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Inventory Of Open Space And Vegetation In Unsrat Campus Based On Ui Greenmetric

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Abstract

Universities play a pivotal role in advancing sustainability through effective management of open spaces and vegetation. This study assesses the condition of green open space and vegetation on the Sam Ratulangi University campus using the UI GreenMetric framework, focusing on the Setting and Infrastructure category. A comprehensive field inventory was conducted across 16 campus locations, recording 74 tree species and a total of 1,972 individual trees, with Swietenia macrophylla (large-leaf mahogany) as the dominant species. The university achieved a total score of 500 out of 1,500 possible points in this category. The highest score was observed in SI 2 (proportion of forest vegetation), which received the maximum 200 points, demonstrating effective maintenance of forested areas. However, SI 5 (ratio of green open space per capita) scored zero, indicating inadequate accessible green space for the campus community. These findings highlight both strengths and challenges in current sustainability practices. Addressing these gaps requires integrated planning to improve green space distribution and enhance campus livability. The study underscores the importance of expanding assessment to other university locations to gain a holistic view of institutional sustainability. Such efforts are essential for informed decision-making, promoting biodiversity conservation, improving environmental quality, and supporting the university's commitment to achieving higher UI GreenMetric rankings.

Keywords: UI Green Metric, Infrastructure, Sam Ratulangi University Campus, Vegetation

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INTRODUCTION

The Unsrat Campus has been designated as an urban forest area under Manado Mayor's Decree No. 7a of 2007, dated January 15, 2007. The availability of green spaces and forested areas within the campus represents a significant asset in supporting the green campus concept. These green areas offer ecological, social, and educational benefits aligned with principles of sustainability and environmental management. Ecological benefits include improved air quality through pollutant absorption and oxygen production, habitat provision for diverse tree species, and contributions to biodiversity conservation and ecological balance (Susilowati et al., 2021). Social benefits arise from green spaces acting as restorative environments that positively impact mental health through exposure to greenery (Vardaka et al., 2022). Open green spaces also facilitate social interaction, recreation, and enhanced quality of life (Tudorie et al., 2020). Educational benefits stem from the potential use of campus green spaces for nature interpretation and environmental education (Harahap et al., 2024). A green campus strategy is an approach to environmental management within educational institutions (Puspadi et al., 2016). It represents the alignment of campus management systems with environmental stewardship (Gholami at al, 2020). This approach prioritizes the implementation of sustainable strategies for environmental protection, management, and conservation in higher education settings (Wimala et al, 2016). Successful implementation of sustainable campus concepts can foster a paradigm shift among academic communities toward more responsible and environmentally conscious practices (Tiyarattanachai, 2016).

Indonesia has established a green campus ranking system known as UI GreenMetric, initiated by Universitas Indonesia in 2010. This program aims to provide information on the status and policies of universities worldwide in implementing green campus concepts (Erina & Pujiningsih, 2022). UI GreenMetric assessments use a framework encompassing environmental, economic, and equity dimensions, broken down into six main categories: Setting and Infrastructure, Energy and Climate Change, Waste Management, Water Management, Transportation, and Education and Research.

In 2022, Sam Ratulangi University was ranked 35th in Indonesia according to UI GreenMetric, a decline from 20th in 2021 and 18th in 2020—an issue of significant concern. With the ongoing construction of new buildings, the campus's open space has been reduced. Consequently, there is a need for in-depth research on the current state of open spaces and vegetation on campus. Such data can serve as the basis for evaluating the Setting and Infrastructure category within the UI GreenMetric framework and inform decision-making to support the development of a sustainable green campus.

As Gültekin & Canik, (2022) explain, the UI GreenMetric framework includes six categories: Setting and Infrastructure (SI), Energy and Climate Change Mitigation (EC), Waste Management (WS), Water Management (WR), Transportation Systems (TR), and Education (ED). This analysis aims to assess the condition of open spaces and vegetation on the Sam Ratulangi University campus and evaluate its setting and infrastructure based on UI GreenMetric calculations.

RESEARCH METHODS

The study was conducted on the Sam Ratulangi University (Unsrat) campus over a period of eight months, from March to October 2023. The duration of the research allowed for comprehensive data collection across different seasonal conditions, ensuring greater accuracy in identifying vegetation types and land use patterns. This extended timeframe also enabled researchers to plan and conduct field surveys methodically, minimizing errors due to weather variability or logistical constraints.

Materials and Equipment

The materials and equipment used in this study are summarized in Table 1, which lists the key tools, their specifications, and their primary research functions. This ensured that all data collection activities were systematic, replicable, and aligned with the study objectives.

Table 1. Materials and Equipment Used in the Study

No	Item	Use
1	Campus Map	Planning field routes and survey zones
2	GPS Device	Recording tree locations and research points
3	Compass (1.5 m)	Orientation and navigation in the field
4	Sample Bags and Scissors	Collecting small plant samples
5	Writing Tools and Computer	Note-taking, data entry, and analysis
6	Landsat Imagery (2022)	Interpreting land use and mapping vegetation
7	Tally Sheets	Recording tree species, diameter, and height
8	Phi-ban, Christen Meter, Clinometer	Measuring tree diameter and height
9	UI GreenMetric Questionnaire	Collecting data aligned with assessment criteria

Procedures

The research methodology was designed to integrate remote sensing, field surveys, and structured data analysis to ensure a holistic evaluation of campus land use and vegetation. The work was carried out in several sequential stages:

1. Developing a working map to gain an initial understanding of existing site conditions and to guide field activities. This map served as a planning tool for organizing survey routes and sample points.
2. Conducting a land-use analysis of the Unsrat campus using spatial analysis techniques, with interpretation of the 2022 Landsat imagery to classify different land cover types such as open spaces, buildings, and vegetation areas. This step provided a preliminary spatial framework for identifying target survey zones.
3. Performing terrestrial surveys to verify and refine the interpretations made from satellite imagery through direct field observation. Field verification was essential to address any discrepancies or misclassifications in the satellite data.
4. Conducting a complete inventory of all trees on the Unsrat campus to document species diversity, diameter, and spatial distribution. This census approach ensured comprehensive data on the structural and compositional characteristics of campus vegetation, which are critical for assessing ecological value.
5. Evaluating the Setting and Infrastructure category of the UI GreenMetric framework, which involved collecting, calculating, and analyzing indicator data to measure campus performance in this dimension.

The Setting and Infrastructure category focuses on physical aspects of the campus such as the extent of green areas, the layout and footprint of buildings, and the proportion of open space relative to the total campus area. Providing environmentally friendly infrastructure that is integrated with sustainable spatial planning enhances the university's image as a green campus while creating a healthier and more productive learning environment. Moreover, campus spatial planning that emphasizes environmental conservation contributes to climate change mitigation, improves air quality, reduces urban heat island effects, and promotes more efficient water and energy management. Through the systematic assessment of these indicators, universities are encouraged to adopt ecological principles in physical development and long-term planning. These efforts support not only environmental goals but also institutional commitments to sustainability education and community well-being.

To collect data for the Setting and Infrastructure (SI.1) indicator, the following key measurements were required:

1. Total campus area (m^2) to establish the baseline for land-use calculations.
2. Total building footprint area (m^2) to evaluate the proportion of impermeable surfaces.
3. Total building floor area (m^2) to assess built space density and vertical development patterns.

In this study, the Setting and Infrastructure aspect was specifically evaluated using the SI.1 indicator, which measures the ratio of open space to total campus area. This ratio is used as an indicator of the university's commitment to providing accessible, sustainable, and healthy green environments for its academic community. By maintaining or expanding open spaces relative to built areas, universities demonstrate leadership in sustainable urban planning and environmental stewardship.

Indicator SI.1 – Ratio of Open Green Space to Total Campus Area

This indicator evaluates the proportion of open green space relative to the total area of the campus. It reflects the institution's commitment to providing a healthy, comfortable, and sustainable environment for its academic community. Adequate green space supports quality of life, microclimate regulation, and biodiversity conservation within the campus setting.

The resulting ratio is used to assess how well a campus provides open green space relative to its total area. This measurement is important because it offers a standardized way to evaluate and compare sustainability practices across different institutions. It recognizes that universities vary widely in size, layout, and development pressures, so a percentage-based ratio allows meaningful comparisons regardless of scale. By quantifying green space provision, institutions can demonstrate their commitment to environmental stewardship and the well-being of their academic communities.

$$Ratio = \frac{Open\ Green\ Space\ Area}{Total\ Campus\ Area} \times 100\% \quad (1)$$

Equation (1) shows the fundamental formula used to evaluate the proportion of green space on campus. In this equation, the numerator represents the total area of open green space available for ecological, recreational, or aesthetic purposes, while the denominator is the overall land area of the campus, including all built and unbuilt spaces. By converting this ratio into a percentage, it becomes easier to interpret and compare across institutions of varying sizes. A higher percentage indicates a greater commitment to preserving open spaces, supporting environmental sustainability, and enhancing the quality of campus life.

The resulting ratio is classified into the following five categories:

[1] ≤ 1%
[2] > 1% – 80%
[3] > 80% – 90%
[4] > 90% – 95%
[5] > 95%

These categories facilitate the classification of campuses based on the availability of open green space, serving as an indicator of the institution's seriousness in adopting green campus principles. Data for this indicator are obtained through direct field measurements, analysis of campus maps, satellite imagery, and other spatial documentation, all of which are verified through field observations.

Indicator SI.2 – Percentage of Campus Area Covered by Forest Vegetation

This indicator assesses the proportion of the campus area that is covered by natural forest vegetation. Such areas are typically dominated by mature trees and dense understory vegetation, supporting high levels of biodiversity. Forest zones on campus serve important conservation functions, enhance local ecosystems, and provide critical ecological services such as carbon sequestration, soil protection, and climate change mitigation. Evaluating this indicator demonstrates the institution's commitment to preserving and managing natural green areas within the campus environment.

The percentage is calculated by dividing the area of the campus with forest cover by the total campus area and then converting it to a percentage.

$$Percentage = \frac{Forest\ Covered\ Area}{Total\ Campus\ Area} \times 100\% \quad (2)$$

This value helps universities understand the contribution of forested areas to overall campus land use planning. The resulting percentage is classified into the following five categories:

[1] ≤ 2%
[2] > 2% – 9%
[3] > 9% – 22%
[4] > 22% – 35%
[5] > 35%

These categories make it easier to classify campuses based on the extent of natural forest cover they maintain. A higher category score indicates a stronger institutional commitment to biodiversity conservation and environmental sustainability. This classification also encourages universities to protect and enhance their forested spaces as vital components of campus ecology and landscape planning. Data for this indicator are obtained through land-use maps, satellite imagery analysis, spatial documentation, and direct field surveys for validation.

Indicator SI.3 – Percentage of Campus Area Covered by Non-Forest Vegetation (Gardens and Landscaping)

This indicator measures the proportion of the campus area covered by non-forest vegetation, including gardens, lawns, landscaped areas, green roofs, vertical gardens, and indoor plants. These types of green spaces play a crucial role in creating a pleasant and livable campus environment, improving comfort, and supporting ecological functions such as microclimate regulation and water conservation. Evaluating this indicator demonstrates the university's efforts to expand and maintain additional green spaces that contribute to environmental sustainability.

The percentage is calculated by dividing the area of non-forest vegetation by the total campus area, then converting the result into a percentage.

$$Percentage = \frac{NonForest\ Vegetation\ Area}{Total\ Campus\ Area} \times 100\% \quad (3)$$

This calculation provides insight into the contribution of managed green spaces to overall campus land-use planning. The resulting percentage is classified into the following five categories:

[1] ≤ 10%
[2] > 10% – 20%
[3] > 20% – 30%
[4] > 30% – 40%
[5] > 40%

These categories help classify campuses based on their investment in developing and maintaining non-forest green spaces. A higher category score indicates a stronger commitment to providing additional green areas that enhance comfort, aesthetic value, and environmental sustainability on campus. Data for this indicator are obtained through analysis of campus spatial planning documents, satellite imagery interpretation, spatial documentation, and validation through field surveys.

Indicator SI.4 – Percentage of Campus Area for Non-Vegetated Water Infiltration

This indicator assesses the proportion of the campus area that functions as water infiltration zones, excluding areas already covered by forest or other vegetation. Non-vegetated infiltration areas include surfaces designed to allow rainwater to seep into the ground, such as bare soil, lawns, permeable paving blocks, con-block surfaces, and other semi-permeable materials. This indicator is essential because it supports effective stormwater management, reduces local flooding risks, and contributes to groundwater conservation, thereby enhancing the overall sustainability of the campus environment.

To calculate this indicator, the area designated for non-vegetated water infiltration is divided by the total campus area. Converting the result to a percentage allows for easier interpretation and comparison among institutions of different sizes.

The following equation is used to calculate this indicator:

$$Percentage = \frac{NonVegetated\ Infiltration}{Total\ Campus\ Area} \times 100\% \quad (4)$$

Equation (4) represents the fundamental formula for estimating the percentage of non-vegetated water infiltration areas on campus. In this equation, the numerator indicates the total surface area that promotes water infiltration without vegetative cover, while the denominator represents the entire campus area. Expressing this ratio as a percentage simplifies analysis and enables clear evaluation of campus spatial planning strategies. A higher value indicates stronger institutional efforts to provide adequate infiltration zones for sustainable rainwater management.

The resulting percentage is classified into the following five categories:

[1] ≤ 2%
[2] > 2% – 10%
[3] > 10% – 20%
[4] > 20% – 30%
[5] > 30%

These categories enable the assessment of how effectively campuses are supporting environmentally responsible rainwater management. A higher category score reflects a greater contribution to flood mitigation and sustainable water resource management. Data for this indicator are obtained through interpretation of campus land-use maps, field measurements, documentation of infiltration infrastructure, and satellite imagery analysis.

Indicator SI.5 – Ratio of Green Open Space per Capita on Campus

This indicator evaluates the availability of green open space per individual on campus. It is designed to assess how well the university provides accessible, healthy, and sustainable outdoor environments for its entire academic community. Open green spaces support recreation, relaxation, social interaction, environmental education, and ecological functions such as cooling and air purification. By measuring the amount of green space allocated per capita, institutions can demonstrate their commitment to enhancing student and staff well-being, promoting sustainability values, and fostering a livable campus environment.

Population Data Required

Calculating this ratio requires accurate and comprehensive data on the total campus population. This includes:

Total Active Students

Includes all students officially enrolled and attending courses during the academic period being assessed.

Number of Registered Students (Full-Time and Part-Time)

Regular students are defined as those actively enrolled in coursework during the semester, measured as Effective Full-Time Students (EFTS). This count excludes short-term participants such as exchange students or those in temporary mobility programs.

Number of Distance Learning Students

Students who are enrolled exclusively in online programs without any physical presence on campus. Including them helps provide a full picture of the university's enrolled population while also recognizing their indirect environmental impact.

Number of Academic and Administrative Staff

Includes full-time faculty members, lecturers, researchers, and all active administrative staff employed at the university.

This detailed population data is essential for accurate calculation of the ratio and ensures that sustainability metrics reflect the true scale of service and responsibility the university manages.

The ratio is calculated by dividing the total green open space area by the total campus population. The resulting value is typically expressed in square meters per person for ease of interpretation. The following equation is used to compute this indicator:

$$Percentage = \frac{Green\ Open\ Space\ Area}{Campus\ Population} \times 100\% \quad (5)$$

Equation (5) defines the fundamental approach for determining the provision of green space per capita on campus. Here, the numerator indicates the total area of accessible green open space, including parks, lawns, gardens, and other vegetated areas designated for general use. The denominator represents the entire academic community, including students and staff. Expressing the result in square meters per person allows for meaningful comparisons across universities of varying sizes and contexts. A higher ratio indicates more generous green space allocation, supporting sustainability goals and improving quality of life on campus.

The resulting ratio is classified into the following five categories to standardize assessment and support institutional benchmarking:

[1] ≤ 10 m^2 per person
[2] > 10 – 20 m^2 per person
[3] > 20 – 40 m^2 per person
[4] > 40 – 70 m^2 per person
[5] > 70 m^2 per person

These categories enable universities to evaluate the adequacy of green open space provided for their campus community. A higher category reflects stronger institutional commitment to creating healthy, livable, and sustainable environments that support physical and mental well-being, social cohesion, and environmental education.

Data for this indicator are gathered from multiple sources to ensure accuracy and reliability, including: Direct measurements of campus green open space using GIS mapping, land-use surveys, or verified planning documents. Official university enrollment records detailing active student numbers, both full-time and part-time. Administrative records for distance learning program enrollment. Human resources databases providing counts of academic and administrative staff. Comprehensive and up-to-date data from these sources are critical for transparent reporting, institutional planning, and effective sustainability assessment.

Indicator SI.6 – Percentage of University Budget Allocated for Sustainability

This indicator measures the proportion of the university's annual budget that is specifically allocated to support sustainability initiatives. Sustainability budgets include funding for the development and maintenance of environmentally friendly infrastructure, enhancement of sustainable facilities, salaries or stipends for staff working on sustainability programs, and a wide range of activities and initiatives supporting green campus development. Evaluating this indicator reflects the university's financial commitment to integrating sustainability principles into its operations and long-term strategic planning.

The percentage is calculated by dividing the total funds allocated for sustainability purposes by the total annual university budget and converting the result to a percentage for ease of interpretation.

The following equation is used to calculate this indicator:

$$Percentage = \frac{Sustainability\ Budget}{Total\ Anual\ Budged} \times 100\% \quad (6)$$

Equation (6) illustrates the basic method for determining the university's financial contribution to sustainability. In this formula, the numerator represents the total funds dedicated to sustainability programs, while the denominator is the total operational budget for the year. Expressing this as a percentage enables clear analysis, institutional comparisons, and strategic planning to enhance sustainability funding over time.

The resulting percentage is classified into the following five categories:

[1] ≤ 1%
[2] > 1% – 3%
[3] > 3% – 10%
[4] > 10% – 12%
[5] > 12%

These categories allow universities to assess the level of financial commitment to sustainability initiatives. A higher category score indicates stronger institutional dedication to sustainable development through deliberate and measurable investment. Data for this indicator are obtained from university financial documents, annual budget reports, detailed sustainability program funding records, and confirmation from budget management units or departments responsible for sustainability expenditures.

RESULTS AND DISCUSSION

The results of the assessment for the Setting and Infrastructure category, which accounts for 15% of the total UI GreenMetric score, are presented in Table 2.

Table 2. Assessment Results for Setting and Infrastructure Indicators

No	Indicator	Maximum Points	Score Awarded
SI 1	Ratio of open space area to total campus area	300	75
SI 2	Proportion of campus area dominated by forest cover	200	200
SI 3	Portion of campus area with non-forest vegetation cover	300	75
SI 4	Proportion of campus area functioning as infiltration zones (excluding forested and vegetated areas)	200	100
SI 5	Ratio of open space area per capita for the academic community	300	0
SI 6	Proportion of annual university budget allocated for sustainability programs	200	50
Total		**1500**	**500**

Based on Table 2, the highest possible score for each indicator is used to reflect the weighting in the UI GreenMetric framework, totaling 1500 points for the Setting and Infrastructure category. The assessment results reveal that the university achieved a maximum score (100%) for SI 2, which evaluates the proportion of campus area dominated by forest cover. Meanwhile, SI 4, which assesses infiltration zones excluding vegetated and forested areas, received a score representing 50% of the maximum. The other indicators—SI 1, SI 3, and SI 6—each received scores equal to 25% of their maximum possible points. SI 5 received no points in this evaluation.

These findings indicate a structured approach to evaluating sustainability criteria on campus, highlighting the importance of green space and its ecological contributions. The perfect score for SI 2 underscores the critical role of forested areas in enhancing biodiversity and carbon sequestration. Forested zones have significant potential to store carbon, helping mitigate climate change (Samphutthanont et al., 2024; Yasin et al., 2024).

Other indicators, such as SI 4 (non-vegetated infiltration zones) with 50%, and SI 1, SI 3, and SI 6 with 25%, demonstrate differentiated priorities in ecological functions. For instance, SI 2—the importance of forest vegetation—emphasizes the role of well-preserved tree cover in carbon uptake and biodiversity conservation. Campuses with extensive forest cover can significantly reduce atmospheric CO_2 levels, as demonstrated in studies highlighting high carbon sequestration rates in green spaces (Darmawati et al., 2022). Similarly, SI 4 (non-forest vegetation and infiltration zones) contributes to ecological balance and aesthetic value. Effective management of these areas can enhance biodiversity through the introduction of diverse plant species, which is particularly important in urban university settings (Mahanani et al., 2024; Wang et al., 2022). Other sustainability indicators (SI 1, SI 3, SI 6) focus on aspects such as land conservation, water management, and institutional investment in sustainability. Prioritizing these areas can lead to improved environmental management and stronger community engagement in sustainability practices (Biswas et al., 2023)

The perfect score of 100% for SI 2 indicates that the entire campus area is classified as forest cover. This is consistent with Manado Mayor's Decree No. 05 of 2007, which designates the area around Sam Ratulangi University as part of the Manado Urban Forest. As a result, the campus maintains a well-preserved tree canopy.

Field research recorded a total of 1,972 individual trees comprising 74 different species spread across 16 research locations on the campus. These locations include various academic units and supporting facilities in the Bahu Campus area of Sam Ratulangi University, such as the Faculties of Agriculture, Animal Science, Fisheries and Marine Science, Engineering, Mathematics and Natural Sciences, Medicine, Economics and Business, Social and Political Sciences, Law, Cultural Studies, and Public Health. In addition, supporting infrastructure includes campus roads, administrative and service units (such as the central office, BRI Bank branch, library, graduate school, auditorium, and teaching hospital), as well as religious facilities (mosque and church), and open fields.

The spatial distribution of trees across the UNSRAT campus is illustrated in Figure 1, while quantitative data on tree species and numbers are presented in Table 3.

Table 3 presents the list of tree species identified during the field survey, including local and scientific names, total counts, and their distribution across 16 designated locations on the Sam Ratulangi University campus.

Based on Table 2, a total of 74 tree species were identified across the Sam Ratulangi University campus, with a total count of 1,972 individual trees surveyed at 16 locations. This finding shows a slight reduction in species richness compared to Tudiano (2016) who recorded 80 species in a similar study. This suggests that while the campus maintains substantial tree diversity, there may have been some loss of species over time.. As noted by (Wills et al., 2017), the presence of trees in urban open landscapes contributes significantly to conservation value, even when species richness is moderate. However, if a monoculture system is chosen for economic and practical reasons during early rehabilitation stages, it is essential to prioritize planting native, wind-dispersed species. This approach supports the long-term sustainability of local tree populations that play critical ecological roles.

Figure 1. Map of Tree Distribution in the Sam Ratulangi University Campus Area

Table 3. Tree Species and Their Locations on Sam Ratulangi University Campus

No	Nama Lokal	Nama Ilmiah	Jumlah	Lokasi															
				1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	Mahoni daun besar	*Swietenia macrophylla King*	521	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
2	Angsana	*Pterocarpus indicus*	200	√	√	√	√	√	√	√	√	√	√	√	√	√			√
3	Kerai payung	*Filicium decipiens*	128	√	√		√	√			√	√	√			√		√	
4	Sengon	*Paraserianthes falcataria*	98	√	√		√	√								√			
5	Mahoni daun kecil	*Swietenia mahagoni*	88	√	√		√	√			√					√			
6	Nantu	*Palaquium obovatum*	86	√	√	√	√	√	√							√		√	
7	Mangga kweni	*Mangifera odorata*	73	√	√	√	√	√		√			√			√	√		√
8	Trembesi	*Samanea saman*	68	√	√		√		√			√			√				
9	Jaran	*Lannea coromandelica*	67			√	√	√		√			√	√		√	√		√
10	Kepuh	*Sterculia foetida*	59		√	√	√	√		√	√	√	√	√	√	√			
11		*Ficus tinctoria*	41		√			√		√	√		√			√	√		
12	Spoit	*Spathodea campanulate*	40		√	√		√	√	√						√			√
13	Glodokan Tiang	*Polyathia longifoli*	39	√	√	√		√								√			√
14	Mangga	*Mangifera indica*	38	√				√			√	√	√	√	√	√			√
15	Beringin	*Ficus benjamina*	37		√	√	√			√	√	√	√			√			√
16	Kecapi	*Sandoricum Koetjape*	37		√			√	√							√			√
17	Ketapang	*Terminalia catappa*	35	√			√	√			√	√	√			√			
18	Jabon merah	*Antocephalus macrophyllus*	33	√	√		√	√											
19	Mimba	*Azadiractha indica*	25			√	√	√											
20	Bungur	*Lagerstoemia speciosa*	18													√			
21	Akasia	*Acacia auriculiformis*	15		√				√							√			√
22	Buton	*Baringtonia asiatica*	15		√		√	√	√										
23	Sukun	*Artocarpus altilitis*	14		√			√	√							√			
24	Matoa	*Pometia pinnata*	13		√	√		√		√	√	√		√		√			
25	cemara norfolk	*Araucaria heterophylla Franco*	12		√		√	√								√		√	
26	Pakoba	*Syzygium poliyanthum*	12						√										
27	Nantu Putih	*Palaquium Sp.*	11					√								√			
28	Nyamplung	*Calophyllum inophyllum*	11					√								√		√	
29	Jati merah	*Tectona grandis*	9		√											√			√
30	Kayu hitam	*Diospyros celebica*	9		√					√			√			√			√
31	Cempaka	*Michelia champaca*	7	√	√			√											
32	Kayu manis	*Cinnamomum burmannii*	7			√	√									√			
33	Aren	*Arenga pinnata*	6		√														
34	Nangka	*Artocarpus heterophyllus*	6		√	√	√	√			√								
35	Flamboyan	*Delonix regia*	5													√			
36	Karet merah	*Ficus elastica*	5													√			
37	cemara laut	*Casuarina equisetifolia*	4													√		√	
38	Dadap duri	*Erythrina variegata*	4													√			

No	Nama Lokal	Nama Ilmiah	Jumlah	Lokasi															
				1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
39	Jabon putih	*Anthocephalus cadamba*	4	√	√		√	√											
40	Jambu air	*Syzygium aqueum*	4			√									√				
41	Jambu putih	*Syzygium malaccense*	4							√	√	√							
42	Jati putih	*Gmelina arborea*	4		√					√			√						
43	Pinus	*Pinus merkusii*	4			√		√								√			
44	Rambutan	*Nephelium lappaceum*	4		√	√										√			
45	Kedondong	*Spondias dulcis*	3		√					√									
46	Makaranga	*Macaranga serratifolia*	3													√			
47	Pangi	*Pangium edule Reinw.*	3													√			
48	Petai cina	*Leucaena leucocephala*	3			√		√											
49	Pucuk merah	*Syzygium myrtifolium*	3													√			
50	Alpukat	*Persea americana*	2				√									√			
51	cemara kipas	*Thuja orientalis*	2		√														
52	Gamal	*Gliricidia sepium*	2						√										
53	Jambu monyet	*Anacardium occidentale*	2		√											√			
54	Jambulang	*Syzygium cumini*	2		√														
55	Johar	*Cassia siamea*	2													√			
56	Kamboja	*Plumeria Tourn*	2													√			
57	Laping kubu	*Melanolepis multiglandulosa*	2													√			
58	Pelahlar	*Dipterocarpus littoralis Blume*	2										√			√			
59	Ulin	*Eusideroxylon zwageri*	2			√													
60	Buah kondang	*Ficus variegata*	2	√				√			√								
61	Belimbing	*Averrhoa carambola*	1																
62	Cempedak	*Artocarpus integer*	1		√														
63	Durian	*Durio zibethinus*	1																
64	Jambu biji	*Psidium guajava*	1													√			
65	Kayawu		1									√							
66	Kayu mas	*Nuclea orientalis*	1					√											
67	Kenari	*Cannarium commune*	1													√			
68	Kersen	*Muntingia calabura*	1		√														
69	Ketapang kencana	*Terminalia mantaly*	1		√														
70	Pulai	*Alstonia scholaris*	1			√													
71		*Ficus alba*	1													√			
72	Kayu auto	*Sterculia macrophylla*	1		√														
73		*Sterculia triloba*	1		√														
74	Mengkirai	*Trema orientalis*	1		√														

Dominant tree species also shape the structure and function of campus forest ecosystems. Limiting functional types based on dominant species can help in understanding the structural framework, ecological functions, and species distribution of these urban forest ecosystems.

One important factor affecting species diversity on campus is damage caused by extreme weather events. Strong winds and storms have caused tree failures, reducing the number of species observed. For example, Ficus minahasae, a species previously recorded, was removed due to safety concerns. Hughes et al., (2023) identified high wind speeds—exceeding 40 m/s (90 mi/h)—as a major risk factor for tree falls, often leading to significant infrastructure damage. Similarly Lorenz et al., (2024) emphasized that prolonged exposure to strong winds, combined with wet soil conditions, increases the likelihood of tree failures, further highlighting the challenges of managing urban forest cover in tropical climates.

Despite these challenges, the Sam Ratulangi University campus still supports a substantial number of trees distributed across diverse academic and administrative facilities. The tree cover contributes to environmental quality, carbon sequestration, microclimate regulation, and the aesthetic character of the campus. These findings underscore the importance of ongoing management strategies that balance safety, biodiversity conservation, and sustainability goals.

The distribution of tree species by diameter class on the Sam Ratulangi University campus is summarized in Table 3 below. This table provides an overview of the size structure of the tree population, which is an important indicator of stand development, age distribution, and management history.

Table 3. Number of trees by stem diameter class

No	Diameter Class (cm)	Number of Trees	Proportion (%)
1	20–30	716	36.31
2	30–40	474	24.04
3	40–50	278	14.10
4	50–60	166	8.42
5	60–70	133	6.74
6	70–80	79	4.01
7	80–90	40	2.03
8	90–100	29	1.47
9	>100	57	2.89
	Total	**1972**	

As shown in Table 3, the majority of trees are concentrated in the smaller diameter classes, indicating a generally young or regenerating stand structure. The largest number of trees (716) is found in the 20–30 cm diameter class, which represents 36.31% of the total tree population on the Sam Ratulangi University campus. This suggests that a significant proportion of the stand consists of relatively young or fast-growing individuals. In contrast, only 29 trees (1.47%) have diameters in the 90–100 cm class, reflecting the presence of older or slower-growing individuals. The presence of trees in the >100 cm class (2.89%) also indicates the survival of some mature individuals that may contribute to biodiversity and ecological stability. Overall, the diameter distribution pattern can provide insights into the stand's age structure, management practices, and natural regeneration dynamics.

These variations in diameter size are influenced by differences in planting periods, as well as a range of biophysical and ecological factors Sharma et al., (2019) explain that tree diameter variability can result from multiple interacting factors:

1. Site quality, such as soil fertility, moisture availability, and light conditions, which directly affect tree health and growth rates over time. High-quality sites tend to support faster growth and larger diameters, while poor sites may limit development.

2. Genetic variation, both among and within species, which leads to differences in growth potential and maximum achievable diameter. Certain species or genotypes are inherently capable of growing larger or faster under comparable conditions.
3. Disturbances, including pest and disease outbreaks, physical damage from wind or human activities, or competition among trees, which can restrict growth and lead to smaller diameters. Disturbances can also alter stand structure by selectively removing or suppressing certain individuals, thereby influencing the overall diameter distribution.

Understanding these factors is essential for designing appropriate management strategies, promoting stand resilience, and maintaining ecological functions on the university campus. Such knowledge can support sustainable urban forestry planning and contribute to broader environmental goals.

CONCLUSION

This assessment of Sam Ratulangi University's campus using the UI GreenMetric Setting and Infrastructure indicators reveals both encouraging strengths and important areas for improvement. The university earned 500 out of a possible 1,500 points in this category, achieving the highest score in SI 2 for maintaining significant forest vegetation cover. However, the campus received no points for SI 5, which measures green open space per capita, highlighting the need for more accessible and well-distributed green spaces for students and staff. The tree inventory documented 74 species and 1,972 individual trees across the campus, with Swietenia macrophylla as the dominant species. While this reflects substantial existing tree cover, improving species diversity and green space accessibility will be essential to support sustainability goals.

For future work, assessments should be expanded to include other Unsrat campuses, such as the Malalayang Medical Campus, Wailan Experimental Garden, and Sea Garden, to build a complete picture of the university's green space management. Further research should also examine the role of campus forests in carbon sequestration and oxygen production to better understand their environmental contributions. It is recommended that the university develop integrated green space planning strategies that prioritize equitable access, increase biodiversity through native species plantings, and enhance the overall quality and sustainability of the campus environment. Such efforts will support not only higher UI GreenMetric rankings but also the well-being of the entire academic community

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