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GEOGRAPHIC INFORMATION SYSTEMS (GIS) FOR SUSTAINABLE MANAGEMENT OF GREEN SPACES IN CONSTANTINE CITY (ALGERIA)

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ABSTRACT

This article highlights the importance of Geographic Information Systems (GIS) in optimising the sustainable management of green spaces in urban environments, particularly in Constantine. By digitising and analysing spatial data, GIS provides cartographic tools for better visualising, evaluating and managing the city's resources. Constantine, rich in natural and cultural potential, needs to enhance and better manage its assets, such as its green spaces, which play an essential role for both residents and the environment. The aim is to identify these resources so that they can be better managed and integrated into sustainable urban development plans. An interactive map of green spaces will be created using GIS data to facilitate this management.

KEYWORDS

GIS, Sustainability, Potential, Green Spaces, Constantine City

CITATION

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Introduction:

In today's urban context, the effective management of green spaces is essential for the well-being of city dwellers and the sustainability of the urban environment. In northeast Algeria, Constantine city is rich in natural resources, with green spaces playing a crucial social and environmental role. However, optimal management of these spaces requires modern tools for monitoring, analyzing and planning. His is where Geographic Information Systems (GIS) come in, offering innovative solutions for mapping and managing green spaces more accurately and dynamically, thanks to digitization and interactive maps. This technology not only makes it possible to visualize spatial data in real time, but also to optimize the planning and management of green spaces, thereby contributing to a better quality of life and sustainable management of natural resources (Poquet, 2022). The latter would be the concern of decision-makers, who need to identify them and assess their potential and availability, in order to define management strategies that maximize their exploitation, while preserving the environment and biodiversity and meeting the demand and needs of their citizens. To this end, the production of an interactive map covering all the green spaces in Constantine city would be an alternative, given the lack of digitized spatial data.

The map will make it easy to find the different areas, while providing information and descriptions appropriate to each area.

Problematic:

- What is the impact of using GIS to identify and manage green spaces in Constantine city?
- How can GIS be used as a decision-making tool to achieve sustainable socio-economic urban development?

Objective:

The objective of this study is to identify the assets of Constantine city in terms of green spaces in order to enhance them. This will enable decision-makers to assess their condition, consider how to maintain and strengthen them, identify weak points and rethink their integration into the various urban planning schemes. In other words, the aim is to optimize the socio-economic role of green spaces in a way that meets the needs of the city and its residents, in a context of sustainable urban development.

This study would thus serve, as a starting point for efforts to enhance the city is potential, with the aim of generalizing its results to other elements of the urban environment, in order to produce a cartographic support including all the elements that make up the wealth and overall potential of Constantine city.

Methodology:

- Materials:

The material used in this study consists of green spaces of Constantine city; specifically those located in the commune of Constantine, and only green spaces intended for recreation and frequented by citizens are taken into consideration (gardens, parks and forests). We also used satellite photos provided by Google Earth 2024, and QGis and ArcGis software to geolocate green spaces and process their data.

- Method:

In this study, we suggested a descriptive approach based on the use of Geographic Information Systems (GIS). This method makes it possible to collect, analyze and visualize geospatial data relating to the forests, parks and gardens of the Constantine city while following the following path

- Data collection: this involves gathering relevant data, including cartography, an inventory of green spaces and all the information relating to each space.
- Spatial analysis: this consists of assessing the distribution of green spaces in Constantine city and identifying the most interesting areas to use as case studies.
- Data visualization: this involves creating an interactive map to make the data accessible and understandable to decision-makers and the public.

1. Concepts and definitions :

- Geographic information system (GIS):

Geographic information systems (GIS) are tools for capturing, storing, analyzing, managing and visualizing geographic data (Deshayes & Chery, 2000).

They combine spatial information (e.g. maps) with descriptive data (e.g. attributes), making them suitable for use in a variety of fields such as urban planning, natural resource management, cartography and environmental analysis to aid decision-making by providing a detailed and integrated view of geographical data.

The application of GIS to the development of green spaces has profoundly transformed their sustainable management (Poquet, 2022) thanks to several key innovations:

- Mapping and spatial analysis: GIS makes it possible to create detailed maps of green spaces, facilitating analysis of their distribution, quality and biodiversity. This helps to identify areas that require special attention.
- Resource planning and management: using geographic data, managers can optimize the use of resources, tailoring interventions to the specific needs of each area (Farah M.I, 2024).
- Monitoring and evaluation: GIS provides tools for monitoring changes in green spaces over time, enabling the impact of sustainable management policies to be assessed and strategies adjusted accordingly.
- Citizen participation: GIS-based platforms make it easier for citizens to get involved in the management of green spaces, by enabling them to report problems and contribute to decision-making.
- Risk management: By integrating climate data, GIS helps to assess the risks associated with extreme events (flooding, drought) and to plan appropriate responses to protect green spaces.

- Interactive map:

An interactive map is a type of digital map that allows users to interact with the data it presents, 'a digital map on which the user can interact to obtain additional information depending on the elements selected or the areas explored'. (Université Laval, Department of Geography).

Unlike static maps, interactive maps allow users to zoom in, scroll, click on elements to obtain additional information, or even modify certain data. They are often used online for applications such as mapping services (e.g. Google Maps), geographic analyses and data visualizations.

- Green spaces:

Green spaces are synonymous with undeveloped urban areas, encompassing vegetation and water elements. They constitute a network of public and private spaces that cannot be built upon, serving multiple functions: agricultural or forestry production, preservation of natural heritage, education, outdoor recreation, and structuring the urban fabric from centers to peripheries (Fergani & Moumene, 2018). These public infrastructures provide city dwellers with uses related to the presence of natural elements (plants, animals, water, etc.).

2. Presentation of the area study:

Constantine, our case study, is the capital of eastern Algeria, covering an area of 2308 km² and home to more than one million inhabitants, and has undergone fairly rapid spatial and demographic change since independence. For this reason, we selected the Chief Municipality of Constantine as our spatial sample, to project our analysis of green spaces and their management using GIS (Fig.1).

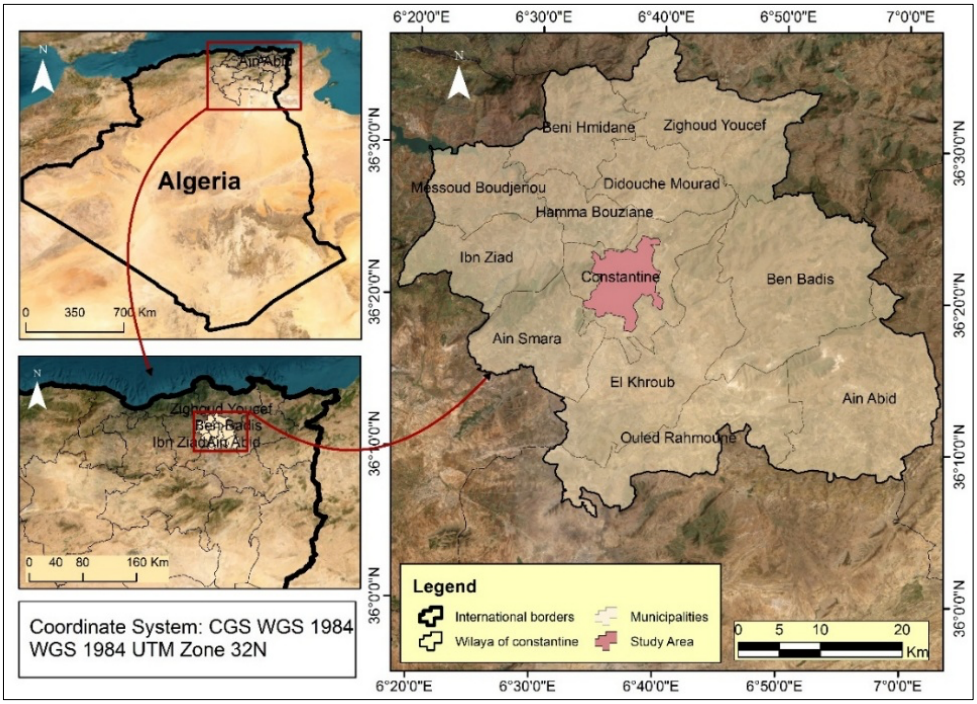

Fig.1 Geographical location of the city of Constantine
Source: Authors, 2024

3. Sampling:

Green spaces are the lungs of the urban environment, embellishing the space but also offering opportunities for social and environmental well-being. They help maintain the natural cycle of biodiversity and provide people with places to relax and enjoy recreational activities.

Constantine has a multitude of green spaces of different types that brighten up its landscape and its inhabitants; however, in this study, we are going to highlight three main categories of public green spaces focused on relaxation and renowned for their ability to welcome visitors: forests, parks and gardens. The last two are generally located in the neighborhoods of the municipality, while forests are usually located in the background of residential areas. These spaces are used by the citizens of Constantine and its visitors, putting their condition at risk of deterioration and disappearance, hence the need to consider solutions for improvement and preservation using the digitization tools that go with new global trends.

4. Inventory of green spaces in Constantine city:

Drawing up an inventory of the plant cover in the city of Constantine is an essential step in the creation of an information bank on the city's potential in terms of green spaces. The tables below present the inventory of green spaces in Constantine province as a whole and an inventory of green spaces within the perimeter of the commune of Constantine, which is our field of study (Tables 1 & 2) (Fig. 2); this is an inventory of public green spaces for recreational purposes only.

Table 1: Inventory of green spaces in Constantine province.

Type of green space	Number	Surface
Forest	9	28074 ha including 1590 ha for leisure activities
Park	2	87 ha
Public Garden	66	73.17 ha
Green space	11	13.9 ha
Crossroads and Road Support	30	92145 ml

Source: Department of the Environment of the wilaya of Constantine, 2018. Authors' processing, 2024.

Table 2: Inventory of green spaces in the municipality of Constantine

Type of green space	Number	Location	Surface
Forest	1	Djebel El Ouahch	308 ha of which 100 ha for leisure activities, including 19 ha reserved for the development of an amusement park (in progress)
Park	2	Zouaghi, Bardo	87 ha
Public garden	13	The chief municipality of Constantine	15.91 ha
Crossroads and roadside support	18	The chief municipality of Constantine	66856 ml

Source: Department of the Environment of the wilaya of Constantine, 2018. Authors' processing, 2024.

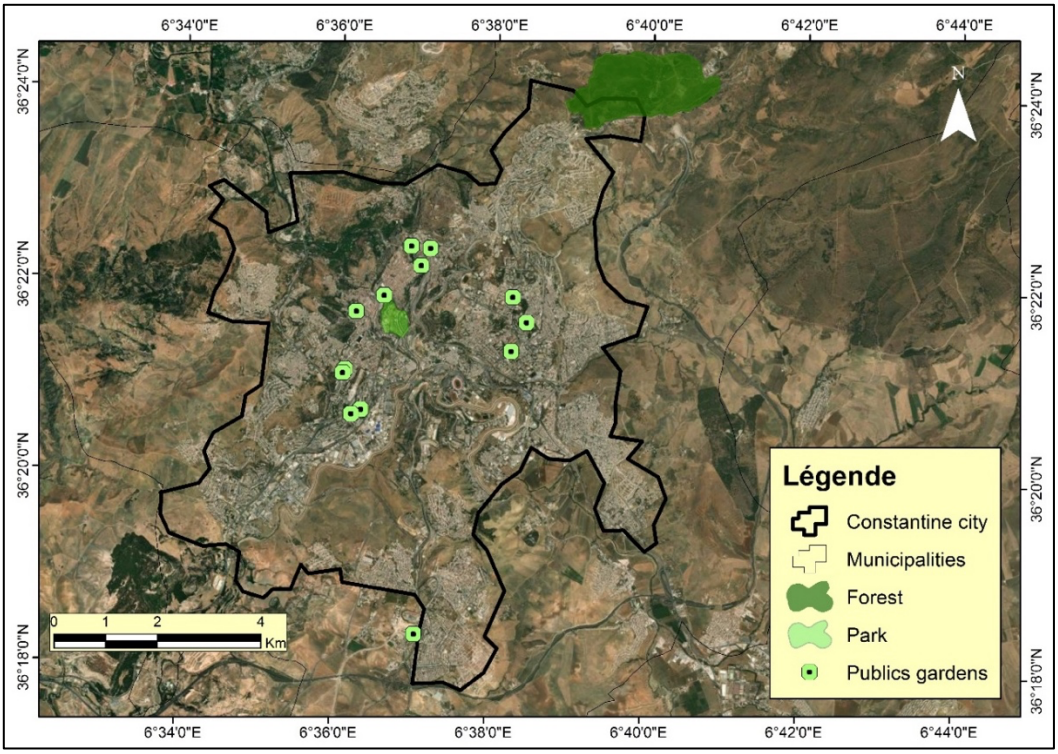

Fig.2 Location of green spaces in Constantine city
Source: Authors, 2024.

In order to provide an overview of our results, we used the "Djebel El Ouahch" forest, the "Bardo" urban park and the "Bennaceur" public garden as a prototype for the final appearance of the interactive map.

5. Results and discussion:

For our case study, we present a photographic representation illustrating the data interpretation stage using GIS (Fig. 3), and a second photographic demonstration of the interactive map, which groups together the three green spaces chosen as a sample. The resulting map allows the user to click on the selected space to obtain its geolocation, surface area, types of trees and planting, types of furniture, as well as a photo or even a video of the space (Fig. 4).

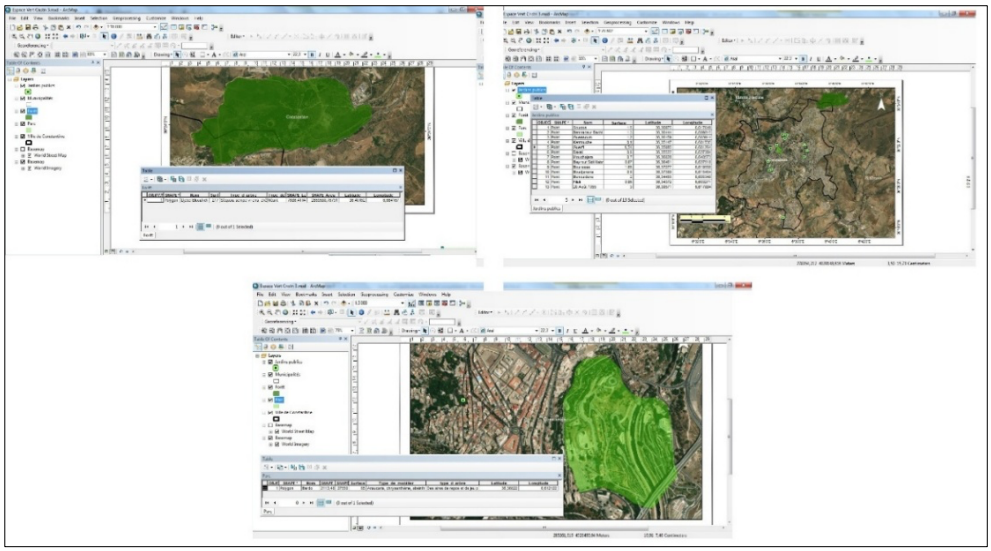

Fig.3 Interpreting data using GIS.
Source: Authors, 2024.

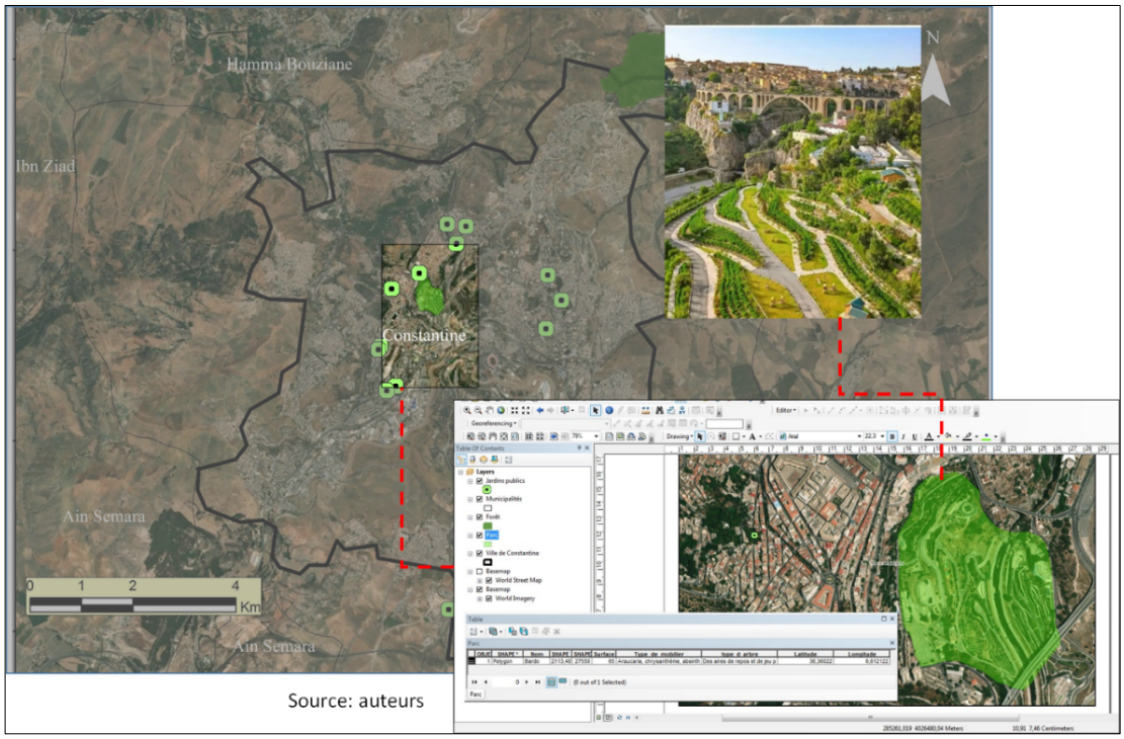

Fig.4 Sample rendering of the interactive map.
Source: Authors, 2024.

Conclusions:

Digitization through GIS is a method of preserving geospatial data in the form of a database that will serve as a protected reference document.

GIS improves the efficiency, transparency and sustainability of land management, making decision-making processes more informed and participatory.

The use of GIS in the development of green spaces in the city of Constantine enables decision-makers to direct investments, optimize the maintenance of green spaces and promote sustainable development policies.

The creation of an interactive map of the green spaces in the city of Constantine will be the subject of a digital document whose role is to:

- Make an inventory of the city's green spaces, their geolocation and their characteristics
- Create a digitized cartographic medium providing relevant data to decision-makers for better management and more intervention that is effective.
- To create a tourist guide enabling visitors to select their favorite outdoor leisure destination, optimising tourist activity and promoting the city's spatial and economic development.

In this respect, the sample selected for this study (the "Djebel El Ouahch" forest, the "Bardo" urban park and the "Bennaceur" public garden) was a guarantee of the effectiveness of the GIS, which enabled us to obtain a significant result that could improve the visibility of the green spaces in Constantine city and determine the relevant ways of enhancing them for the benefit of decision-makers.

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