# *Roots of Resilience: Leveraging GIS and Python to Map Campus Biodiversity Hotspots*

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**Abstract — This paper presents an innovative methodology for tree data analysis, utilizing a cohesive integration of Jupyter Python, Folium, and additional analytical tools. By systematically gathering and processing data on tree coordinates, common names, and botanical classifications, this study provides a refined perspective on tree distribution and species diversity within the study area. The analysis focuses on spatial patterns, ecological significance, and environmental impacts of trees within urban landscapes, contributing to a deeper understanding of biodiversity and sustainability. Our approach integrates spatial analysis, dynamic data visualization, and advanced statistical techniques to assess tree species distribution across different campuses. We collected accurate geographic data on tree locations using handheld GPS devices, which were then processed and visualized using Python libraries. Folium was employed to create interactive maps highlighting areas of high biodiversity that require further conservation efforts. The significance of this research lies in its contributions to urban planning, biodiversity conservation, and environmental management. The data-driven approach offers insights into optimizing green spaces in urban settings, helping policymakers develop sustainable development strategies that prioritize ecological integrity. By focusing on trees as critical components of urban ecosystems, the study emphasizes their role in mitigating urban heat islands, enhancing air quality, and promoting mental health and well-being. Ultimately, this paper demonstrates how integrating interdisciplinary tools and ecological research can support more resilient and environmentally harmonious urban landscapes, contributing to broader global efforts in sustainable urban development.**

***Keywords— Tree Analysis, Jupyter Notebook, Python, Pandas, Matplotlib, Folium, Spatial Analysis, Data Visualization, Urban Planning, Biodiversity Conservation.***

## I. INTRODUCTION

Trees are vital to ecological balance, serving as key components in sustaining biodiversity, regulating climate, and enhancing human well-being. Their role extends beyond providing oxygen; they contribute to air purification, carbon sequestration, soil stabilization, and water cycle regulation [1]. Within urban settings, trees mitigate the urban heat island effect, promote mental health, and foster social cohesion by providing green spaces [2]. Given these extensive benefits, understanding tree populations through tree analysis is crucial for informed environmental management and urban planning [3].

This study focuses on a detailed tree analysis conducted within the campus areas of Patrician College of Arts and Science, St. Patrick's School, St. Patrick's ICSE School, St. Michael's School, and the Children's Block. These educational institutions are located within a shared green space, offering a unique opportunity to assess environmental health and biodiversity in an urban environment. Over three months, our team collected extensive data, documenting tree species, geographic coordinates, and population counts across these locations. The primary objective was to analyze tree distribution, density, and species diversity to evaluate the overall environmental health and sustainability of the area.

The methodology involved integrating Geographic Information Systems (GIS) tools and Python libraries such as Pandas, Matplotlib, and Folium [4]. The data collection process began with mapping tree coordinates using handheld GPS devices, followed by categorizing tree species based on botanical classifications. Tree analysis software helped in generating visual outputs, such as heat maps and spatial plots, which enabled us to identify areas with high biodiversity and assess the distribution patterns of tree populations [5].

The significance of this analysis lies in its potential contributions to urban planning and biodiversity conservation efforts. With rapid urbanization leading to green space reduction, studies like this provide valuable insights into optimizing land use without compromising ecological integrity. Furthermore, our findings could assist policymakers in creating sustainable development strategies, particularly in maintaining biodiversity corridors and enhancing green cover within educational campuses [6]. The data-driven approach adopted in this study also underscores the importance of leveraging technology to enhance our understanding of environmental phenomena.

The outcomes of this tree analysis align with broader global efforts focused on preserving urban biodiversity and enhancing climate resilience. In particular, educational institutions are increasingly recognizing the role they play as biodiversity hotspots, which serve as living laboratories for students and researchers alike [7]. By nurturing diverse tree populations, campuses can contribute to local biodiversity conservation, promote environmental education, and provide healthier, more vibrant spaces for learning. This analysis highlights the importance of trees in maintaining ecological balance while demonstrating how technological tools can be applied to monitor and preserve biodiversity in urban settings. The integration of data visualization, spatial analysis, and advanced computational tools allows for a more nuanced understanding of tree populations, leading to better-informed decisions regarding environmental stewardship and urban development. These insights can help identify areas in need of conservation efforts or guide strategic planning for future green spaces.

## II. MATERIALS & METHODS

### *A. List of Materials Used in Experiments*

Our tree analysis project involved various materials and equipment designed to ensure accurate data collection and comprehensive analysis. The following is a list of materials used:

- **Smart Phone**: This is for precise location mapping of trees across the campus.
- **Botanical Reference Guides:** Used for accurate species identification based on tree morphology [9].
- **Measuring Tapes and Diameter Tapes:** Utilized to measure tree height, and canopy spread [10].
- **Data Recording Sheets:** These record tree characteristics such as species, age, health status, and geographic coordinates [11].
- **Tree Tags/Markers:** Temporary tags for marking trees during the survey [13].
- **Field Notebooks:** These annotate observations and supplementary notes during field visits [14].

### *B. Step-by-Step Procedure*

The data collection and analysis process spanned three months and involved a combination of fieldwork, data processing, and spatial analysis. Below is the detailed procedure:

1. ***Planning and Site Preparation:***
    - Initial planning meetings were held to divide the campus into different zones: Patrician College of Arts and Science, St. Patrick's School, St. Patrick's ICSE School, St. Michael's School, and the Children's Block. [15].
    - Maps of the campus were reviewed to determine areas of focus, particularly regions with dense tree cover [16].
2. ***Preliminary Survey and Marking:***
    - Teams walked through each zone to identify tree clusters, high-density areas, and other significant features. Trees were marked with temporary tags for systematic documentation [17].
    - Mobile was calibrated, and test data points were collected to ensure accuracy [18].
3. ***Data Collection:***
    - Each tree was cataloged with the following data: species, health status (assessed based on visual indicators such as leaf colour, bark texture, and signs of disease), and location (coordinates captured using Mobile) [11][12].
    - Botanical reference guides were consulted to confirm species identification based on leaves, bark, and overall morphology [9]. [26].
    - Photographs of each tree were captured, providing visual support for subsequent analysis [12].
4. ***Data Organization and Entry:***
    - All data were recorded in both field notebooks and digitally as Excel files, with information entered into a structured dataset using Microsoft Excel and pandas in Python [11][14].
    - Trees were grouped by species, and each group was further classified by health status and zone location [16][20].
5. ***Spatial Analysis and Visualization:***
    - Geographic coordinates were imported into GIS software, where Folium and Python were used to create heat maps and visual representations of tree distribution [21].
    - The distribution of tree species across different zones was analyzed, focusing on identifying biodiversity hotspots and areas with low tree density [22].
    - Species diversity indices were calculated to assess biodiversity levels within the campus [23].
6. ***Validation and Cross-Verification:***

    Multiple verification rounds were conducted to cross-check the data against physical observations. Discrepancies in tree identification or measurement were resolved through re-inspections [24].
7. ***Final Data Analysis and Reporting*:**
    - The processed data were analyzed using statistical tools in Jupyter Notebook. Correlations between tree distribution and environmental factors (e.g., soil type, sunlight exposure) were explored [25].
    - Key findings were compiled into reports, highlighting significant observations like the even distribution of trees, concentrations of native species, and the role of non-native species in enhancing campus biodiversity [26].

### *C. Tools & Instruments Used for Data Analysis*

The following tools and instruments were crucial in ensuring the accuracy and reliability of our tree analysis:

- **Global Positioning System (GPS) Devices:** High-precision handheld GPS units were used to capture the geographic coordinates of each tree, ensuring accurate spatial mapping [8] [10].

- **Jupyter Notebook (Python):** Python libraries such as pandas, NumPy, and matplotlib were used for data organization, analysis, and visualization. Additionally, the Folium library facilitated the creation of interactive maps to display tree distribution [11][21].

### *D. Ensuring the Reliability of Experiments:*

Reliability was prioritized throughout the project by adopting the following practices:

- **Data Accuracy and Consistency:** Multiple data collection rounds ensured consistent results, with each tree being re-evaluated by different team members to reduce identification errors [24].
- **Instrument Calibration and Testing:** All Mobile, measuring tapes, and other instruments were calibrated before use to minimize measurement errors [8].
- **Cross-Verification:** The tree identification process involved cross-referencing data with botanical experts and using multiple field guides to confirm species [26] [9].
- **Systematic Sampling Approach:** Dividing the campus into predefined zones and adopting a systematic sampling approach helped avoid bias and ensured comprehensive coverage of the area [16] [20].
- **Geographic Information System (GIS) Software:** GIS was employed to overlay tree data onto maps, allowing for the examination of spatial relationships and the identification of biodiversity patterns [21] [20].

## III. RESULT

The tree analysis project involved in-depth data visualization and Python analysis (in Jupyter Notebook). The process unfolded as follows:

**Data Input and Processing:** The data on tree names, biological names, and counts was meticulously organized using pandas in Python [13][14]. Additionally, we used Folium to map the coordinates of the trees' current locations, providing an interactive visualization of tree distribution across the campus. This geospatial representation allows users to easily explore and analyze various tree species' spatial patterns and densities. By integrating these tools, we achieved a comprehensive approach that merges statistical analysis with interactive mapping, making the insights accessible and visually appealing. This multi-platform strategy demonstrates how Python can complement each other to create powerful data analysis pipelines.

- **Visualizations in Jupyter Notebook**:
We used Python libraries in Jupyter Notebook to analyze and visualize tree data. By utilizing pandas, we organized the data into structured lists, facilitating a systematic understanding of tree distribution across locations. We visualized the findings with Matplotlib, employing bar charts to depict the number of trees for each species, allowing easy comparison of their relative abundance. Line charts provided insights into trends and fluctuations in tree diversity over time, highlighting species contributions to the overall population. This combination of visualization techniques enabled us to identify patterns and variations in tree species distribution effectively.

a) **Structured lists (Source code): -**

```
import pandas as pd

sch1 = pd.read_csv(r"C:\Users\ELCOT\Desktop\TREE PROJECT\ALL OUR CAMPS\CSV\ST PATRICK'S.csv")

#ST PATRICK'S

sch1.head(5)
```

b) **Visualization Charts (Source code): -**

```
import matplotlib.pyplot as plt
data = pd.read_csv(r"C:\Users\lab\Documents\ourcampus.csv")
plt.figure(figsize=(16,7))
plt.plot(data['TREES NAME'], data['NUMBER OF TREE'], marker='o', color='blue')
plt.title('OUR CAMPUS', fontsize=14)
plt.xlabel('TREES NAME', fontsize=12)
plt.ylabel('NUMBER OF TREE', fontsize=12)
plt.xticks(rotation=45, ha='right')
plt.tight_layout()
plt.show()
```

- **Visualizations using Folium (Jupyter Notebook):**
We utilized Python libraries such as pandas, matplotlib, and Folium to represent our data. In Jupyter Notebook, we created and organized the tree data in lists and performed data cleaning using the pandas library. This involved addressing missing values, standardizing tree names, and ensuring consistency across the dataset. After cleaning the data, we used it for analysis and visualization with the help of the pandas and matplotlib libraries. Additionally, we utilized Folium to map the coordinates of the trees' current locations, providing an interactive view of the tree distribution on campus. These tools allowed us to create detailed charts, plots, and maps, enhancing the insightfulness and interpretability of the data. [13] [14].

**Importing Libraries and Modules: -**

```
!pip install folium --quiet
import folium
import pandas as pd
from IPython.display import HTML
```

**These are the different campuses: -**

1) *Patrician College of Arts and Science,*
2) *St. Patrick's Anglo-Indian School,*
3) *St. Patrick's ICSE School,*
4) *St. Michael's School, and Children's Block*

## 1. Patrician College of Arts and Science

In recognizing the vital role of trees, Patrician College embarks on a transformative journey, where each planted sapling symbolizes our commitment to sustainability and holistic education. With a foundation rooted in environmental consciousness, our initiative begins with a flourishing life in A-block, where six trees will take hold, ushering in a new era of green vitality across campus. This endeavor, extending to B-block with five trees, reflects our steadfast dedication to cultivating not just minds, but also vibrant ecosystems that inspire and nurture. As we embrace the verdant promise of C-block's garden, envisioning seven to eight trees as pillars of tranquility, we reaffirm our pledge to create spaces that rejuvenate the spirit and stimulate the senses. With ten trees set to grace both D-block and E-block, our college becomes a sanctuary where nature's wisdom intertwines with scholarly pursuits, fostering a community that thrives in harmony with the natural world. The addition of these trees not only beautifies the campus but also creates inviting spaces for study and relaxation.

**These are the different zones on campus: -**

### *A-BLOCK:*

| | TREES NAME | SCIENTIFIC NAME OF TREE | NUMBER OF TREES |
|---|---|---|---|
| 0 | MANGO TREE | Mangifera indica | 3 |
| 1 | INDIAN BEECH TREE | Millettia pinnata | 4 |
| 2 | Asian Bullet Wood | MIMUSOPS ELENGI | 8 |
| 3 | COCONUT TREE | Cocos nucifera | 9 |
| 4 | NEEM TREE | Azadirachta indica | 1 |
| 5 | ALMOND TREE | Prunus dulcis | 1 |
| 6 | FIG TREE | Ficus carica | 1 |
| 7 | PALM TREE | Arecaceae | 6 |
| 8 | TAMARIND | Tamarindus indica | 2 |
| 9 | BANANA TREE | Musa | 8 |
| 10 | GOLDEN BAMBOO TREE | Phyllostachys aurea | 12 |

### *B-BLOCK:*

| | TREES NAME | SCIENTIFIC NAME OF TREE | NUMBER OF TREES |
|---|---|---|---|
| 0 | ACACIA | genus Acacia | 3 |
| 1 | HAINANIA | Hainania trichosperma Merr | 4 |
| 2 | BANANA TREE | Musa | 7 |
| 3 | PAPAYA TREE | Carica papaya | 2 |
| 4 | NEEM TREE | Azadirachta indica | 5 |
| 5 | ALMOND TREE | Prunus dulcis | 2 |
| 6 | MONKEY POD TREE | Samanea saman | 1 |
| 7 | COCONUT TREE | Cocos nucifera | 3 |
| 8 | INDIAN BEECH TREE | Millettia pinnata | 5 |
| 9 | ASHOK TREE | Saraca asoca | 1 |
| 10 | CHRISTMAS TREE | Araucaria columnariS | 1 |
| 11 | BIRD CATCHER TREE | Pisonia grandis | 1 |
| 12 | GULMOHAR TREE | Delonix regia | 2 |
| 13 | JACKFRUIT TREE | Artocarpus heterophyllus | 1 |
| 14 | STERCULIA FOETIDA | Sterculia | 1 |

### *C-BLOCK:*

| | TREES NAME | SCIENTIFIC NAME OF TREE | NUMBER OF TREES |
|---|---|---|---|
| 0 | JACKFRUIT TREE | Artocarpus heterophyllus | 4 |
| 1 | INDIAN BEECH TREE | Millettia pinnata | 5 |
| 2 | MANGO TREE | Mangifera indica | 7 |
| 3 | GUAVA TREE | Psidium guajava | 3 |
| 4 | COCONUT TREE | Cocos nucifera | 13 |
| 5 | NEEM TREE | Azadirachta indica | 2 |
| 6 | PAPAYA TREE | Carica papaya | 1 |
| 7 | BANANA TREE | Musa | 18 |
| 8 | BRID CATCHER TREE | Pisonia grandis | 4 |
| 9 | ROYAL PALM TREE | Roystonea regia | 10 |
| 10 | CHRISTMAS PALM TREE | Adonidia merrillii | 3 |
| 11 | MONKEY POD TREE | Samanea saman | 1 |
| 12 | ALMOND TREE | Prunus dulcis | 1 |
| 13 | ASHOK TREE | Saraca asoca | 1 |
| 14 | SAPOTA TREE | Manilkara zapota | 1 |
| 15 | CONIFER TREE | Pinophyta | 3 |

### *D-BLOCK:*

| | TREES NAME | SCIENTIFIC NAME OF TREE | NUMBER OF TREES |
|---|---|---|---|
| 0 | COCONUT TREE | Prunus dulcis | 1 |
| 1 | MANGO TREE | Mangifera indica | 1 |
| 2 | AFRICAN TULIP TREE | Spathodea campanulata | 2 |

### *E-BLOCK:*

| | TREES NAME | SCIENTIFIC NAME OF TREE | NUMBER OF TREES |
|---|---|---|---|
| 0 | ASHOK TREE | Saraca asoca | 13 |
| 1 | NEEM TREE | Azadirachta indica | 4 |
| 2 | ALMOND TREE | Prunus dulcis | 1 |
| 3 | ROYAL PALM TREE | Roystonea regia | 4 |
| 4 | INDIAN BEECH TREE | Millettia pinnata | 5 |
| 5 | YELLOW ELDER TREE | Tecoma stans | 1 |
| 6 | GOLDEN BAMBOO TREE | Phyllostachys aurea | 25 |
| 7 | MONKEY POD TREE | Samanea saman | 6 |
| 8 | GULMOHAR TREE | Delonix regia | 3 |

### *Parking:*

| | TREES NAME | SCIENTIFIC NAME OF TREE | NUMBER OF TREES |
|---|---|---|---|
| 0 | ASHOK TREE | Saraca asoca | 2 |
| 1 | NEEM TREE | Azadirachta indica | 2 |
| 2 | ALMOND TREE | Prunus dulcis | 4 |
| 3 | Asian Bullet Wood | MIMUSOPS ELENGI | 3 |
| 4 | SACRED FIG TREE | Ficus religiosa | 2 |
| 5 | INDIAN BEECH TREE | Millettia pinnata | 5 |
| 6 | COCONUT TREE | Cocos nucifera | 2 |
| 7 | SAPOTA TREE | Manilkara zapota | 1 |
| 8 | CUSTARD APPLE TREE | Annona squamosa | 1 |
| 9 | GOLDEN BAMBOO TREE | Phyllostachys aurea | 28 |

## 2. St. Patrick's Anglo-Indian School

- Embracing vertical gardening techniques, we can set up a combination of living walls and modular vertical planters to accommodate approximately 20 to 25 trees. These vertical gardens will utilize unused wall spaces, transforming them into lush greenery, thereby maximizing the available area while adding aesthetic appeal to the school environment.

- Implementing a variety of dwarf and compact tree species, such as dwarf fruit trees, columnar trees, and bonsai specimens, we can optimize the space and ensure that each tree thrives within the confined area. These smaller trees will still provide shade, beauty, and educational value without overwhelming the limited space.

- Introducing innovative planting solutions such as espaliered trees, which can be trained to grow flat against walls or fences, we can further maximize space efficiency while adding a decorative element to the school landscape. Espaliered trees offer the opportunity to showcase creativity in tree arrangement and design, creating visually appealing patterns and shapes.

- Incorporating multi-functional trees that serve dual purposes, such as fruit-bearing trees or trees with medicinal value, we can enhance the ecological and educational benefits of the planting project. These trees will beautify the school surroundings and provide opportunities for hands-on learning about sustainable food production or traditional herbal remedies.

- Utilizing raised planters and container gardening techniques, we can create elevated green spaces within the school premises, allowing for the cultivation of trees even in areas with limited ground space. These raised planters can be strategically placed in courtyards, patios, or rooftops, offering a unique and accessible way to incorporate trees into the school landscape.

- By embracing these innovative strategies tailored to the specific constraints of space at St. Patrick's School, we can still achieve a significant impact through tree planting, fostering a greener, more vibrant environment that enriches the lives of students and staff alike.

- We have compiled a comprehensive list of trees from our campus, documenting each species along with their locations

The gathered data on tree names, biological names, and counts was meticulously organized using pandas in Python.

| | NAME OF TREE | SCIENTIFIC NAME OF TREE | NUMBER OF TREES |
|---|---|---|---|
| 0 | TAMARIND | Tamarindus indica | 4 |
| 1 | BAMBOO TREE | Bambusa vulgaris | 19 |
| 2 | NEEM TREE | Azadirachta indica | 16 |
| 3 | PORTIA TREE | Thespesia populnea | 1 |
| 4 | ASIAN BULLET WOOD | MIMUSOPS ELENGI | 16 |
| 5 | ALMOND TREE | Prunus dulcis | 5 |
| 6 | TECTONA TREE | Tectona grandis | 3 |
| 7 | COCONUT TREE | Cocos nucifera | 9 |
| 8 | BANANA TREE | Musa | 12 |
| 9 | RAMBUTAN TREE | Nephelium lappaceum | 1 |
| 10 | ORCHID TREE | Bauhinia variegata | 9 |
| 11 | FISHTAIL PALM | Caryota | 13 |
| 12 | PALM TREE | Arecaceae | 8 |
| 13 | INDIAN BEECH TREE | Millettia pinnata | 22 |
| 14 | MONKEY POD TREE | Samanea saman | 17 |
| 15 | AMALTAS TREE | Cassia fistula | 1 |
| 16 | ASHOK TREE | Saraca asoca | 39 |
| 17 | MANGO TREE | Mangifera indica | 14 |
| 18 | SAPOTA TREE | Manilkara zapota | 5 |
| 19 | GULMOHAR TREE | Delonix regia | 12 |
| 20 | CAPE FIG | Ficus capensis | 7 |
| 21 | GUAVA TREE | Psidium guajava | 4 |
| 22 | JAMUN TREE | Syzygium cumini | 1 |
| 23 | CHILEAN JASMINE | Mandevilla laxa | 3 |
| 24 | OLEANDER TREE | Nerium oleander | 1 |
| 25 | CHRISTMAS TREE | Araucaria columnariS | 3 |
| 26 | AFRICAN TALISAY | Terminalia Mantaly | 8 |
| 27 | ALEXANDRIAN LAUREL | Calophyllum inophyllum | 2 |
| 28 | COOK PINE | Araucaria columnaris | 1 |
| 29 | BAMBOO CYCAD | Ceratozamia hildae | 15 |
| 30 | ROYAL PALM TREE | Roystonea regia | 12 |

## 3. St. Patrick's ICSE School

- Certainly! Here are some innovative ideas for planting 10 to 15 trees at St. Patrick's ICSE School, aimed at providing a delightful experience for children.

- Establish a "fruitful learning orchard" featuring fruit-bearing trees such as apple, orange, mango, and guava. Children can learn about different fruits, and their nutritional value, and enjoy seasonal fruitpicking activities, fostering a hands-on learning experience.

- Plant a butterfly garden with trees and flowering plants that attract butterflies. Species like butterfly bush, milkweed, and citrus trees will not only provide nectar for butterflies but also serve as educational tools for teaching about pollination and insect life cycles.

- Create a "medicinal plant garden" featuring trees with medicinal properties such as neem, aloe vera, and Tulsi. Children can learn about traditional healing plants and their uses in herbal medicine, promoting health literacy and wellness education.

- The data on tree names, biological names, and counts was meticulously organized using pandas in Python [13][14].

- We have compiled a comprehensive list of trees from our campus, documenting each species along with their locations.

The gathered data on tree names, biological names, and counts was meticulously organized using pandas in Python.

| | TREES NAME | SCIENTIFIC NAME OF TREES | TREES COUNT |
|---|---|---|---|
| 0 | INDIAN BEECH TREE | Millettia pinnata | 7 |
| 1 | MONKEY POD TREE | Samanea saman | 3 |
| 2 | NEEM TREE | Azadirachta indica | 5 |
| 3 | ALMOND TREE | Prunus dulcis | 3 |
| 4 | BAMBOO CYCAD | Ceratozamia hildae | 16 |
| 5 | ASHOK TREE | Saraca asoca | 14 |
| 6 | TECTONA TREE | Tectona grandis | 2 |
| 7 | GULMOHAR TREE | Delonix regia | 1 |
| 8 | PINE | Pinus roxburghii | 1 |

### 4. St. Michael's School, and Children's Block.

In recognizing the vital role of trees, Michael's Academy embarks on a transformative journey, where each planted sapling symbolizes our commitment to sustainability and holistic education. The implementation of a tree-planting initiative at St. Michael's Academy has led to the creation of diverse and educational green spaces that engage students in unique, hands-on learning experiences. The following results highlight the outcomes of planting 10 to 20 trees across different thematic zones:

- We have compiled a comprehensive list of trees from our campus, documenting each species along with their locations.
- The data on tree names, biological names, and counts was meticulously organized using pandas in Python [13][14].

The gathered data on tree names, biological names, and counts was meticulously organized using pandas in Python.

| | TREES NAME | SCIENTIFIC NAME OF TREE | TREES COUNT |
|---|---|---|---|
| 0 | BAMBOO TREE | Ceratozamia hildae | 4 |
| 1 | PALM TREE | Arecaceae | 7 |
| 2 | SACRED FIG TREE | Ficus religiosa | 2 |
| 3 | ASHOK TREE | Saraca asoca | 17 |
| 4 | Asian Bullet Wood | MIMUSOPS ELENGI | 7 |
| 5 | YELLOW ELDER TREE | Tecoma stans | 2 |
| 6 | COCONUT TREE | Cocos nucifera | 5 |
| 7 | NEEM TREE | Azadirachta indica | 12 |
| 8 | FOX TAIL PALM TREE | Wodyetia bifurcata | 17 |
| 9 | BOTTLE PALM TREE | Hyophorbe lagenicaulis | 9 |
| 10 | ALEXANDRIAN LAUREL | Calophyllum inophyllum | 8 |
| 11 | TECTONA TREE | Tectona grandis | 20 |
| 12 | BANANA TREE | Musa | 5 |
| 13 | INDIAN BEECH TREE | Millettia pinnata | 6 |
| 14 | ALMOND TREE | Prunus dulcis | 7 |
| 15 | ROYAL PALM TREE | Roystonea regia | 17 |
| 16 | PAPAYA TREE | Carica papaya | 5 |
| 17 | PINE | Pinus roxburghii | 2 |
| 18 | SAPOTA TREE | Manilkara zapota | 2 |
| 19 | MONKEY POD TREE | Samanea saman | 1 |

The Patrician College, Patrick's School, and Michael's School are all located on the same campus, creating a vibrant educational environment enriched by nature. Within this campus, a diverse array of tree species contributes to the ecosystem, providing aesthetic beauty, shade, and habitat for wildlife. To effectively understand the distribution and abundance of these trees across each institution, we have compiled a detailed inventory of the tree species present in each location. This comprehensive dataset not only includes the names of the tree species but also encompasses their respective coordinates and counts within the campus area. By analyzing this data, we can uncover important insights regarding the biodiversity of the campus environment. To visualize this information clearly, we will employ both line charts and bar graphs. Line charts will help illustrate trends in tree distribution over time or between different areas, while bar graphs will provide a straightforward comparison of the number of tree species found at Patrician College, Patrick's School, and Michael's School. These visualizations will enhance our understanding of the campus's ecology

## Campus:-

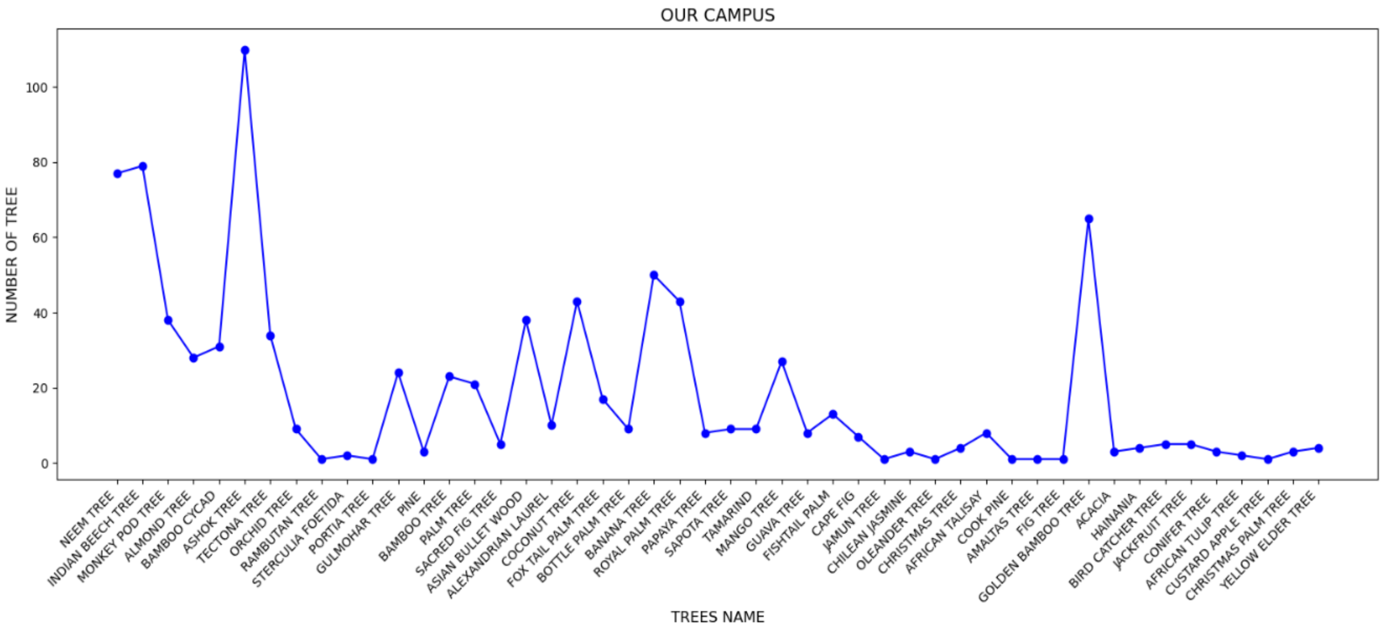


***Figure: Distribution of tree species on campus based on tree counts, illustrating species diversity and abundance. For details, see the paragraphs below.***

The line chart illustrates the distribution of various tree species across the campus, depicting the number of trees for each species. The vertical axis represents the number of trees, while the horizontal axis lists the different species, revealing noticeable peaks and troughs in the data. This variability reflects the diversity of the tree population on campus, which is a key indicator of a healthy and balanced ecosystem[12].

The most prominent peaks in the chart occur with species such as the **Ashok Tree** and **Golden Bamboo Tree**, which are the most abundant. The higher counts for these species suggest they may be particularly well-suited to the local environmental conditions or favored in campus landscaping due to their aesthetic qualities, shade provision, or ecological benefits. Their prevalence also indicates that these trees could play a significant role in supporting local wildlife by providing habitats and resources for various animal species.

On the other hand, some species show much lower counts, such as the **African Mahogany**, **Bird Catcher Tree**, **Cinnamon Tree**, and **Yellow Elder Tree**. The limited numbers of these trees may be due to their less favorable growing conditions, historical planting trends, or competition with other species. Such low representation can signify potential ecological challenges, such as susceptibility to pests or diseases, which may affect specific tree species more than others[13][14].

The fluctuating pattern across the chart shows that while some species dominate, many others maintain smaller but significant populations. For instance, trees like the **Bamboo Orchids**, **Teak Trees**, and **Bottle Palm Trees** have moderate counts, indicating that they are present in sufficient numbers to contribute to the overall diversity without overwhelming the landscape. This mid-range frequency suggests a balanced distribution where various tree species coexist, supporting the stability of the ecosystem.

Analyzing this distribution can guide campus landscape management strategies. The data helps identify species that may need more attention, whether through conservation efforts, increased planting, or protective measures to prevent decline. For example, increasing the number of underrepresented species could enhance biodiversity, leading to a more resilient campus environment.

Moreover, this analysis can serve as a baseline for future comparisons, enabling the monitoring of tree population changes over time. This is important for detecting trends linked to environmental shifts, campus development, or other factors affecting tree growth. Regular monitoring can inform proactive measures to maintain a sustainable and thriving campus landscape[14].

Overall, the line chart serves as a valuable tool for understanding the distribution and diversity of tree species on campus. It not only highlights the current state of the campus's greenery but also provides a foundation for making informed decisions that promote a healthy and sustainable landscape.

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## Ground:-

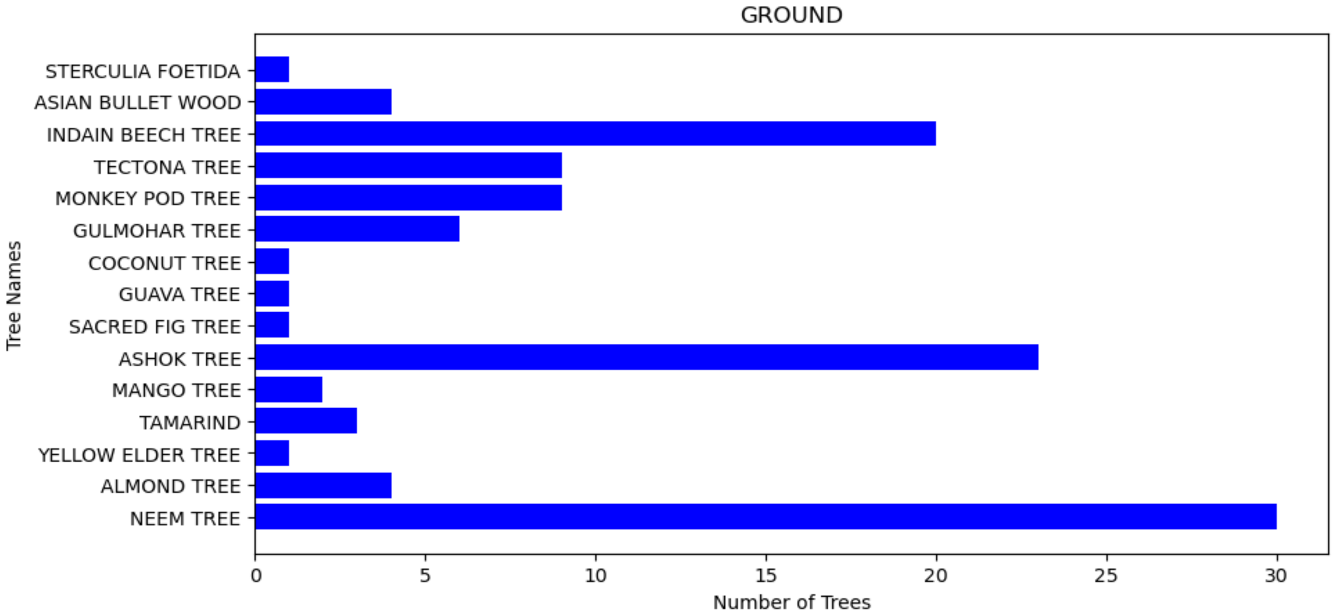



***Figure: Distribution of tree species on Ground-based on tree counts, illustrating species diversity and abundance. For details, see the paragraphs below.***

The analysis of tree distribution across the campuses of Patrician College, Patrick's School, and Michael's School reveals a significant diversity in tree species, with a total count showcasing the ecological richness of these environments. The bar chart representing the number of trees emphasizes the prominence of specific species, underscoring their contribution to the local ecosystem.

Among the species documented, the **Neem Tree** stands out as the most abundant, with an impressive count of approximately 30 trees. Known for its numerous benefits, the Neem Tree (Azadirachta indica) is not only a vital component of the local flora but also serves various purposes for the community. Traditionally, its leaves, bark, and seeds have been used in traditional medicine, organic farming, and pest control, making it a valuable asset in sustainable practices. Its high density within the campuses indicates an adaptation to the local climate and soil conditions, and its resilience enhances its survival rate compared to other species[12].

In addition to the Neem Tree, the **Almond Tree** (Prunus dulcis) holds a notable presence in the study area. Though fewer in number than the Neem Tree, the Almond Tree's contribution cannot be understated. As a fruit-bearing tree, it provides edible nuts and plays a crucial role in supporting local wildlife by offering food and habitat. Such fruit trees enrich the campus grounds' biodiversity and serve educational purposes for students studying plant sciences and ecology[11].

Other significant species identified include the **Ashok Tree** (Saraca asoca) and the **Sacred Fig Tree** (Ficus religiosa). The Ashoka Tree, revered in Indian culture, is known for its Attractive flowers and shade-providing canopy. It is often planted in public areas for its aesthetic appeal and is associated with several cultural and religious practices. Meanwhile, the Sacred Fig Tree, also known for its religious significance, particularly in Buddhism and Hinduism, serves as a critical element in promoting environmental awareness among students and faculty.

The analysis also highlights the **Coconut Tree** (Cocos nucifera), **Guava Tree** (Psidium guajava), and **Gulmohar Tree** (Delonix regia), which collectively contribute to the diversity of the ecosystem. Each of these trees serves various functions, including food production, shade provision, and habitat for various species. The Coconut Tree, for instance, is an integral part of coastal ecosystems and provides numerous products, from coconuts to coir. The Guava Tree, with its rich fruit, not only supports local wildlife but also serves as a source of nutrition for students and residents alike.

Furthermore, species such as the **Monkey Pod Tree** (Samanea saman) and **Indian Beech Tree** (Pongamia pinnata) highlight the importance of incorporating native flora in campus landscaping. These trees are essential for maintaining ecological balance, preventing soil erosion, and enhancing the overall aesthetic of the campuses[13].

The tree distribution analysis catalogs species while highlighting their ecological roles. By promoting diversity, campuses can enhance ecological integrity, improve air quality, and create educational opportunities for students. This study underscores the need for ongoing conservation efforts to preserve vital resources for future generations. As environmental stewards, campuses have the opportunity to foster awareness and responsibility among students, encouraging a culture of respect for nature and its many benefits.

## A. Jupyter Notebook (Folium)

### 1. Setup: Importing Libraries and Modules: -

```
!pip install folium --quiet
import folium
import pandas as pd
from IPython.display import HTML
```

The code begins by installing and importing the necessary libraries:

- **folium:** Used for generating interactive maps and visualizing geospatial data.
- **pandas:** Provides data structures for easy data manipulation and analysis.
- **IPython.display.HTML:** Allows embedding HTML in Jupyter Notebooks.

The !pip install folium --quiet command ensures Folium is installed. The --quiet flag suppresses unnecessary output during installation.

### 2. Initializing a Folium Map: -

```
Tree_pro = folium.Map(location=[13.013572846507344, 80.24930889510055], zoom_start=15)
Tree_pro
```

A Folium map is created and centered around specific coordinates. The key components are:

- **location:** Sets the center of the map using latitude and longitude values.
- **zoom start:** Defines the initial zoom level. A value of 15 offers a close-up view.

The map is stored in the variable Tree_pro, which is displayed in the notebook using its name.

### 3. Variable Assignment: -

```
Tree_pro = m
m = folium.Map(location=[13.013572846507344, 80.2493088951005], zoom_start=48)
```

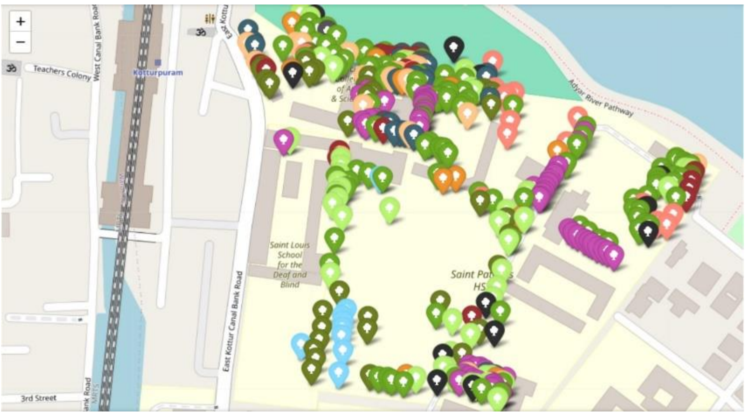
In this snippet, there is an assignment error: Tree_pro = m should likely be m = Tree_pro or be removed altogether. The code then reinitializes the map with the same coordinates but a different zoom level (48), which is extremely zoomed in.

### 4. Adding Markers with Folium: -

```
folium.Marker([13.013513,80.250271], popup='Tamarind Tree ', icon=folium.Icon(color='green', icon='glyphicon glyphicon-tree-deciduous')).add_to(m)
folium.Marker([13.013597,80.250305], popup='Sapota TREE', icon=folium.Icon(color='green', icon='glyphicon glyphicon-tree-deciduous')).add_to(m)
folium.Marker([13.013611,80.250357], popup='ASHOKA TREE', icon=folium.Icon(color='green', icon='glyphicon glyphicon-tree-deciduous')).add_to(m)
folium.Marker([13.013634,80.250315], popup='MIMUSOPS ELENGI', icon=folium.Icon(color='cadetblue', icon='glyphicon glyphicon-tree-deciduous')).add_to(m)
folium.Marker([13.013575,80.250412], popup='COCONUT TREE', icon=folium.Icon(color='beige', icon='glyphicon glyphicon-tree-deciduous')).add_to(m)
folium.Marker([13.013574,80.250412], popup='COCONUT TREE', icon=folium.Icon(color='beige', icon='glyphicon glyphicon-tree-deciduous')).add_to(m)
folium.Marker([13.013565,80.250448], popup='COCONUT TREE', icon=folium.Icon(color='beige', icon='glyphicon glyphicon-tree-deciduous')).add_to(m)
```

The following lines add markers representing tree locations to the map:

**Output: -**





- This code creates an interactive map using the Folium library in Python to visualize tree locations with custom markers. The map is centered at specified coordinates with an initial zoom level, allowing close-up exploration. Different tree species are represented as markers with distinct colours and icons, enhancing the map's visual clarity.

- The script starts by setting up the environment with necessary library imports, followed by creating a map object centered at a chosen location. The zoom level is initially set to 15 but later adjusted to an extremely high level (48), which is likely unintended due to a mistake in the variable assignment.

- Markers are added to the map with the "folium.Marker" function. Each marker represents a specific tree, with a custom popup that displays the tree's name when clicked. The marker's icon and colour are customized using Folium's Icon class.

- Finally, the map object is displayed within the Jupyter Notebook, allowing users to interact with the markers and explore the tree distribution visually. The code is useful for projects involving geospatial data analysis and environmental studies, enabling a clear and interactive way to map and analyze tree locations in a given area.

## IV. CONCLUSION

The campus conducted a three-month survey three months ago of its tree population, identifying 892 trees of 48 species. The study highlighted the ecological importance of the trees, their impact on biodiversity, and their role in providing wildlife habitats and improving air quality. Data analysis was conducted using Python's Pandas, and it was visualized using Folium mapping and Jupyter Notebook. The study identified key biodiversity hotspots and recommended promoting native species and aligning tree-planting initiatives with sustainability goals to support campus sustainability and ecological stewardship efforts. The findings of the study will be used to guide future tree-planting initiatives and environmental conservation efforts on campus.

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