WEB VISUALIZATION AND SPATIAL ANALYSIS OF TREE SPECIES DISTRIBUTION AT UNIVERSITY OF THE PHILIPPINES DILIMAN ACADEMIC OVAL

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ABSTRACT:

Understanding the distribution of tree species is crucial for ecological comprehension and effective conservation strategies. This research presents a web-based platform aimed at visually representing the trees found at the University of the Philippines Diliman campus. Open-source geospatial tools such as OpenStreetMap, KoboToolbox, Pl@ntNet, JOSM, uMap, and QGIS were employed for data visualization, collection, analysis, validation, and spatial pattern assessment. Through these tools, a total of 11 tree species were identified, with acacia emerging as the dominant species, especially concentrated along the academic oval. The application of Kernel Density Estimation (HeatMap) in QGIS revealed these spatial distribution patterns. The findings contribute to the effective management, conservation, and restoration of the campus' green spaces, shedding light on the significance of trees in urban ecosystems. The online interactive map developed serves as a valuable tool for improving management and conservation strategies. Importantly, the study assesses the effectiveness of open-source tools, showcasing their versatility and comparable capabilities to proprietary alternatives in geospatial applications.

1. INTRODUCTION

Understanding the distribution of tree species is essential for gaining insights into ecological patterns and implementing effective conservation strategies. With this objective in mind, our research proposes the development of a web-based platform that will visually represent the trees found on the campus. This platform will feature an interactive map integrated into a dedicated website.

One of the primary goals of our study is to address the absence of a centralized, open geodatabase containing information about the campus' trees. Additionally, we aim to map the distribution of tree species across the campus and analyze their spatial patterns, as no prior research has been conducted in this area. To accomplish this, we will utilize open geospatial tools such as OpenStreetMap, which will allow us to visualize a wide range of geopoints representing the trees. Furthermore, we will leverage Quantum Geographic Information System (QGIS) for spatial analysis, including calculating feature statistics, performing geoprocessing tasks such as data interpolation, and analyzing the distribution patterns of trees.

Originally, our study intended to encompass the entire University of the Philippines Diliman campus. However, due to time constraints, we have decided to focus our pilot study exclusively on the academic oval. The academic oval, also known as the Sunken Garden, spans approximately 13.0 hectares and is surrounded by key university buildings: Gonzalez Hall (University Library) to the west, Malcolm Hall (College of Law) to the north, Vinzons Hall and the Virata School of Business (formerly known as College of Business Administration) to the east, and Benitez Hall (College of Education) to the south (Iskomunidad, UP Diliman, 2013).

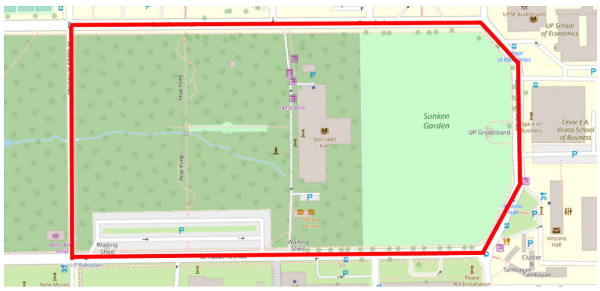

Figure 1. UP Diliman Academic Oval

The outcomes of our study will contribute to the effective management, conservation, and restoration of the campus' green spaces. Our aim is to raise awareness and foster a deeper appreciation for the importance of trees in urban ecosystems. To achieve this, we will develop an online interactive map that will be accessible to all users. This map will serve as an informative tool for enhancing management and conservation strategies concerning the campus' natural resources. Furthermore, our research will provide a web-based platform that visually showcases and provides information about the trees through various maps. Users will have the ability to filter and manipulate different data to explore the diverse tree species present.

The objectives of this study are to establish a centralized, open geodatabase containing information about the existing trees on the campus, map the distribution of tree species across the campus, and identify the spatial distribution patterns for each species.

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2. METHODOLOGY

In this research study, we advocate the utilization of open-source technologies and emphasize the openness of our data, which will be made available to the general public. Approximately 88% of the tools employed in this study are open-source, as elaborated below:

2.1 Pl@ntNet (Open Source)

Pl@ntNet is a plant identification tool that operates on both Android and iOS platforms. It is a free and open-source application with a global network of plant enthusiasts. By capturing an image of a plant, the app provides suggestions regarding its identity, ranked by percentages. Pl@ntNet utilizes a vast collection of community-contributed plant pictures as its prediction model.

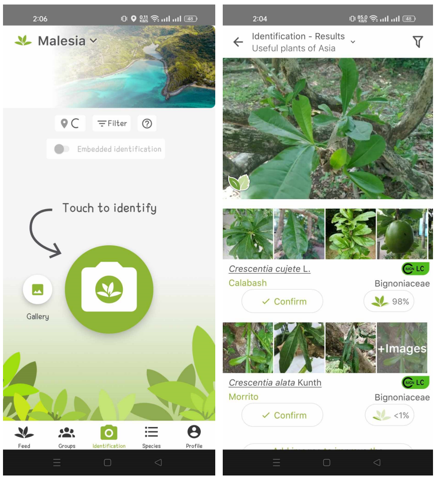

Figure 2. Pl@ntNet Interface using an Android Device

2.2 KoboToolBox and KoboCollect (Open Source)

KoboToolbox is a platform built on open-source principles, designed to facilitate data collection, management, and analysis. It allows users to create customizable digital surveys, collect data offline using Android devices through the KoBoCollect mobile application, and visualize real-time data. KoboToolbox prioritizes data privacy and security, empowering organizations to gather accurate information and make informed decisions.

2.3 Java OpenStreetMap (Open Source)

JOSM (Java OpenStreetMap Editor) is a robust desktop application utilized for editing and contributing to the OpenStreetMap (OSM) project. It provides advanced features and tools for creating, modifying, and analyzing map data. JOSM allows offline downloading and editing of OSM data, making it convenient for areas with limited internet access. Its user-friendly interface offers extensive editing capabilities, including adding and modifying map elements, applying tags, and ensuring data quality. JOSM is widely recognized and highly regarded within the OSM community as a comprehensive and flexible mapping tool.

2.4 uMap (Open Source)

uMap is an open-source web mapping tool that allows users to create interactive maps with customized data and layers. It offers a user-friendly interface for adding markers, lines, polygons, and other map elements. uMap supports various data formats, enabling users to import and visualize their geospatial data. Additionally, it provides customization options for map styles, pop-up windows, and user interactions. uMap is commonly used by individuals, organizations, and communities for developing and sharing interactive maps for various purposes, including data visualization, highlighting points of interest, and collaborating on mapping projects. It operates on the Leaflet and Django frameworks.

2.5 QGIS (Open Source)

QGIS (Quantum GIS) is a powerful and user-friendly open-source Geographic Information System (GIS) software. It facilitates the visualization, analysis, and management of geospatial data. QGIS supports a wide range of data formats and provides advanced tools for data editing, geoprocessing, spatial analysis, and map production. It offers comprehensive features for creating thematic maps, conducting spatial queries, performing georeferencing, and integrating data from multiple sources. QGIS is widely used in fields such as environmental science, urban planning, agriculture, and natural resource management, making it a popular choice among both novice and experienced GIS users.

2.6 Google Sites (NOT Open Source)

Google Sites is a web-based tool provided by Google that allows users to create and publish websites without requiring advanced technical skills. It offers a simple drag-and-drop interface, facilitating the design and customization of web pages. Google Sites provides a variety of templates and themes for creating visually appealing websites.

In this research study, we started from scratch due to the limited availability of tree data on platforms such as OpenStreetMap and other open-source platforms. The workflow of our study is depicted in the diagram below.

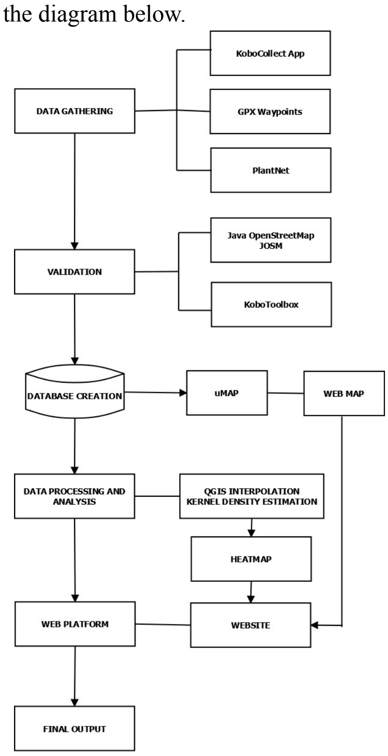

Figure 3. Diagram of General Workflow

This contribution has been peer-reviewed.

The research study comprises five major phases, as outlined in the diagram:

1. Data collection phase
2. Data validation phase
3. Database creation
4. Data processing and analysis
5. Web platform creation

During the data collection phase, we utilized a combination of tools to gather and analyze information. Our main tool of choice was the KoboCollect application, which allowed us to create customized digital surveys and efficiently collect data using Android devices in the field. To ensure accurate location mapping, we incorporated GPX Waypoints to capture geospatial data. Furthermore, we employed the PlantNet app to assist with plant identification and gather botanical data. Together, these tools offered a comprehensive and dependable approach to collecting and analyzing data for our study.

For data collected using KoboCollect, the following data model was used:

- tag: natural=tree
- name/genus
- leaf type: broadleaved or needle leaved
- denotation: urban or avenue
- address: Quezon City
- source: survey
- location: latitude, longitude
- picture

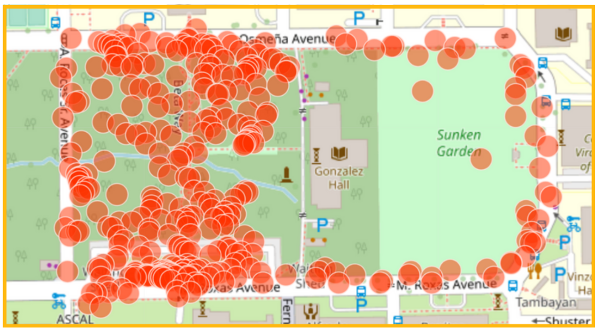

Figure 4. Visualization of Points Collected via KoboCollect

The data collection dates and the number of points collected are as follows:

Dates of Collection	Number of Points Collected
May 28, 2023	197
June 4, 2023	149
Total Points Collected	346

Table 1. Data Collection Stats

During the Data Validation Phase, we implemented two essential tools to ensure the accuracy and quality of our collected data. The Java OpenStreetMap (JOSM) software played a crucial role in thoroughly reviewing and validating the geospatial data we collected, ensuring adherence to desired standards and accuracy. Additionally, KoboToolBox facilitated the validation of the remaining survey data, enabling cross-referencing and verification of responses to ensure data integrity. By leveraging these tools, we significantly enhanced the reliability and credibility of our research findings by validating and authenticating the collected data. On June 6, 2023, we performed data checking via GPS and overlaid the resulting points with the previous data collected via KoboCollect to rectify any topological errors.

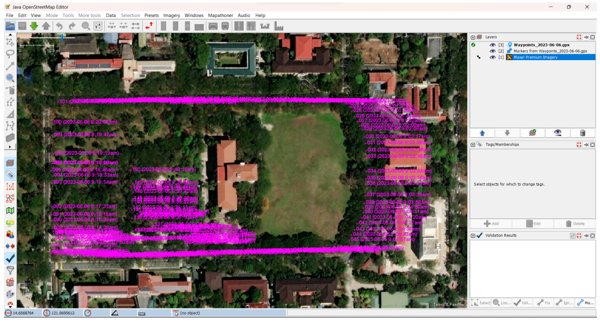

Figure 5. GPX points collected using Garmin handheld 64x

The Database Creation phase involved utilizing uMap, a versatile web mapping tool, to develop an interactive and visually appealing database. Through uMap, we were able to import and visualize our geospatial data, creating interactive maps with customized layers and markers representing key data points. This approach allowed us to effectively organize and present our research findings in a user-friendly and accessible manner, enhancing the overall understanding and analysis of the study's data. The database we created is freely downloadable through this platform.

In the Data Processing and Analysis phase, we utilized QGIS software, specifically the Kernel Density Estimation (HeatMap) tool, to analyze and visualize the density of our collected data points. This tool enabled us to identify and map areas of high concentration and intensity, providing valuable insights into the spatial patterns and distribution of our research variables. By leveraging QGIS Kernel Density Estimation, we uncovered significant trends and patterns in the data, enabling us to draw meaningful conclusions and make informed decisions based on the results of our analysis.

Lastly, during the Web Platform Creation phase, we leveraged the user-friendly and versatile Google Sites tool to design and develop an engaging and informative website. Google Sites offered a range of templates and customization options, enabling us to create a visually appealing and accessible platform to showcase our research findings. Through Google Sites, we successfully built a professional and intuitive web presence that effectively communicated the study's objectives, methodology, and key results to a wider audience.

3. RESULTS AND DISCUSSION

In total, we have identified 11 different tree species during our ground collection efforts. These species include acacia, mahogany, guyabano, cotton tree, dao tree, gmelina, banana tree, caimito, kawayan, balete, and narra. Through the analysis conducted using QGIS K-density estimation, we determined the dominant tree species within the study area.

Name of Species	Count
Acacia	145
Balete	1
Banana	1
Mahogany	92
Guyabano	2
Cotton Tree	7
Gmelina	15
Dao Tree	23
Caimito	20
Kawayan	5
Narra	21
TOTAL	332

Table 2. Tree species distribution and tree count

Our analyses revealed that the most prevalent tree species in the study area is acacia, which is primarily concentrated along the perimeter of the academic oval. Following acacia, mahogany was found to be the dominant species in the southern part of the academic oval. The remaining tree species exhibit isolated occurrences throughout the study area, indicating their scattered presence.

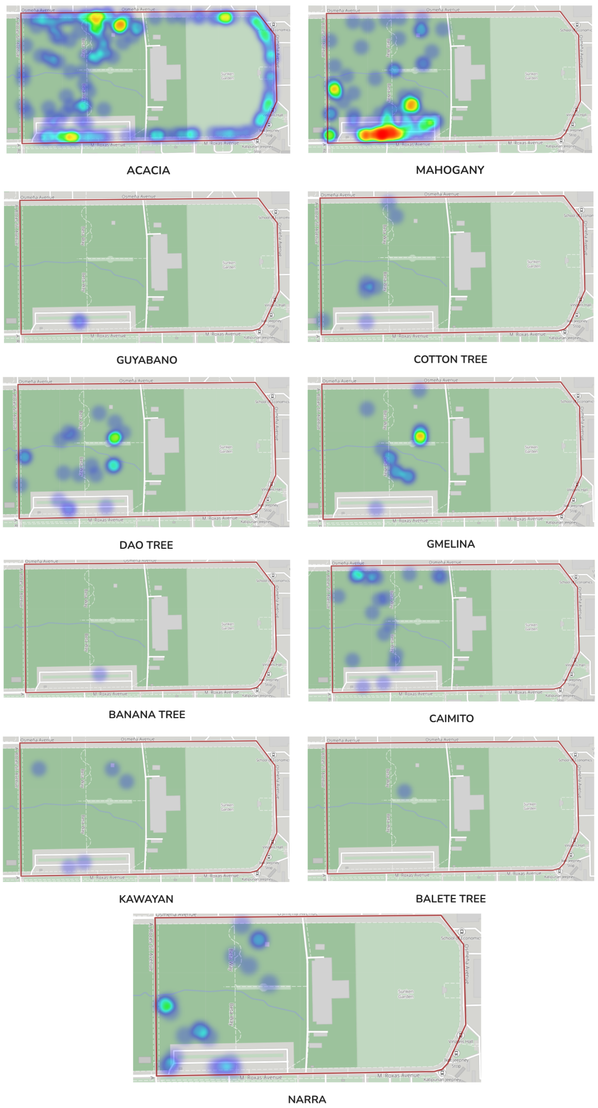

Figure 6. Heatmaps of the different tree species along the Academic Oval

Our website is now accessible and can be visited via the following link: http://bit.ly/updtrees. By accessing this website, you will have the opportunity to explore our tree map and delve into the analyses of various tree species.

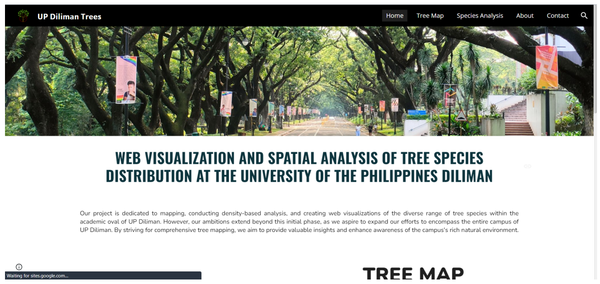

Figure 7. User interface of our website

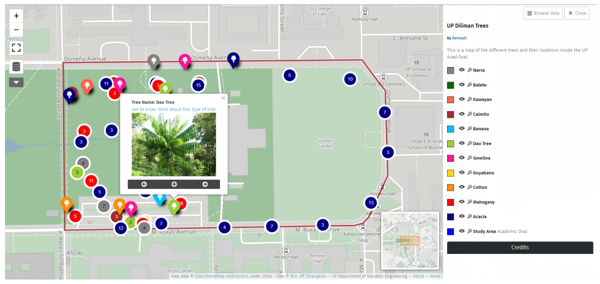

Figure 8. Tree map interface via uMap

4. CONCLUSION

Based on the findings and discussions presented in our research, it was observed that acacias emerged as the dominant tree species, comprising a total of 145 individuals. The prominence of acacias can be attributed to their historical significance as they were among the first trees to be planted during the early years of Spanish rule. These trees were initially introduced following the transfer of UP to Diliman in the late 1940s. Notably, their successful establishment required the removal of hard adobe grounds through blasting, enabling them to take root and exhibit rapid and robust growth. As a result, acacias now hold a prominent position within the academic oval, providing vital shade in areas that were once covered by grassland.

The effectiveness of the open-source tools utilized in this research was evaluated based on their ability to seamlessly integrate and provide essential functionalities. Pl@ntNet and KoboCollect facilitated efficient data collection in the field. JOSM enabled precise data validation, ensuring data accuracy. QGIS proved instrumental in generating insightful spatial analyses. uMap and Google Sites were effective in creating a visually appealing and interactive platform for showcasing the research results.

Our study demonstrates that open-source geospatial tools are robust and versatile, providing comparable functionalities to proprietary alternatives. The successful implementation of these tools showcases their effectiveness in aiding ecological research and conservation efforts. The insights gained from this study contribute to informed decision-making and serve as a foundation for future studies aimed at enhancing urban ecosystem conservation.

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