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Application of GIS and Remote Sensing in Urban Green Space Planning (Case Study: Qochan City)

D.Akbari[1*]

1, Department of surveying Engineering University of Zabol

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ABSTRACT

The integration of urban services is one of the most important achievements of the urban geographic information system (GIS), which will clarify, unify and facilitate services by creating a database in GIS, and it will be a step in the direction of reaching the urban information management system and decision support of senior city managers, which can be used as a new and powerful tool for better city management. Gathering information (spatial and descriptive) of all aspects of green space in the region, elements, furniture and urban facilities in Qochan city is one of the main operations to achieve better management in the region. Using Quick Bird satellite images and evaluating the potential of these data in producing a number of green space information layers such as linear, point and surface complications and the ability to update area information is one of the activities that makes it easy for managers to access information.

1. Introduction

Nowadays, the concept of cities without green space in its various forms is unimaginable. As centers of human activity and life,cities have no choice but to accept a functional structure influenced by natural systems in order to guarantee their sustainability (Gelan, 2021). In the meantime, green space as an essential and integral element of the body of cities, plays an essential role in their metabolism. Previously, green spaces had mostly decorative roles (beautification of the urban landscape) and entertainment (recreational areas), but with the increasing development of urban areas in recent decades and the overtaking of urbanization over urban development, which has been associated with many problems such as excessive population growth, non-targeted physical development of cities, and increased environmental pollution (Bai et al., 2022). Now urban green space has found an important rolein maintaining and balancing the urban environment and modulating air pollution. In addition to the environmental function, the green space has other functions such as building and directing the physical development of the city as well as social-psychologicalfunction (Shahtahmassebi et al., 2020).

One of the important pillars of decisions in the field of green space is the existence of accurate and timely statistics on the number of trees, area and type of green space, etc. in the urban green space, as well as knowing their exact location. which, in addition to providing data for any kind of planning and design, also helps to reduce the economic costs of organizations and companies related to the provision and maintenance of green spaces, today, by using satellite images, including the Quick Bird satellite image, which has a high resolution and the facilities provided in the geographic information system (GIS) environment, it is possible to identify,update and map all kinds of urban green space complications with less physical presence and high speed and accuracy (Vatseva et al., 2016). GIS has a significant role in environmental studies, including locating urban green spaces. On the

*Corresponding author's email : davoodakbari@uoz.ac.ir
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other hand, it seems necessary to improve and have comprehensive information about green spaces. In this regard, relevant managers and researchers aretrying to use GIS technology, remote sensing, land mapping and Global Positioning System (GPS) to make more correct decisionsin the maintenance, management and planning of green spaces. By using these technologies and tools, different modeling methods can be used together and more complex spatial analysis models will be applicable (Sharma et al., 2022). In recent years, it has become clear that the methods of using GIS systems, along with the effective use of new digital data, can give new life to the theories of spatial modeling and environmental planning (Pouya and Aghlmand, 2022). GIS, by providing digital databases and the ability to store, analyze and manage data, has a high ability in green space planning studies, preparing green space databases, and finding locations for building new parks. The storage and management of these criteria and types of data in systems such as GIS, RS, and GPS and their very high capabilities provide a verysuitable opportunity for planners and designers to collect and analyze different data in different models. Basic management research on urban green spaces in the first stage requires access to accurate and timely statistics and information about urban green spaces. Undoubtedly, the lack of access to accurate and timely statistics and information makes any planning in this field difficult. The cityof Qochan is not an exception to this rule, but due to the location of this city and its location in a mountainous region, the presenceof historical attractions in this city has doubled the attention to the management of green space in this city. On the other hand, the crossing of Etrak river through the center of this city is considered as a positive point in the management of green space. Therefore, in order to plan for the preservation, development and basic management of the city's green space, accurate and timely maps, statistics and information must be given basic attention

2. Materials and Methods

2.1. Research background

Examining the background of the research and the works done shows that recently in the field of urban green space planning, there is a lot of use of existing technologies. Shivanand combined GIS techniques with questionnaire surveys to improve survey methods and measurements related to urban green space planning in Canada Island (Shivanand, 2005). Kong and Nakagoshi analyzed the changes of urban green space during 1989-2004 in Jian city, China using GIS and remote sensing of spatio-temporal gradient (Kong and Nakagoshi, 2006). Kyushik and Jeong evaluated the spatial distribution of urban parks in Seoul, South Korea by using GIS (Kyushik and Jeong, 2007). In Hanoi, Vietnam, Duc Uy and Nakagoshi used land suitability analysis and landscape ecology in the environment of GIS and Matlab software (Duc Uy and Nakagoshi, 2008). Examples of works done in Iran include the following: Warsi et al. (2007) have located green spaces in Khorramabad using GIS. Hashemi et al. (2008) analyzed the trend of urban green space changes in District 2 of Tehran Municipality. Pourahmad et al. (2008) have investigated the management of urban green spaces in District 9 of Tehran. Hataminejad and Omranzadeh (2009) have examined and proposed per capita urban green spaces in Mashhad. Azani et al. (2010) and also investigated urban green space planning in the southern regions of Iran. Regarding the green space of the city of Qochan, we can mention two projects of marginal parks organization for accommodation of travelers and green space of Qochan using satellite data as well as the project of collecting spatial and descriptive information required by GIS.

2.2. Study area

In order to evaluate the ability of satellite images, GIS and land mapping ability in urban green space planning, parts of Qochan city were selected as the study area. The city of Quchan has a cold and dry climate. The importance of this area is due to its proximity to Etrak River and the urban axis (Sento Road), the presence of a market and a dense commercial-service sector. The set of these conditions and other features show a coherent and integrated image of the region. This area has a good amount of green space and therefore the planners and managers of this city show more importance in beautifying and managing the green space of this city.

Fig 1. Satellite image of Quchan

2.4. Data and methodology

In order to conduct this research, in addition to using the documentary method and reviewing the available sources and reports, mainly the survey method, field operations and collecting information from the ground have been used. The main materials and data used in this research are:

- ✓ Quick Bird satellite image. The images of this satellite have the highest spatial resolution among the available commercial satellites. The resolution of this satellite is 2.4 meters in multispectral image and 0.64 meters in panchromatic.
- ✓ Conducting field operations and ground mapping of the tolls and green spaces of the area using mapping cameras and global positioning system (GPS).
- ✓ Removal of urban furniture and facilities (lighting, water resources, etc.) using GPS

Other required data were obtained from the organization of parks and green spaces of Qochan and the municipality of this region. The satellite image was first geometrically corrected and georeferenced using GPS ground data and a 1:20000 map of the municipality in the UTM coordinate system. ERDAS software was used for this. After that, all the complications and phenomena in the green space were digitized in a visual way and when needed using ground mapping and GPS in the Arc GIS software environment. Finally, different layers of complications were prepared in the form of linear, point and polygon in the Arc GIS environment, and after editing, a topology was created for them and the geographic database was designed in this way. As mentioned earlier, Quick Bird satellite image was used for more accuracy and identification of complications. The image was georeferenced in the UTM coordinate system. At first, satellite image preparation and pre-processing was done. The geometric correction of this image was equal to (RMSE) 0.6 and the topography was corrected. Then, using the final fused images, tree species and urban green space complications were identified as much as possible. In order to increase the accuracy and correct control of existing complications, field operations were carried out using theodolite camera and GPS. Mapping of the effects of green space in the area, including trees, green space passages, squares, hedges, etc., was done and all data was entered into the GIS system. In the last stage, the collected data was completed by revisiting the correction area and entered into the GIS system for final registration, and three layers of information were created in GIS. The first layer is dotted and related to trees and shrubs. The second layer with linear complications was assigned to the hedges. Finally, the third layer, which is related to gardens, ponds, parks, lawns, fields, etc., was made in the form of a polygon. This complication has four information fields in which the area, environment, coverage and use are mentioned. In this way, a 1:2000 map of urban green spaces was produced and updated with the help of satellite images and field operations in the GIS environment.

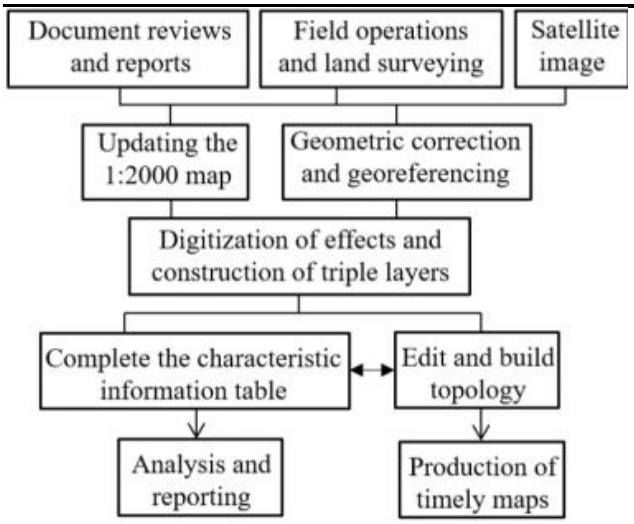

Fig 2. steps of the methodology

Considering that the Quick Bird satellite image has a high resolution, it is important to use this image to review

large-scale urban maps, because the results of previous studies and observations indicate that the complications of green spaces, including trees, gardens, ponds, etc., construction features such as shops in the park, restrooms, security building, etc. can be extracted from these images as needed to update 1:2000 maps of urban green spaces, even by using fused images, the type of tree species can be recognized to some extent.

3.Results and discussion

According to the investigation, all existing features of the parks and green spaces of the study area were collected, digitized and entered into the geographic information database. These data were classified as linear, point and polygon complications. In each of the layers, required characteristic information was entered and related calculations such as length, area and circumference were performed.

a) Point effects: The point effects collected in the study area included all tree and shrub species, lighting poles, telephone booths, etc. In this survey, 44 tree species were identified, which mainly included Tehran pine, elm, edible mulberry, plantain and sparrow's tongue.

b) Linear tolls: In the linear tolls layer, the hedges were numbered and the length of each one was calculated according to theirtype.

c) Polygonal complications: Polygonal complications such as gardens, lawns, ponds, the boundaries of parks and squares werealso identified and quantified, and the area of each of them was determined.

The results of the findings show that today, by using satellite images with high resolution (about 50 cm), it is possible to capture many spatial complications, including green space, with computer processing. The high spatial resolution of these images makes it possible to examine the details of many spatial complications, including green space, and with their help, it is possible to classify, separate and extract the complications of green space in minimum time and with reasonable accuracy at low cost. The maps and information generated from satellite images can provide the required information to managers and green space planners and help them prepare, implement and monitor their projects. and better estimate the costs of development and maintenance of green space.Green space information extracted from satellite images will help to quantify and evaluate the functions of green space. On the other hand, satellite images will provide urban planners and managers with the possibility of understanding the complications of urban green spaces, and the possibility of establishing an integrated view of all green (and non-green) spaces. Large-scale urban maps prepared in connection with green space complications, especially in areas that have recently been designated as green areas, have deficiencies that need to be updated. Quick Bird image data is a very suitable and low-cost source for enriching and updating these maps from the perspective of green space complications. Also, determining the position of trees in areaswhere the density of trees is not so high is easily done using this type of image, especially the fused images make it possible to identify tree species based on spectral reflectance and the shape of the canopy, for example, pine, elm, mulberry, and plantain species can be separated well, and in the case where the tree crowns are tangled due to density, the spectral value of the fused images can be used to separate the tree crowns and determine their position. The results obtained from the research show that preparing a map and extracting the required information of green space using satellite images is cheaper and faster than other methods, and the Quick Bird image has the ability to capture the location of trees, especially in areas where the density of trees is not high. Where the crowns of the trees intersect with each other, determining the position of the tree is done with less accuracy. Finally, by using digital maps of the existing green space and processing them, it is easy to calculate the number of trees and the area of grass, therefore, the necessarydecisions can be made for the cost of green space maintenance and tree pruning, and green space contractors estimate more realistic prices for participating in green space tenders. Figure (3) is an example of construction projects carried out in the direction of urbandevelopment.

Fig 3. An example of completed construction plans

4. Conclusion

The expansion of urbanization and the city in the last few decades has caused the urbanization and the city to grow at a strange speed, as well as the cities to expand physically and swallow the agricultural lands and gardens around the city and produce many environmental effects, also, the establishment of industrial factories and... around and in the suburbs of the city have also caused environmental pollution and air pollution and the occupation of virgin land, with the increase of these pollutions, big governments thought of a solution and the issue of sustainable development was raised, the issue of sustainable development was raised with the slogan of preserving resources for future generations, and numerous researches were conducted with the titles of sustainable development in different countries, and today, measures are taken in advanced industrial countries to protect the environment, especially advanced European countries, but unfortunately, there is an unfortunate situation in third world countries, which have the highest pollution statistics in the world. Because in order to achieve sustainable development, especially in cities, modern tools must be used, in this article, we mentioned remote sensing technologies and geographic information systems in achieving sustainable urban development, in this way, today, by using remote sensing technology, we can see many environmental problems, crisis management in the event of unexpected events, the way the city has expanded over the years, the direction of the physical expansion of the city,the destruction of forests and gardens, from above with a wide view and implement correct planning, also, remote sensing images combined with geographic information system can create communication routes at the city and country level and choose the best routes. Today, even with the help of the geographic information system, we can show the social status and quality of life of the people of different neighborhoods in the city on the map and plan for them, and also determine the best place for the physical developmentof the city and determine the best place for dumping garbage, and in fact the use of this technology is very important and necessary which can overcome many problems and achieve a logical development with the slogan of sustainable development. Considering that preparing urban green space map using Quick Bird satellite image and GIS technology in urban scales is less expensive than ground mapping, and it is also possible to update the complications of digital maps quickly, it is suggested to use these images to enrich and update other complications on 1:2000 urban maps. It is also suggested to use GIS technology and form a geographic database of urban green space for better planning. Satellite data have the necessary potential to perform time series analysis and determine the trend of changes in urban green space, and by using existing satellite data, it is possible to evaluate the process of evaluating changes in urban green space during the past years.

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