International Journal of Engineering and Information Systems (IJEAIS)
ISSN: 2643-640X
Vol. 10 Issue 4 April - 2026, Pages: 52-60

Geomatics Techniques for Evaluating Land Use Planning by Processing Google Earth Images

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Abstract: *This study utilizes geomatics techniques (Erdas Imaginary and Geographic Information Systems software) to process and analyze images extracted from Google Earth to assess land use planning and urban expansion. Most previous studies relied on satellite imagery from Landsat, Sentinel, and other sources, which consists of multiple beams requiring lengthy processing and analysis. The study focuses on the city of Hilla before and after 2003 due to the significant urban expansion and its impact, including the problems it causes. Images were analyzed using Erdas Imaginary software with a Supervised classification formula, and the original and final images were verified using the kappa coefficient. The results revealed the extent of urban expansion in the study area and confirmed the availability of adequate infrastructure and services to accommodate this expansion through field surveys. Urban planning was governed by strict laws and standards that could not be circumvented, taking into account the limited income of the population. Therefore, this research also includes an evaluation of land use planning in the study area before and after 2003, examining its positive and negative effects and offering recommendations for achieving optimal planning. The best way to observe the difference in land use between these two years was to process Google Earth images using geomatics applications, as the processing results revealed these differences.*

Keywords: **Land use, Urban Planning, Geomatics, Erdas imagine and Economic Risk**

1. Introduction

This research paper aims to analyze an image downloaded from Google Earth using the ERDAS classification system to assess urban expansion and to produce maps illustrating this expansion using a Geographic Information System (GIS) application. Some studies have used satellite imagery downloaded from Landsat Sentinel and other satellites, but these images require extensive processing and analysis, as well as a long timeframe, to assess land use [1]. The study area was selected for several neighborhoods in the city of Hilla, the capital of Babylon Governorate, located 100 kilometers south of Baghdad. The city is characterized by the presence of the Hilla River, which divides it into two parts. The study area, comprising three adjacent neighborhoods, was chosen because it houses most of the government offices and has witnessed significant urban development since 2003. One of the most important factors influencing land use planning and development is the economic aspect. Before 2003, Hilla suffered from economic hardship, and its residents had limited incomes. After 2003, the population experienced increased economic growth, leading to urban expansion onto vacant land for housing purposes. However, the exploitation of most agricultural land and its conversion into residential areas has negatively impacted the quality of land-use planning, due to the neglect and non-enforcement of most laws and standards, stemming from the absence of an authority to hold violators accountable. Google Earth images, analyzed by the ERDAS program and produced using GIS maps, show an increase in urban sprawl after 2003, as illustrated in sections 2, 3, and 4. These sections demonstrate the image analysis and processing process, including how the original image was matched with the final image using the kappa factor, in addition to a field survey to determine the increase in infrastructure and its impact on urban expansion.

2. LAND USE PLANNING

Through fig. (1) and fig. (2) show the study area; note the large difference in population expansion of the area after 2003. This expansion has had a significant negative effect because the expansion was only in terms of population (increasing role of residential and commercial) without any expansion in terms of services, health, and environment, which increased the pressure on the infrastructure and services of the former and old, which is supposed to be calculated within the previous planning of the land. Such an expansion was planned in advance, that the use of the scheme wrongly without legal control can be considered as slums of land use. The indiscriminate use of the land leads to many economic, social, environmental and planning problems. It also works on the aging of cities and neighborhoods and the degradation of some of the poorer uses and competition for other uses, such as the decline in residential use for commercial use and administrative activities, especially in the city center [2,3].

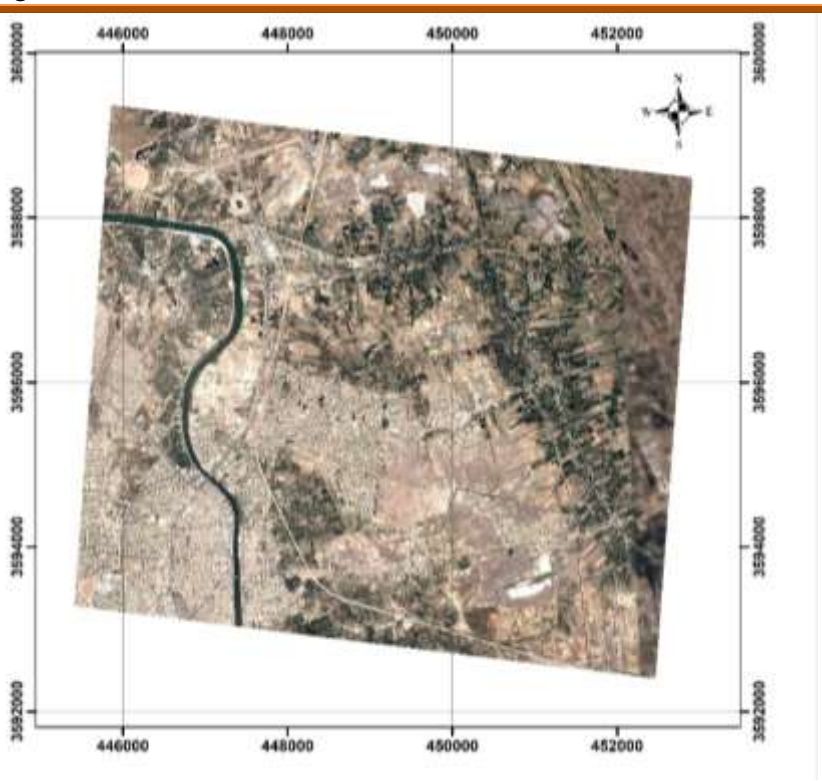

Fig. (1) Hilla city – three neighbored – before 2003

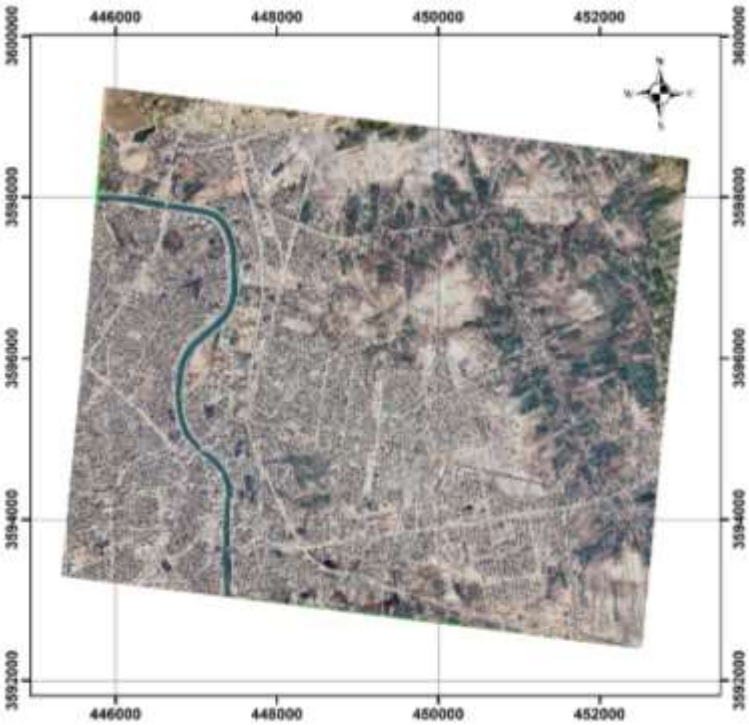

Fig. (2) Hilla city – three neighbored – after 2003

3. GEOMATICS TECHNIQUE USE

This technique is represented by three parts: the Erdas imagine program, GIS program and field surveying work.

3-1 Erdas Imaginary Program

The Google Earth image of the study area (before and after 2003) was used and downloaded for Google Earth Pro., where the date of the image before 2003 is 2002 and in 2024 for images after 2003. The processing of these images including only subset the study area and georeferenced to: UTM, Zone 38, WGS 84. According to the metadata report, the image has a pixel size (1 m* 1 m), one-layer type thematic.

In this software, the process includes: -

1. Insert Google Earth image as Raster
2. Create a signature spectrum for each feature (houses, buildings, streets, green lands, vacant lands, rivers, etc.) in image by Signature Editor tool.
3. Supervised Classification. Where it provides tools for categorizing pixels using interactive supervised techniques. You provide examples of what particular classes look like, which are then used by the software algorithms to derive rules for mapping all other pixels into the class values.
4. Calculating the area for each feature.

3-2 GIS program

After processing the image, to determine the degree of compatibility of the main image with the supervised classification, the ground truth points were collected in manual confirmation and used to present a Confusion Matrix and the Kappa Coefficient for the supervised classification. This method consists of: -

Insert an image that is processed — Arc toolbox — Segmentation and classification – Create Accuracy assessment by selecting 125 points randomly (shown in fig (3)) – Compute confusion matrix

According to these steps, the Kappa Coefficient equals 0.96.

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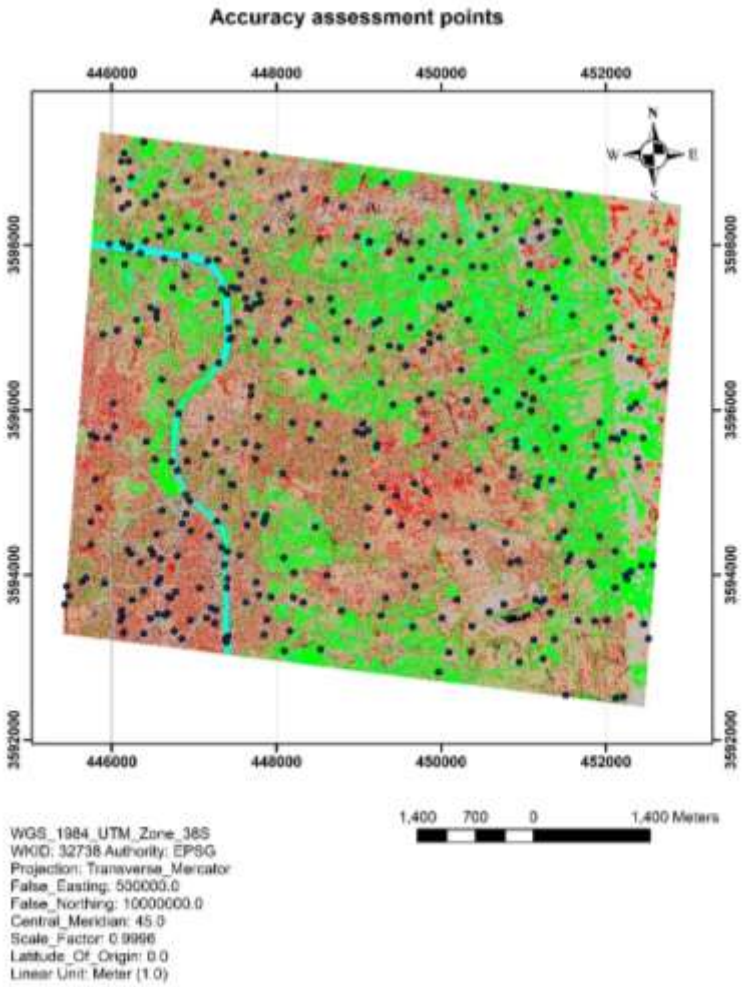
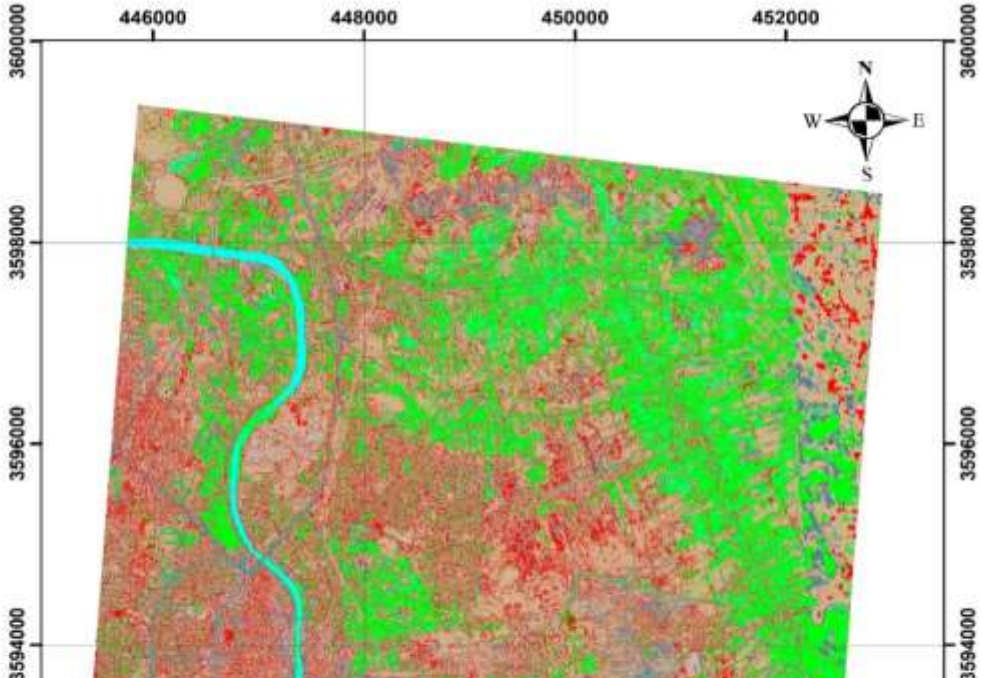
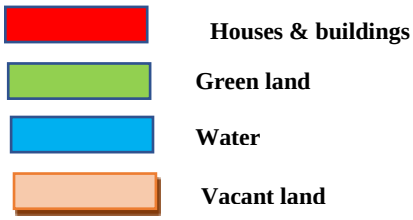


Fig. (3) Accuracy assessment points

Then Arc GIS program was used to produce the best map of the classification of land use, this classification shown in map (1) and map (2). Where the red, green, blue and light are represent house and buildings, green land, water and vacant land respectively, these are shown in maps below.

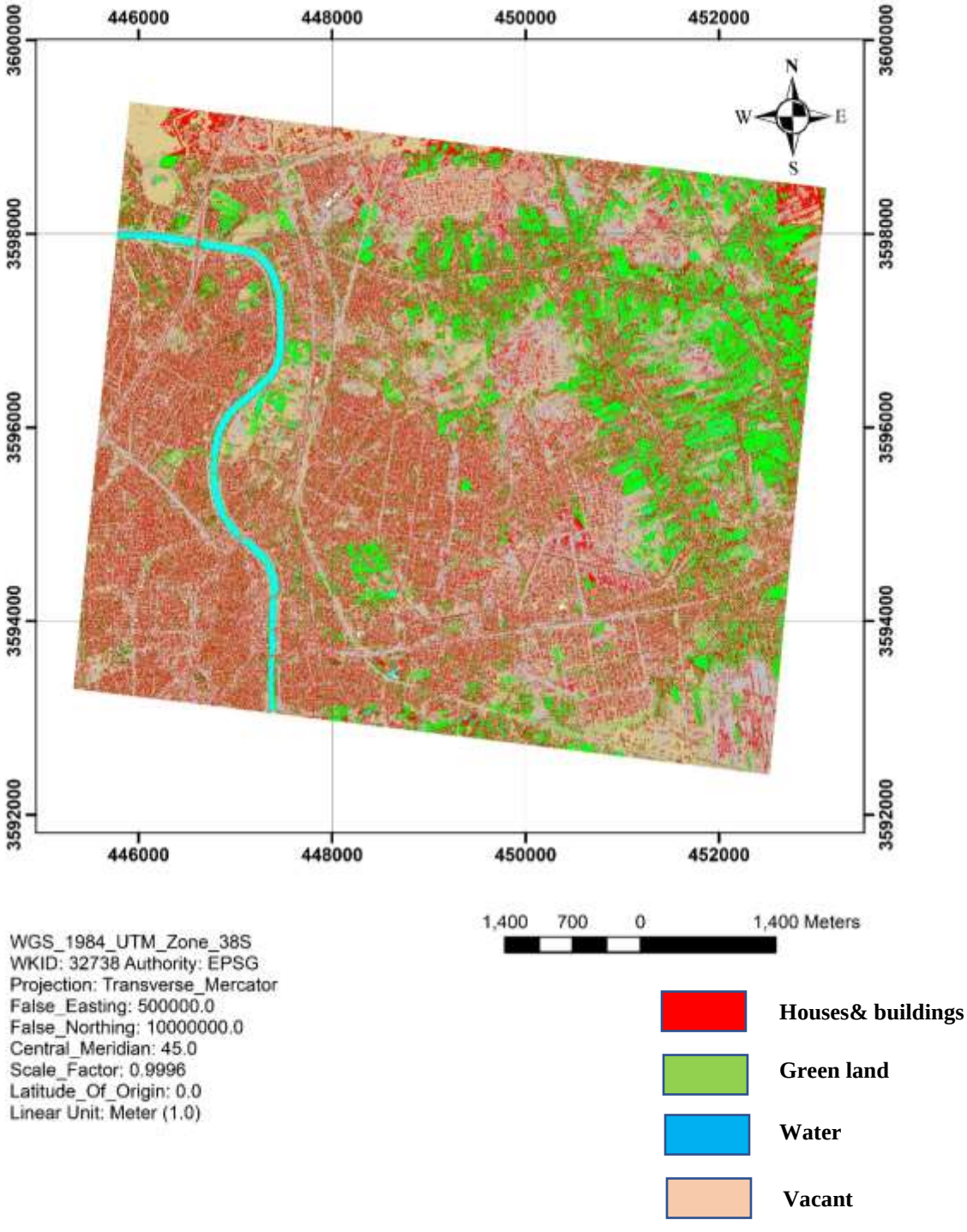




Map (1) classification features in Hilla city before 2003

3-3 Field surveying works.

Map (2)



classification features in Hilla city after 2003

This works including the field survey about data collection of the service buildings like schools, college, hospitals, medical building, oil station, water station and sewage and rain networks and the relevant departments were visited to obtain all information related to service buildings before and after 2003 and to know the extent of the increase in these buildings. The table (1) refer to the no. of these buildings

Table (1) refer to the no. of services buildings before-after 2003

No.	Item	No. before 2003	No. after 2003
1	Government schools	11	15
2	Private schools	0	10
3	Government hospital	1	1
4	Private hospital	1	3
5	Medical building	4	4
6	College,	1	1
7	Oil station	2	2
8	Water station	1	1
9	sewage and rain networks	1	1

4. THE RESULTS OF STUDY

After analyzing the image by Erdas imagine program and verifying the classification by finding Kappa coefficient, which reached 0.96. The area for the red colour (houses and building) equal (6.34 Km^2) before 2003 while after 2003 equal to (12.83 Km^2) and the green land before 2003 equal (10.58 Km^2) while after 2003 equal (7.98 Km^2), that's mean there is increase in houses and building, the service building shown in table (1) it is not consistent with the increase in the number of houses that will show its effect as explained in the fifth paragraph.

5. THE EFFECT OF EXPANDED

The plan is designed to serve the citizens and future generations and provide the best situation in order to achieve the best financial returns resources for the future. The goal of the development of schemes is not waste money and waste in the preparation of plans as happens in our current reality. This randomness in the use of the land leads to risks, the most important of these risks are:

5-1 - Environmental and health risks:

The increase that occurred and the random expansion of the study area caused an environmental and health problem in order to provide the health and environmental services for the region and beyond.

5-2- Economic risks:

When the municipality prepares structural plans, and when it also implements its own laws and regulations, the primary objective is the well-being of the person and his service, the realization of individual and collective interests and the provision of services. This will lead to the support of the economy and the provision of funds, which have been developed primarily for the benefit of citizens, while the emplaning work will become a burden on the state budget, and the citizen will bear part of these funds and pay the financial penalty in case of non-compliance and response commitment to the public interest, and do not forget here bickering and disputes between individuals and the entity responsible "authority", Because of the lack of power and the neglect of laws and standards by the citizen and the departments concerned that adversely affected the economic aspect.[4,5]

5-3- Social Risks:

Social risks stem from citizens' lack of commitment to work and organizing laws, especially with regard to the land and other restrictions. This creates disputes and problems between citizens first and between the abused citizen at his land and the workers within the municipality and the responsible party.

5-4- Contradiction and conflict of land uses:

There are contradictions between the uses of rural and urban land within each of them. The most obvious example is the urbanization of the urban green belt and the changing landscape of urban areas, due to the urbanization of urban structures, for example the construction of a school within a green area.[6]

It is clear that the planning of the use of land for the study area after 2003 was supposed to be applied to all the systems, laws, legislation and planning standards and the use of the power of the Authority against violators and transgressors on the criteria of planning and this is through the following

- Activating the power of the government authority and accounting for violators and offenders of the planning law.
- Activate the role of service departments concerned with the implementation of the Planning Law.
- Joint cooperation between the citizen and the local government in order to implement the law.
- Also mention that the local government or municipal departments should have the role of the planning process by providing sufficient space for services, health and recreational services that benefit the citizen.

5-5- Urban risks and deformation of urban fabric:

In case the citizen does not comply with building laws, issued regulations and construction without a license and violating the use and increase the area of construction from the area issued in the license and allow the construction of a modern floor above an old floor, any overlap in the years of construction, all these factors lead to distort the construction of the neighborhood firstly and the city secondly, The city is destroying many homes and the inconsistencies between the building patterns used.[7,8]

6. CONCLUSIONS:

- The study proved the possibility of dealing with images uploaded from the Google Earth website according to the results of the image analysis by finding the Kappa coefficient, which shows the extent of the classification matching the main image. And Image analysis using geomatics techniques has shown the extent of the increase in residential buildings after 2003 compared to the scarcity of service buildings.
- Planning the use of land before 2003 was within the criteria and regulations and laws cannot be exceeded.
- The partial use of the land after 2003, through the expansion of the population only, and neglect of other aspects and the violation of the standards and laws skipping by the citizens because of the weakness of the power, negatively impacted on the planning of land uses and transformed into slums negatively affected the citizen and the city.
- For the purpose of controlling the land use and planning the use of the land must activate the power of the Department as well as the role of the departments involved in the implementation of the Planning Law.
- Land use planning and studies should be conducted to modernize residential areas and provide sufficient space for health, security, environmental, and recreational services. This should be facilitated by using maps prepared using Google Earth image analysis for ease of use.

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