

Figure (4): Urban growth sprawl map. Most of urban facilities sustained in the previous border of the town (2003's border).

REFERENCES

Alves, D., Skole D (1996). Characterizing land cover dynamics using multi-temporal imagery. International Journal of Remote Sensing, V.17 (4). pp.835–839.

Black, G. (1993). Genocide in Iraq: the Anfal campaign against the Kurds," Human Rights Watch.

Black, R., Kniveton, D., & Schmidt-Verkerk, K (2011). Migration and climate change. Environment and Planning, V.43(2). pp. 431–450.

Boano, C (2008). FMO research guide on climate change and displacement, Forced Migration Online. PP.18–21.

Carr, E. R (2005). Placing the environment in migration: Environment, economy, and power in Ghana's Central Region," Environment and Planning A. V.37(5). pp.925–946.

El-Raey, M., Nasr, S., El-Hattab, M., Frihy, O (1995). Change detection of Rosetta Promontory over the last forty years. International Journal of Remote Sensing, V.16, pp. 825–834.

El-Baz, F., Breed, C., Grolier, J., McUauley, J (1979). Eolian features in the western desert of Egypt and some applications to Mars. Journal of Geophysical Research Atmosphere. Res. V.84. pp.8205–822.

Foley, J. A., DeFries, R., Asner, G. P., Barford, C., Bonan, G., Carpenter, S. R (2005). Global consequences of land use. Science, V.309(5734), pp.570–574.

Gar-On Yeh, A., Xia, L. (2001). Measurement and monitoring of urban sprawl in a rapidly growing region using entropy," Photogrammetry Engineering and Remote Sen. V.67 (1), pp. 83–90.

Hegazy, I.R.; Kaloop, M.R. (2015). Monitoring urban growth and land use change detection with GIS and remote sensing techniques in Daqahlia governorate. Egypt International Journal of Sustainable Built Environment, V.4, pp.117–124.

Lee, J., Tian, L., Erickson, L., Kulikowski, D. (1998). Analyzing growth management policies with geographical information systems," Environmental Planning. V.25 (6). PP.865–879.

Miller, R. B., & Small, C. (2003). Cities from space: potential applications of remote sensing in urban environmental research and policy," environmental Science & Policy, V.6(2), pp.129–137.

Muttitanon, W., Tripathi, N. (2005). Land use/cover changes in the coastal zone of Bay Don Bay, Tailand using Landsat 5 TM data. International Journal of Remote Sensing, V.26 (11). pp. 2311–2323.

Mukherjee, S. (1987). Land use maps for conservation of ecosystems,". Geographic Review of India, V.3, pp.23–28.

Myers, N., & Kent, J. (1995). Environmental exodus: an emergent crisis in the global arena,". Climate Institute.

Pilon, G., Howarth, J., Bullock, A. (1988). "An enhanced classification approach to change detection in semi-arid environments," Photogrammtry Engineering and Remote Sensing, V.54, pp. 1709–1716.

Radke, J., Andra, S., Al-Kofani, O., Roysan, B. (2005). Image change detection algorithms: a systematic survey," IEEE Trans. Image Process, V.14 (3). PP.291–307.

Ramadan, E., Feng, X. & Cheng, Z. J. Zheijang. (2004). Satellite remote sensing for urban growth assessment in

Shaoxing City, Zhejiang Province. Journal of Zhejiang University SCIENCE, V.5(9), pp.1095-1101.

Sirkeci, I. (2005). War in Iraq: Environment of insecurity and international migration. International Migration. V.43(4), pp.197–214.

Shalaby, A., Tateishi, R. (2007). Remote sensing and GIS for mapping and monitoring land-cover and land-use changes in the Northwestern coastal zone of Egypt," Applied Geography. 27, 28–41.

Sankhala, S., Singh, B. (2014). Evaluation of urban sprawl and land use land cover change using remote sensing and GIS

techniques: a case study of Jaipur City, India. International Journal of Emerging Technology and Advanced Engineering. Eng. V.4 (1), pp.66–72.

Sivakumar V. (2014). URBAN MAPPING AND GROWTH PREDICTION USING REMOTE SENSING AND GISTECHNIQUES, PUNE, INDIA. The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences, V.8, pp. 967-970.

Steffen, W.L., Walker, B.H., Ingram., J.S., Koch, G.W. (1997) "Global Change and Terrestrial Ecosystems: The

Operational Plan IGBP Report" International Geosphere-Biosphere Program, Stockholm, No.21.

Vitosek, P.M., Mooney, H.A., LuBcheneo, J., Melhao, J.M. (1997). Human Domination of Earth's Ecosystems," Science, V.277, pp.494-499.

www.allmapsoft.com/

www.sulamar.com

اعداد خرائط النمو العمراني بأستخدام تقنيات التحسس النائي وال GIS ، موقع الدراسة: دربنديخان، اقليم كردستان، العراق

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المستخلص

يعتبر التغير في استخدام الأراضي والغطاء الأرضي ، أحد أهم عوامل التحولات البيئية على النطاق العالمي ، في صلب نقاش التنمية المستدامة. هناك اجماع على أن البشر هم القوة الدافعة الرئيسية التي تغير الغطاء الأرضي في العالم. من أجل تحقيق تنمية كبيرة ، ينبغي على السلطات الحضرية التفكير في استخدام اليات مفيدة لمراقبة كيفية استخدام الأرض الآن لإطلاعهم على الخطة المستقبلية. إن إدراك التغيير الحضري أمر حاسم لاتخاذ القرار الأمثل والتخطيط المناسب. يُعرف الاستشعار عن بعد عبر الأقمار الصناعية بأنه وسيلة قوية لتقييم ورصد تغير استخدام الأرض / والغطاء الارضي في الدقة المكانية والزمانية المختلفة. كما أنه يوفر تكاليف ووقت أقل من تلك التي تتم باستخدام النماذج التقليدية. تُعد بيانات وتقنيات الاستشعار عن بُعد مفيدة للغاية نظرًا لمرونتها في توفير المشاهدات والتغطية المتكررة على منطقة واحدة وفي الوقت الفعلي والوقت القريب من الوقت الفعلي للحصول على البيانات. تستخدم الأرض التغير والنمو الحضري في الاستشعار عن بُعد ، حيث يقوم بتحليل نطاقين من الصور الجوية أو الأقمار الصناعية لمنطقة معينة يتم تسجيلهما في وقتيين مختلفين. تهدف هذه الدراسة إلى إنتاج خريطة نمو حضري لمدينة دربنديخان الصغيرة، في غرب إقليم كردستان – العراق ، باستخدام بيانات وتقنيات RS-GIS المتكاملة مع البيانات الميدانية من عام 2003 إلى عام 2012. كشفت النتائج أن المدينة قد امتدت بنسبة 2.7 مرات ، من 1.9 كم تقريبًا في عام 2003 إلى 5.3 كم 2 في عام 2012 ، بشكل أساسي إلى شمال وغرب المدينة. خلال هذه الفترة تضاعف عدد السكان بشكل رئيسي بسبب الهجرة من المناطق الريفية إلى المناطق الحضرية. توضح الخريطة المطورة أن توزيع المرافق ، باستثناء المدارس ، يتجه نحو المحافظة في جميع أنحاء وسط المدينة وليس موزعًا بشكل جيد في جميع أنحاء المدينة. ونتج عن ذلك أن حوالي 90٪ من الشوارع كانت أقل من 15 مترًا.

الكلمات المفتاحية: النمو العمراني، اكتشاف التغيرات، GIS، دربنديخان، التحسس النائيRS ، مرئيات لاندسات.ETM, Google earth/