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Original Article

Application of WebGIS in Managing and Monitoring Greenery in Schools: A Case Study at the Thu Dau Mot University

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Abstract: This research developed a WebGIS system for managing green spaces at the Thu Dau Mot University. The system utilizes PostgreSQL for data storage and GeoServer for spatial data sharing, enabling efficient communication of field data. The platform's user-friendly interface, combined with QGIS tools and PostGIS/PostgreSQL, allows for easy data visualization and management, even for users without GIS expertise. This cost-effective solution facilitates quick information sharing, fosters a shared understanding of the data, and enables more efficient and sustainable management of the university's green spaces.

Keywords: WebGIS, GIS, PostGIS/PostgreSQL, GeoServer, trees.

1. Introduction

Trees are an element that creates urban appearance and life. In many cases, citizens' pride in their city is not economic growth or high-rise buildings, but greenery. More and more people are discovering other values of trees in all biological, technical, economic and socio-cultural aspects. Equipping surrounding trees not only helps beautify the urban environment, increase aesthetics, reduce the rough beauty of architecture, the diverse shapes and colors of flowers and leaves create vivid harmony. in the landscape [1]. Trees also have the ability to absorb polluted gases and provide oxygen in the air, creating a fresh and clean environment for residents. However, the management of green spaces still faces several challenges, such as a lack of accurate information, difficulties in monitoring, and insufficient coordination between government agencies and the community [2].

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In this context, WebGIS enhances decision-making and resource management by providing real-time spatial data and visualizations, crucial for effective environmental and urban planning. Because traditional investigation, statistics and management work has not brought results, it is often costly and does not meet set requirements [3-5]. A key feature of the WebGIS platform is its ability to empower citizens to actively contribute to green infrastructure management. This citizen-driven approach not only enhances the accuracy and timeliness of data but also strengthens the relationship between the public and public administration [6].

In recent years, the geographic information system (or GIS) combined with the network development platform to form WebGIS has been demonstrated and widely applied in WebGIS applications in administrative data management [7], look up land use planning information [8] or support finding a accommodation [9]. GIS serves as an effective tool to convert real data into digital data, facilitating easier management and decision making. In addition, the ability to combine GIS and the Internet increases the utility called WebGIS. The application of WebGIS has become a popular method with many advantages, allowing users to share, edit and manipulate data online, creating effective connections between stakeholders.

From the above reasons, the author formed the topic: "Application of WebGIS in Managing and Monitoring Greenery in Schools: A Case Study at Thu Dau Mot University" to improve tree management and data storage using WebGIS. is a necessary choice, a practical orientation that does not require much experience for users, making use easy and effective in the long term in the area.

2. Data and Methods

2.1. Data Collection

Spatial data includes: points of green objects, facilities (Polygon), local road (Line).

Attribute data: coordinates (X, Y), height, diameter, circumference and ecological characteristics information.

2.2. Methods of Implementation

Below Figure 1 showing the high-level architecture and components of the WebGIS system for green tree management at Thu Dau Mot University.

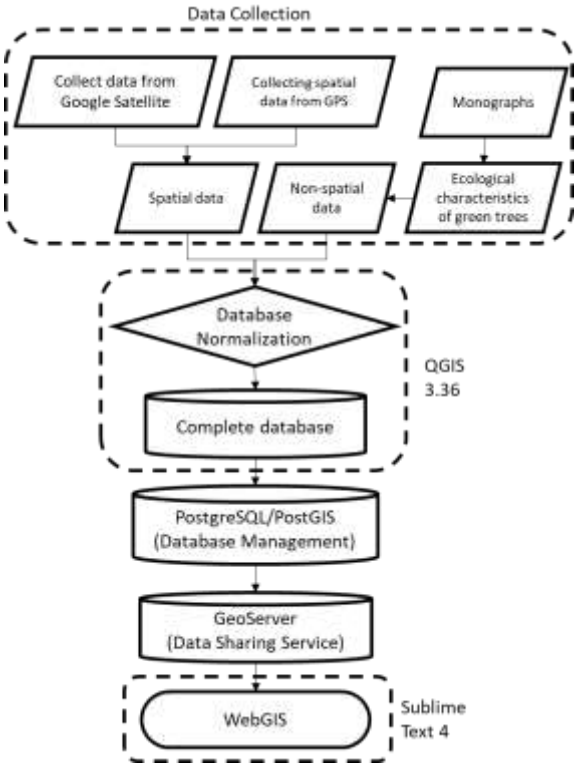

Figure 1. Implementation process.

Research method: The process of building and designing WebGIS is specifically described through the following stages:

Collect data: First of all, it is necessary to collect the necessary data to build the WebGIS system. Including collecting spatial data from Google Satellite to have information about the Thu Dau Mot University area. In addition, it is necessary to use GPS to determine the location of each field green object on campus. At the same time, collect non-spatial data from

monographs to learn about the ecological characteristics and scientific names of plants.

Standardize the database: After collecting data, use QGIS software to standardize and transform the collected data into a complete database. During this process, spatial data processing is carried out, assigning attributes and determining the exact location of green tree objects on the map.

Database management: Next, use PostGIS/PostgreSQL to manage the database. PostgreSQL is a powerful relational database management system, while PostGIS is an extension of PostgreSQL that supports storing and querying spatial data. Create a tree data table, define attribute fields and relationships between them to store tree information effectively.

Data sharing: To share tree data, use GeoServer. GeoServer is a spatial data server that allows creating, managing, and sharing spatial data via a web interface or API. Create GeoServer configuration to provide access and interoperability with tree data.

Interface design: Finally, use a code editor with Sublime Text software or similar tool to design the interface for the WebGIS system. By creating pages that display, search, and interact with tree data, user-friendly interfaces and intuitive interactions are ensured.

2.2.1. Field Methods

The field data collection is conducted by manually measuring and recording the ecological characteristics of the trees within Thu Dau Mot University. This includes:

- Measuring the height of the trees;
- Measuring the diameter of the tree trunks;
- Determining the tree density;
- Calculating the tree canopy area.

The field data objects about the individual trees are collected across the university campus. This field-based approach allows for understanding the general condition and distribution of the existing tree population.

In addition, collect additional data on school buildings to form the base layer for the map

2.2.2. Methods of Collecting Data and Figures

Based on the data collected from the field method, select and classify the components needed for the research content to establish a statistical table, fully displaying the information fields. In addition to actual data, the research also exploits public and public information such as introduction page, address, phone number, email, ... of Thu Dau Mot University. Ecological information including genus, species, order, family, etc and origin related to trees is collected from monographs on tree species. In addition to synthesizing general knowledge, related dissertations and reports serve to provide a foundation for implementing the topic.

2.2.3. Spatial Analysis Methods and Map Editor

Spatial analysis and map editing are two important methods in processing spatial and non-spatial data using software such as QGIS. In this method, QGIS will be the software that plays an important role in performing analysis, editing symbols, changing the style and color of tree objects, rows of houses and rows of buildings after digitization.

2.2.4. Analytical Methods Using GIS and Technology WebGIS Building Tool

During the process of implementing the research, the author applied QGIS software to analyze digitized data and edit maps for objects into tree groups to form a complete database source. In addition, the research uses additional tools such as Sublime Text, PostGIS/PostgreSQL and GeoServer to serve the construction of WebGIS.

For the Sublime Text tool, it is a software for editing code, source code and hypertext forms (.html, .js, .php, .css,...). With the ability to support administrators in many programming languages, write code and edit source code for WebGIS applications.

PostGIS/PostgreSQL allows administrators to create and manage data tables. Can perform queries, extract information from the database, such as searching for trees in a specific area or calculating the area of trees in a specified area.

The database has been standardized and managed with PostGIS/PostgreSQL, GeoServer can be used to share spatial data of tree objects, house rows, and school rows based on the network platform. GeoServer is an open source spatial data server that allows publishing and sharing of spatial data via a web interface or API.

3. Results

3.1. Analyze and Standardize Object Data

The data of each tree object within the area is collected in the field and the results are recorded with the support of Excel. The data is presented in tabular format above, and needs to be converted to Comma Delimited ".csv" format for adding data to QGIS software. Proceed to edit the map, choose colors, format and export the ".geojson" file into groups of trees.

Proceed to use PostGIS/PostgreSQL for storage. For text columns, the Text format is required, the integer data column is Integer format, and the decimal data column is Double precision. The data is divided into specific columns as follows:

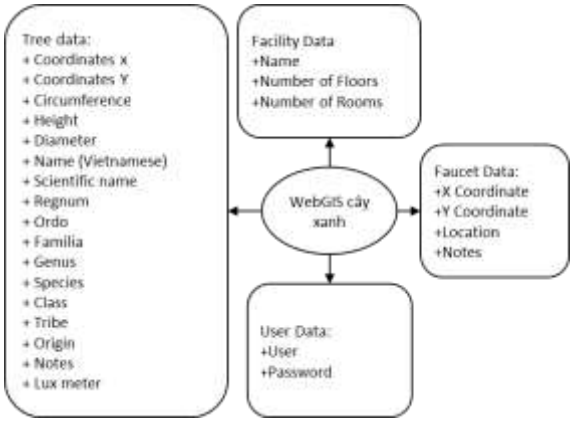

Figure 2. Diagram of WebGIS data.

Table 1. Data description

No	Name	Datatypes	Describe
1	id	Integer	Numerical order
2	geom	Geometry(PointZ,4326)	Spatial data type is enabled
3	toadox	Double precision	Coordinates X
3	toadoy	Double precision	Coordinate Y
4	perimeter	Double precision	Perimeter of green tree object
5	height	Double precision	Height of relative
6	diameter	Double precision	Diameter of the object
7	tenvn	Text	Vietnamese name of green tree object
8	tenkh	Text	Scientific name of green tree object
9	gioi	Text	Regnum of the green tree object
10	bo	Text	Ordo of green tree objects
11	ho	Text	Familia of the green tree object
12	chi	Text	Genus of green tree object
13	loai	Text	Species of green tree object
14	lop	Text	Class of the green tree object
15	tong	Text	Tribe of the green tree object
16	nx	Text	Origin and origin of green tree objects
17	ghichu	Text	Notes
18	lux_meter	Integer	Light intensity under the tree canopy

Table 2. Description of facility data

No	Name	Datatypes	Describe
1	id	Integer	Numerical order
2	geom	Geometry (PointZ,4326)	Spatial data type is enabled
3	name	Integer	Names of buildings and classrooms
4	sltang	Integer	Number of floors of the building or classroom
5	slphong	Integer	Number of rooms in the building or classroom

3.2. WebGIS System Function Division

WebGIS site is divided into two groups: users and guests. The highest level is the administrator, responsible for maintaining and restoring data, managing all activities when operating the WebGIS website, and fix errors within the system. Receive, approve and contact and respond to users if necessary.

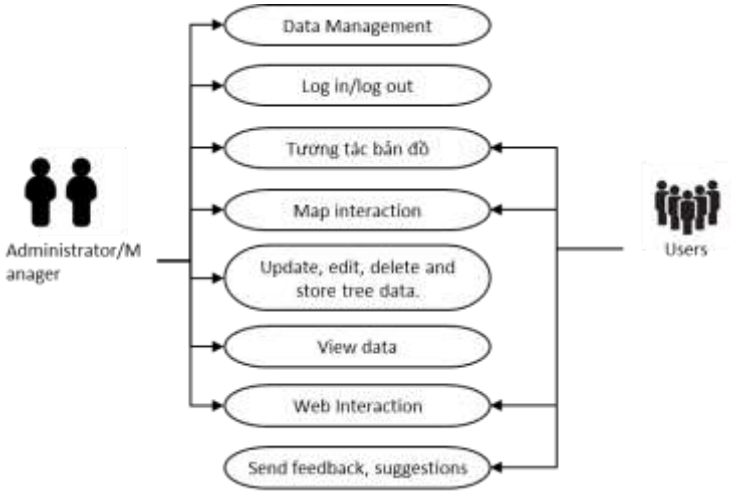

Figure 3. System function division diagram.

The administrator has the authority to activate accounts and assign permissions to users. Activated accounts will have access to the WebGIS system solely for viewing information and data layers if they have not been granted specific permissions. The permissions for actions within the system include: add new data, delete data, edit data.

3.3. Describe the Functions of the WebGIS Site

Zoom the map: The user clicks on the Zoom in command button or Zoom out button, or rolls the mouse to zoom the map to the specified place.

Displaying data: When clicking on any green tree object, the WebGIS system will automatically return a dialog box containing the data of the selected object.

Search query: When searching for any tree name (Vietnamese) or scientific name, the system will return results from the database to the user.

Distance Measurement Tool (km) : Measures distances between points, useful for assessing spatial relationships.

Area Measurement Tool (km^2) : Calculates the area of specific regions, aiding in understanding the scale of green spaces.

View Information of Objects on the Map : Users can access general information about objects directly on the map for quick insights.

Locate the user : the WebGIS system will automatically determine the location with the user's permission.

Display Layers : The background layers displayed are divided into two groups including the background data group from Google and OpenStreetMap, the remaining is the group of green objects.

3.4. Complete the Interface of the Tree Management WebGIS Page

The site structure of Web.GIS website content is shown in Figure 5.

Figure 4. Properties display dialog box.

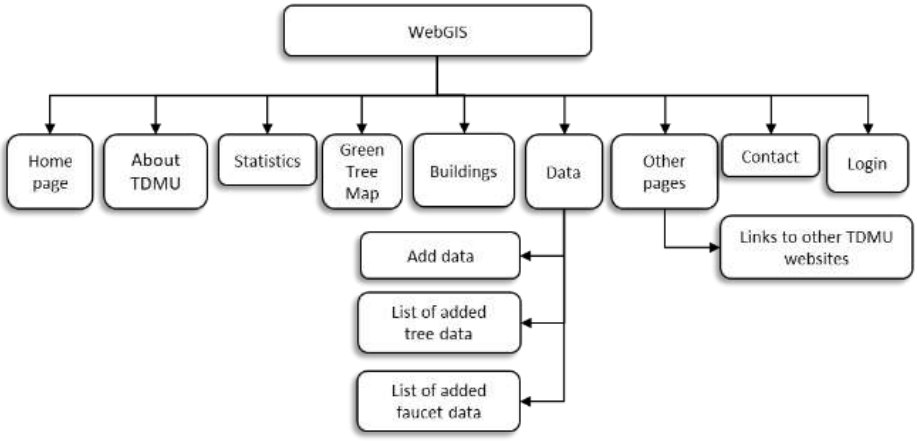

Figure 5. WebGIS site structure.

Figure 6. Home page interface.

Home page: The content of the main page includes brief introductions to the methods applied when designing and building the WebGIS website (Figure 6).

Statistics page: Mainly shows the detailed quantity of existing green plants that the research has collected throughout Thu Dau Mot University, and is also classified according to the percentage of green plants provided. umbrage. Besides, the WebGIS site provides some representative images for each type of tree.

Tree map page: Displays spatial location on Google Sattlite and OpenStreet platforms, Layers are grouped. The WebGIS website also provides additional keyword search functions by tree name (Vietnamese) and scientific name in the database from PostgreSQL collected below the map, and returns the search results. next to (Figure 7).

Facilities page: The facilities page interface mainly shows the classrooms and buildings of Thu Dau Mot University on the base layer of Google Sattlite and OpenStreetMap, and also provides recorded field images. receive (Figure 7).

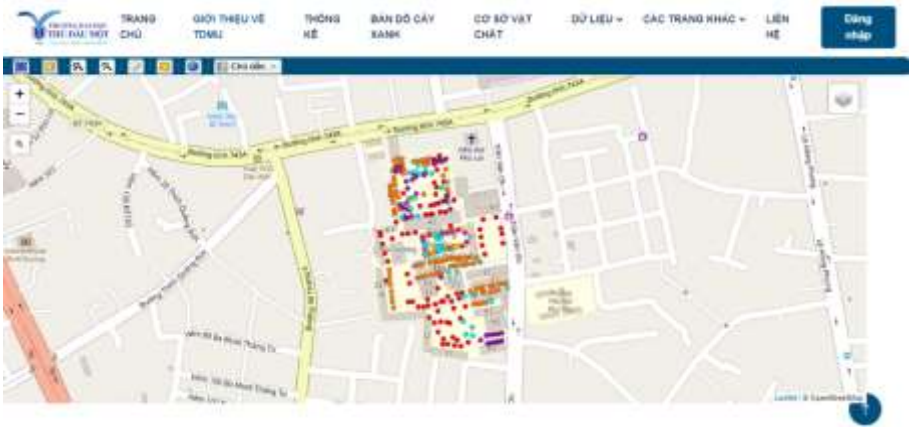

Figure 7. Webgis map interface of green trees and facilities in the research area.

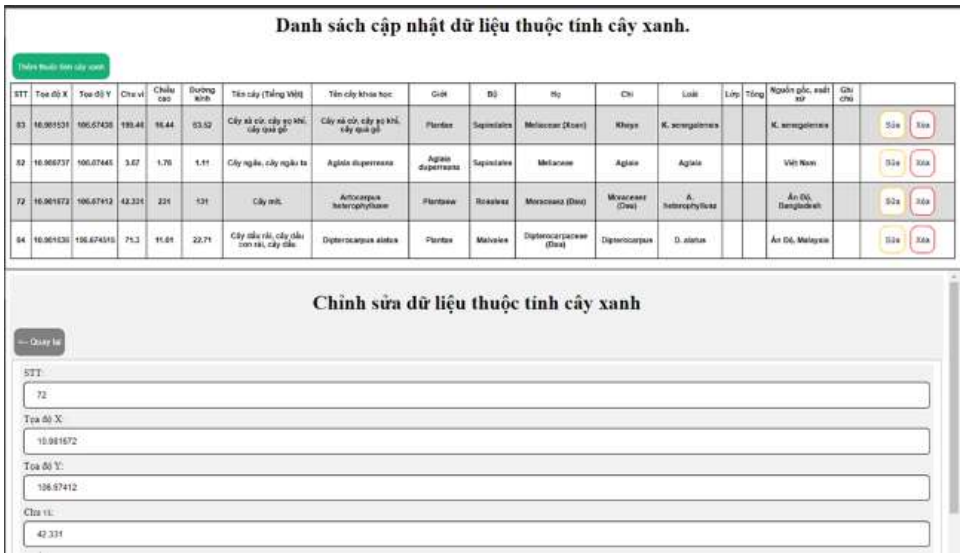

Figure 8. List and data editing interface.

Contact page: Mainly displays contact information and a few words of thanks to users who have experienced the WebGIS website.

Add data page: Add data function includes tree and sprinkler data. After adding data, it is saved directly into PostgreSQL.

The WebGIS page provides an additional page with a list of added data and can be corrected online when incorrect information is entered by clicking the “Edit” button to lead to the edit page to update incorrect information. At the same time, you can completely delete the added data line with the "Delete" button. For faucet data, the same operations are designed and performed.

4. Conclusion

The research has successfully built and designed a WebGIS system that displays a database of green tree objects and stores new data in PostgreSQL. The flexible coordination of QGIS tools with PostGIS/PostgreSQL and GeoServer has enabled more effective communication of field data information.

This approach allows users to utilize the system's functions without requiring in-depth knowledge of GIS. Integrating multiple layers of data enables users to visualize the relationships between trees, infrastructure, and campus facilities effectively. Additionally, the real-time data management capabilities of the system contribute to improved decision-making regarding the management of green spaces, allowing for timely responses to environmental changes and maintenance needs.

This makes it a cost-effective solution for the university's green space management needs. This approach has enhanced the university's ability to manage and monitor its green spaces more efficiently and sustainably.

Acknowledgements

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