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Determining and Predicting the Water Demand Dynamic System Model Mapping Urban Crawling and Monitoring Using Remote Sensing Techniques and GIS

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ABSTRACT

The problem of rapid population growth is one of the main problems effecting countries of the world the reason for this the growth in different environment areas of life commercial, industrial, social, food and educational. Therefore, this study was conducted on the amount of potable water consumed using two models of the two satellite and aerial images of the Kadhimiya District-block 427 and Al-Shu'laa district-block 450 in Baghdad city for available years in the Secretariat of Baghdad (2005, 2011,2013,2015). Through the characteristics of geographic information systems, which revealed the spatial patterns of urban creep by determining the role and buildings to be created, which appear in the picture for the year 2008, 2013, 2015, respectively, compared to buildings and residential areas allocated in 2005. Comparison of each year before to estimate the number the population is the bidder in these years. The amount of water consumed in this period has also been obtained to estimate the amount of water produced for sanitation. The knowledge of growing buildings, increasing population and percentage of increase in the amount of water consumed. Geographic information systems reveal spatial patterns of civilian creep by measuring dimensions in new urban expansion areas from city middle and roads. In various years and in order to knowledge changes that have occurred in particular in the built-up areas, and the urban analyze congestion for periods of lagging and the growth prediction of urban area in the coming years.

Key word: GIS, Population growth, Water consumption, Remote sensing techniques, Satellite and aerial images

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تحديد نموذج التنبؤ الديناميكي للطلب على المياه والتنبؤ به رسم خرائط للزحف والمراقبة في المناطق الحضرية باستخدام تقنيات الاستشعار عن بعد ونظم المعلومات الجغرافية

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الخلاصة

مشكلة النمو السكاني السريع هي واحدة من المشاكل الرئيسية التي تعاني منها بلدان العالم السبب في هذا النمو في مختلف مجالات البيئة والتجارية والصناعية والاجتماعية والتعليمية. لذلك أجريت هذه الدراسة على كمية المياه الصالحة للشرب المستهلكة باستخدام نموذجين للصورتين الستلايتية والجوية لمحلة في منطقة الكاظمية 427 ومحلة 450 في مدينة الشعلة في مدينة بغداد للسنوات المتاحة في أمانة بغداد (2005، 2011، 2013، 2015). من خلال خصائص نظم المعلومات الجغرافية التي كشفت عن الأنماط المكانية للزحف الحضري من خلال تحديد الدور والمباني التي سيتم إنشاؤها والتي تظهر في الصورة للعام 2008 و 2013 و 2015 على التوالي مقارنة بالمباني والمناطق السكنية المخصصة في 2005. وعمل مقارنة كل صورة مع صورة السنة التي قبلها ومع السنة التي اعتبرت اساس المقارنة في 2005. كما تم الحصول على كمية المياه المستهلكة في هذه الفترة التي يمكننا من خلالها تقدير كمية المياه المنتجة للصرف الصحي. إي من خلال معرفة المباني المتزايدة وزيادة عدد السكان ونسبة الزيادة في كمية المياه المستهلكة تكشف نظم المعلومات الجغرافية عن الأنماط المكانية للزحف المدني من خلال قياس الأبعاد في مناطق التوسع العمراني الجديدة من وسط المدينة والطرق. في سنوات مختلفة من أجل معرفة التغيرات التي حدثت على وجه الخصوص في المناطق المبنية، ومن ثم تحليل الازدحام الحضري لفترات زمنية مختلفة والتنبؤ نمو المنطقة الحضرية في السنوات المقبلة.

الكلمات الرئيسية: نظم المعلومات الجغرافية، النمو السكاني، استهلاك المياه، تقنيات الاستشعار عن بعد، الصور الفضائية والجوية

1. INTRODUCTION

Water is the most important natural resource in the twenty-first century and must be preserved to keep life on earth, **Wafula**, and **Ngigi**, **2015**, and due to the rapid increase in population numbers and the increase in buildings in the cities which led to a rise in water usage, which needs to provide effective models of operation in distribution of the water network to meet the needs of the individual during the year, **Kumar, et al., 2016**. It is necessary to secure a long-term and reliable supply of potable water as an essential element in water management by determining and predicting the water demand, **Wafula**, and **Ngigi**, **2015**. The lack of compatibility between water demand and supply (supply lower than demand) was be the biggest problem for the future of human beings on earth. Some researchs showed that in 2025, about 3 billion people will not be able to use potable water which represents about 60% of world's population, **Wafula**, and **Ngigi**, **2015**. Population growth is a global phenomenon and this increase is very rapid in developing countries, **Rimal, 2011**, **Mohammed, Ali, 2014,** and **Hegazy**, and **Kaloop, 2015**. The urbanization process unplanned has become the main problem in developing and developed countries, **Rimal, 2011**.

Population growth, migration, political instability, economic opportunities, employment and the central policies are among the main reasons for the high level of urbanization in most countries و **Rimal, 2011**, **Mohammed, Ali, 2014,** and **Hegazy**, and **Kaloop, 2015**. In other words,

accelerated urban growth is related to population concentration in an area and the city's requirements, **Qiu, 2003**. It considers urban expansion; land cover change and land use are one of the main factors in the depletion of water resources and water resources and deterioration of water quality, **Hegazy**, and **Kaloop, 2015**. The expansion of urban development has led to a change in the use of natural resources and a change in the use of land and land cover patterns, so urbanization is known as a revolution in the use of land relative to the time frame, which modernizes economic and social activities, **Rimal, 2011**. That is, the construction of land has become rapid, affecting the decrease of these lands, which may have been agricultural land, and negatively affects the exploitation of natural resources.

Urbanism is therefore a concern for natural resources and the water demand increase continues in very large quantities, **Mohammed,** and **Ali, 2014**. This is due to two main reasons: the continuous increasing in population and human uses of water. The census of population normal is very costly. Therefore, it is not carried out periodically. As a result, no perfect population data is ready in any given year between successive censuses every decade, **Qiu, 2003**, **Lo, 1986**. Therefore, there has been increasing interest in mapping urban crawling and monitoring using remote sensing techniques and GIS. **Epstein, et al., 2002,** and **Qiu, 2003**. GIS is used as a tool to study the limits of urban expansion and growth with its impact on the exploitation of environmental resources as well as GIS reveals the spatial and temporal pattern of urban expansion along with modeling to determine the crawl body to see the nature of future crawling, **Rimal, 2011**, **Sudhiraa, 2004**, and **Hegazy**, and **Kaloop, 2015**. The methodology of remote sensing and GIS-technologies provides key tools that it can use to analyze land use interpretations, **Hegazy**, and **Kaloop, 2015**. GIS is a system that facilitates decision making for urban planning processes and its modeling has been very extensively in urbanization research, **Hegazy**, and **Kaloop, 2015**. Urban areas have very complex forms and structures that illustrate the use of land and urban growth must be studied as a spatial description that can be observed and captured in GIS, **Rimal, 2011**.

Aerial imagery was used for a long time in calculating the number of housing units that monitor and estimate the sum population based the middle size of the household for each style of dwelling, **Qiu, 2003**. The methodology of remote sensing and GIS-technologies provides key tools that we can use to analyze land use interpretations. Therefore, there has been increasing interest in mapping urban crawling and monitoring using remote sensing techniques and GIS, **Epstein, et al., 2002,** and **Qiu, 2003**. GIS is a system that facilitates decision making for urban planning processes and the GIS modeling has been very extensively in urbanization research, **Hegazy**, and **Kaloop, 2015**. The main objective of this study is to use remote sensing and GIS techniques with high-resolution images to detect changes in urban growth, water consumption in residential areas in the Kadhimiya District-block 427 and Al-Shu'laa district-block 450 in Baghdad city.

2. MATERIALS AND METHODS

2.1 Study case description

In order to achieve the objective of the study, two residential areas were identified, Al-Kadhimiya district-block 427 and Al-Shu'laa district-block 450 in Baghdad city for available years in the Mayoralty of Baghdad (2005, 2011,2013,2015), which differ in terms of the level of living, the housing area and the regularity of the road network. Therefore, each district has been compared for several years began from 2005 for each district and as provided by the maps of the Mayoralty of Baghdad, where the picture for 2005 for district 427 and 450 is the basic picture of comparison, as shown in **Fig. (1-a** and **2-a)**. With Arc GIS, a layer was drawn for each housing unit each year and compared to 2005 (Mayoralty of Baghdad).

2.2 Data Collection and Analysis

The high-resolution images of Al- Kadhimiya district-block 427 and Al-Shu'laa district-block 450 in Baghdad city were used respectively for the years (2005, 2011, 2013, 2015) provided by the Mayoralty of Baghdad, then made the image 2005 is the basic image of the comparison. The GIS program was used to draw and identify the increasing buildings in 2008 and made the shapefile layer and then draw a second shapefile layer for the buildings that were built during the eight years from 2005 to 2013 and then draw a shapefile layer of buildings within ten years in 2015. So, that the incremental structure of each year can be identified by the year in which the combination of the three layers is combined, making it easier to compare.

3. GIS METHODOLOGY

Monitoring of population growth has become a main use of remote sensing and GIS information. Increase monitoring is the method of identifying and/or characterize changes in the characteristics of land overlay and land employ based on sensor data for several years. The basic premise in the use of remote sensing information to detect variation in the operation enable determine the variation between several dates. Therefore, we need high-resolution images to know the changes in increasing population growth in residential areas for a specific period of time through working layers by GIS program and compare the layers together to reveal the growth of population and increase and know how to start depletion of natural resources because increases in the use of water resulting from the population.

Water is an essential axis of life to all on Earth. And the increasing world population, water demand and pressure on limited water resources is increasing. Population increase is a main reason to water insufficiency. Increase population it is increased demand and competition for water in homes, Water is also needed for agriculture and manufacturing production be based on water for treatment, waste disposal and cooling. The water request for industrial use is rising because fast manufacturing to meet the increasing needs of the increasing population. Areas with water scarcity are often characterized by low water resource and height population density and height population increase ratio. Population increase limits the value of water obtainable per person and directs people to peripheral areas and cities. Future people increase will affect water strain and lack. Population growth leads to this raise. While proceeds development and changes in drain greatly affect, because many people left rural agricultural areas and transport and live in

the urban or industrial areas. Climate variation is also carefully linked to population increase and will also put further pressure on the availability of water resources. Rising demand for potable water has led to water scarcity in many places. Water scarcity can be measured in many ways. While social, economic and political factors are all helpful in determining arrival to water. The availability of water is the beginning of the start of water assessment at present and in the future. Countries classify their water as scarce and scarce if there is less than 1,000 cubic meters of fresh water available per person per year. Water scarcity affects all social and economic sectors and threatens the health of ecosystems.

Population growth leads directly to increases in total water demand, while other demographic factors such as population distribution and age structure modify the pattern of demand and identify increases in household water demand. In general, Water consumption per person is expected to increase with income, not to mention that one of the causes of water shortages is urbanization and rapid population growth, which adversely affect livelihoods and health. The expected disparity between population growth and the adequacy of water resources within the region raises serious questions about the adequacy of water resources in view of current population rates and the timing of potential conflict within the region. This study, using the dynamic system model of the region, suffers from severe water scarcity by the middle of the century with potentially catastrophic humanitarian consequences.

4. RESULTS AND DISCUSSION

Fig. (1-b and **2-b)** shows the housing units established during the three years in yellow color in 2008 while **Fig. (1-c** and **2-c**) shows the housing units established during the eight years in blue color in 2013. Residential units can be seen in red color in 2015 as shown in **Fig. (1-d** and **2-d)** i.e. in 10 years, compared with the basic picture of 2005 (Mayoralty of Baghdad). As there is an increase in residential buildings in this growing form, there is an increasing in the population, leading to an increase in the use of larger quantities of water, which leads to pressure on sewage pipes increasingly. It is worth using household water filters, which are used in almost every household, which in turn consumes almost double the amount used during the filtration process, which the residents resort to not to trust the power of water in the faucets for drinking.

The residential units in the district-427 are approximately 400 m² and the residential units in the district-450 are approximately 150 m² and the prices of units in the district-427 higher than the district-450.

The Shape file is configured by using GIS for each year to enable us to compare the built-up residential units during these years more clearly. It can be seen that the yellow residential plaques were built in 2008 as shown in **Fig. (3-a** and **4-a),** which is a large number but relatively less than the other years, which is a three-year construction product compared to the base image in 2005, and compared to the **Fig. (3-b** and **4-b)** in 2013, which appears in blue color. This study found a clear increase in the number of housing units, which is the product of building eight years and the increase in construction and housing units was been very clear in 2015 as shown in **Fig. (3-c** and **4-c)**. **Fig. (3-d** and **4-d)** shows all layers with some of the increase is evident in buildings and residential units for each year from the previous. **Fig. 5** shows through the GIS during 2008, 2013, and 2015, increase the added building numbers and areas as a result of

population increase which leads to increase the water consumption and sewage flow rate to sewage networks.

Fig. 6 and 7 show the annual water consumption supplied from water supply network/Mayoralty of Baghdad for Al- Kadhimiya district-block 427 and Al-Shu,laa district-block 450 which reveal the decreasing water quantity during 2005-2016. It was observed the average daily water consumption for block-450 (4720 m^3/day) double block-427 (2550 m^3/day) due to high population density and small housing units as shown in **Fig. 8**.

5. CONCLUSION

Geographic information systems (GIS) with high-resolution images was used to detect changes in urban growth, water consumption in residential areas in the Kadhimiya District-block 427 and Al-Shu'laa district-block 450 in Baghdad city. The main conclusions of the study are as follows:

1) It was observed through the GIS during 2008, 2013, and 2015, increase the numbers and areas of the added buildings as a result of population increase which leads to increase the water consumption and sewage flow to sewage networks.
2) It was noted that the building numbers or areas added during the years 2008-2015 in the block 427 more than block 450.
3) In general, added building numbers and areas refers to increase in population numbers which lead to increase in water consumption and sewage disposal.
4) The average daily water consumption for block-450 more than block-427 due to high population density and small housing units.

6. SHAPES AND TABLES

a: 2005

a: 2005

b : 2008

c: 2013

d : 2015

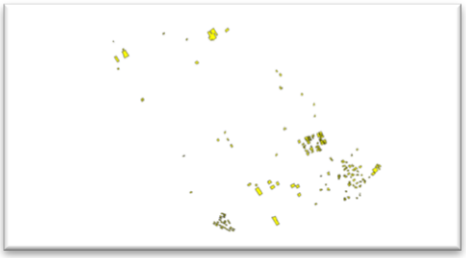
Figure 1. Al-Kadhimiya district-block 427.

b : 2008

c: 2013

d : 2015

Figure 2. Al-Shu'laa district-block 450.



a: Shapefile 2008

b: Shapefile 2013

c: Shapefile 2015

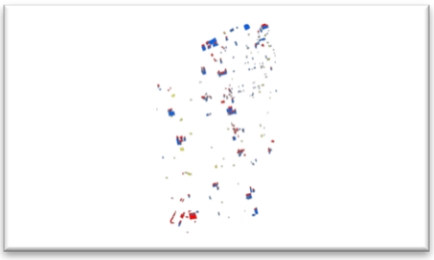
d: Shapefile 2008, 2013 and 2015

Figure 3. Shapefile Al- Kadhimiya district-block 427.

a: Shapefile 2008

b: Shapefile 2008

c: Shapefile 2008



d: Shapefile 2008, 2013 and 2015

Figure 4. Shapefile of Al-Shu'laa district-block 450.

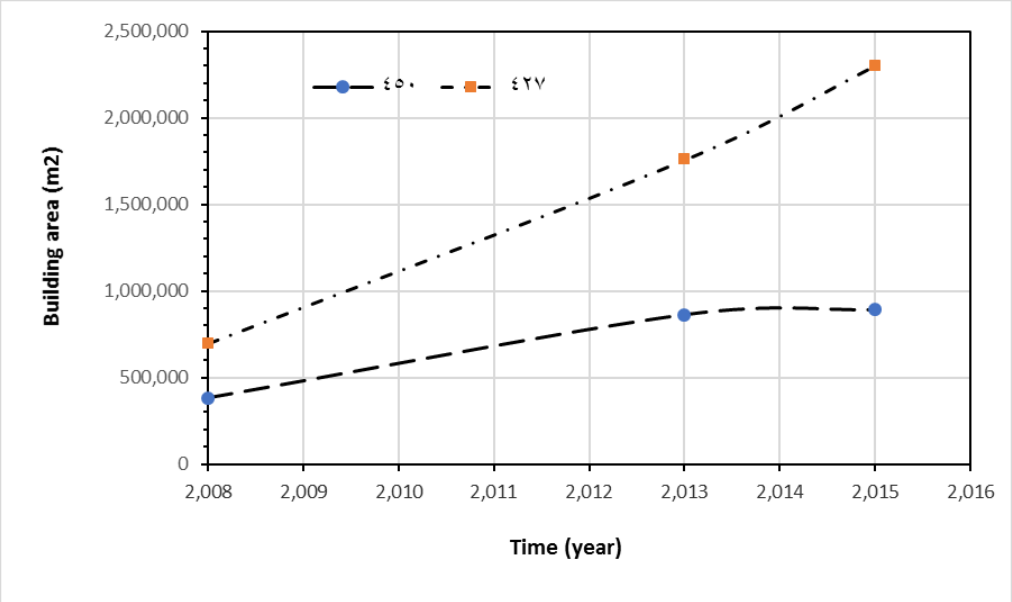


Figure 5. Building area added in block 427 and 450 for 2008, 2013, and 2015.

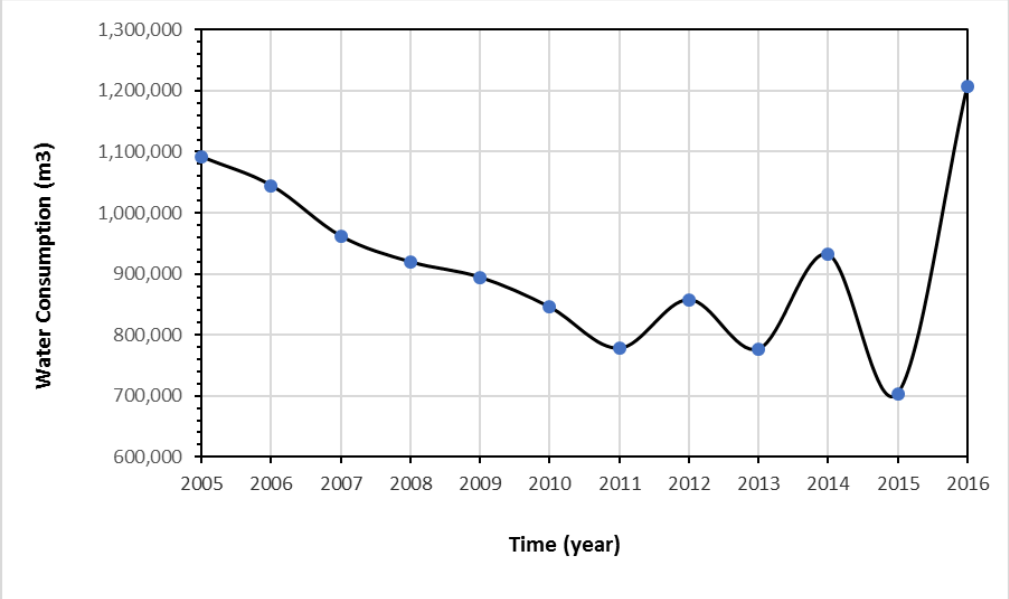


Figure 6. Annual water consumption for Al- Kadhimiya district-block 427.

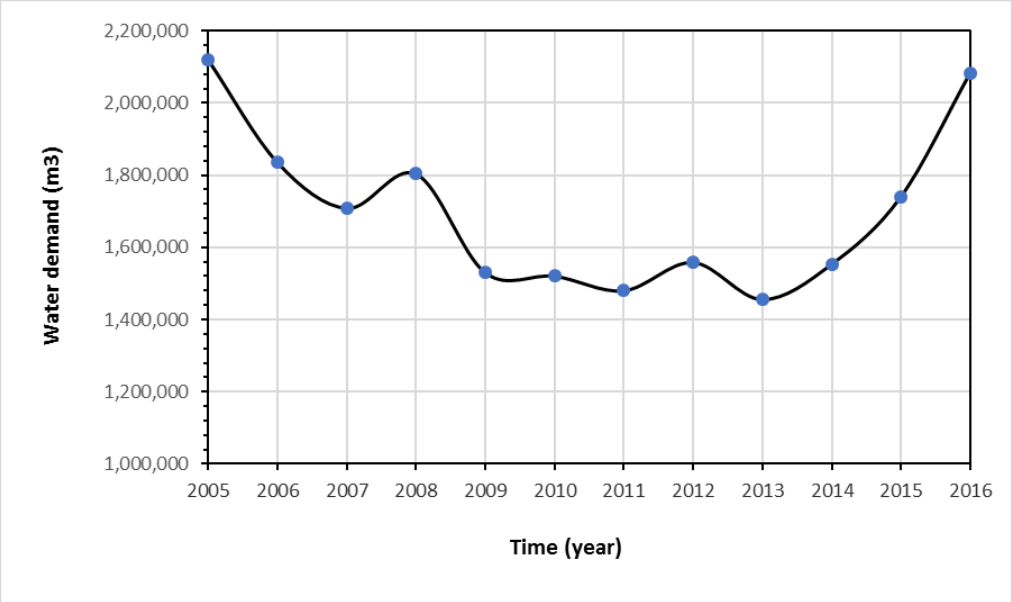


Figure 7. Annual water consumption for Al-Shu'laa district-block 450.

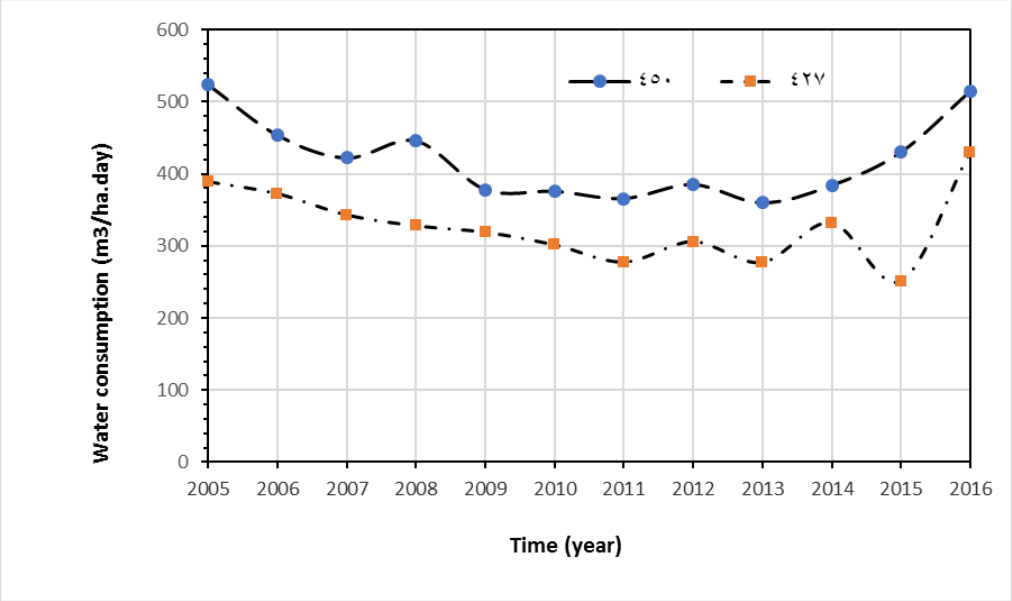


Figure 8. Water consumption in block 427 and 450 for 2005-2016.

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