"Evaluating the Functional Efficiency of Campus Green Spaces from an Environmental Sustainability Perspective: A Case Study of Diyala University"

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Abstract

Higher education institutions are increasingly expected to transform their campuses into environmentally sustainable environments that address ecological challenges while serving the needs of local communities. This study assesses the functional performance and sustainability of green spaces at Diyala University, whose campus covers an area of 1,654,774 m² and is designed to accommodate 12,000 students. Based on the UI Green Metric framework, the spatial analysis revealed that barren and undeveloped land accounts for 53.1% (576,145 m²) of the total master plan area (1,086,352 m²), whereas vegetation cover occupies only 30.7% (333,900 m²), and built-up areas constitute 6.8% (74,267 m²). A weighted Goal-Achievement Matrix (GAM) was applied to evaluate 25 planning and design criteria across three campus zones. The results indicated that overall functional performance was poor, with scores of 41 for Zone A, 30 for Zone B, and 42 for Zone C, all of which fell below the minimum acceptable threshold of 50 points. The main factors contributing to this poor performance included severe soil salinity associated with inadequate drainage infrastructure, the absence of modern drip irrigation systems, and the lack of an integrated sustainable environmental management plan. The study provides practical assessment metrics and strategic guidelines to support university administrators and facilities management teams in improving campus landscape planning, waste management, and resource allocation.

Keywords: Sustainable campus, university green spaces, Goal-Achievement Matrix, landscape architecture, UI GreenMetric, Diyala University.

Introduction

Universities occupy the pinnacle of higher education and scientific research, and are considered the cornerstone of advancing research and scientific progress. In light of global transformation, the role of universities has emerged as an institutional model that integrates sustainability into all its functions. A sustainable university is not merely a campus for education, scientific and academic research, community service, and green spaces; rather, it is an institution that redefines its mission, curricula, and administrative systems to mitigate environmental problems resulting from the misuse of resources, a problem that has begun to affect all of humanity (19). As a global institution, the university can play a fundamental role in scientific research and in preparing distinguished researchers and specialists in research centers who provide

educational programs in the field of the environment that can raise collective environmental and cultural awareness of sustainability, and contribute effectively to confronting those risks and challenges and play a developmental role in achieving the Sustainable Development Goals (18). Establishing a foundational framework driven by university administration to implement sustainability programs across all aspects of campus life (from the planning and design of facilities and green spaces to academic instruction and the ongoing guidance provided to the university community, including faculty, staff, and students) fosters development that is highly beneficial for those just beginning their journey. In doing so, universities chart a clear path toward implementing the components of sustainable campus development such as optimizing the quality of educational environments by establishing diverse, reliable criteria to measure campus sustainability. The success of this approach relies on the active participation of all stakeholders including staff in formulating policies and standards. This includes, most notably, the development of "green" organizational frameworks aimed at fostering a deeper human connection to the environment, promoting environmental awareness, and ensuring equity in the distribution of resources. equitable resource distribution (13). Therefore, evaluating the efficiency of green spaces on the University of Diyala campus is a pressing necessity; such an assessment is essential to identify functional challenges and issues, enhance efficiency, improve operational performance, and align these spaces with sustainability principles.

Research hypothesis:

The hypothesis regarding the functional roles of green spaces at the University of Diyala varies according to the extent to which established design and planning standards are applied specifically concerning the distribution and spatial organization of the various units of vegetation. This assessment is based on a quantitative evaluation matrix that utilizes weighted factors determined by the researcher..

Data Used and Scope of the Study

The study is situated within the campus of Diyala University in Diyala Governorate, and the dataset was obtained from official sources.

Research Methodology and Organization

The study employed a quantitative, descriptive methodology to present the elements of the research problem. It also utilized criteria incorporated into a statistical matrix to evaluate the efficiency of the spaces through direct observation, drawing upon the researcher's expertise in the field. The research was organized into two dimensions: theoretical and applied.

First axis

First: The Concept of Green Spaces

It is an urban space that yields public benefits, fulfilling recreational, health, climatic, and social functions (7). (8) defined green and open spaces as the art of

integrating architecture with its surroundings; the term "art" is used here to denote the harmonious composition of land topography, vegetation, and pathway surfacing elements that combine to create a cohesive artistic tableau. Furthermore, green spaces and their design guide urban planning and serve the function of supporting sustainability (15).

Secondly: The Sustainable University

A sustainable university integrates environmental stewardship, academic research, scientific research, and community engagement into its core institutional framework. It embeds ecological principles into its educational mission, administrative policies, and daily operational practices. Beyond internal campus development, such an institution actively generates a positive socio-ecological impact by implementing best practices in green technology, reducing resource consumption, and serving as a living laboratory for sustainable, ecofriendly applications(11).

Thirdly: The Importance of Sustainability in the University Environment

The importance of sustainability lies in its capacity to ensure long-term environmental balance and to protect the natural systems and resources essential for human survival and prosperity. Furthermore, sustainability is pivotal in addressing global challenges such as climate change, resource depletion, and global warming thereby ensuring a just and sustainable world while safeguarding the rights of future generations (1). Regarding the university environment specifically, universities play a vital role in promoting sustainability through research, education, events, and institutional practices (14). indeed a university campus can be viewed as a small city with its own water consumption patterns.

Fourthly: Green spaces and their functions within the sustainable university campus.

Green spaces on university campuses offer opportunities for direct interaction with nature, foster effective social activities, and cultivate a sense of belonging to the institution. Addressing the growing societal challenges associated with stress-inducing conditions which can negatively impact physical and mental health requires an understanding of how green spaces and landscape design elements can improve psychological well-being. This knowledge is essential for developing design and planning solutions that effectively respond to the diverse health challenges affecting human well-being (9).

1- The environmental importance of green spaces within a sustainable university campus.

Higher education institutions are taking measures to reduce their impact on climate change and enhance sustainability. Some institutions have conducted greenhouse gas emission inventories as a first step toward achieving the desired transformation. Examples include the University of Cape Town (South Africa), Clemson University (USA), and De Montfort University (UK) (16). for vibrant green spaces and the improvement of the urban environmental landscape; green infrastructure contributes to enhanced air quality and the regulation of local microclimates in urban areas. Numerous studies have examined the impact on the "urban heat island" phenomenon,

concluding that temperature spikes often amounting to several degrees—can be mitigated through the effective transpiration and shading provided by such smart green cover (5).

2- The health and psychological importance of green spaces within a sustainable university campus.

Society faces mounting challenges across various spheres of life, negatively impacting mindsets and fostering feelings of frustration and stress. Consequently, the university tracks its progress, sets improvement goals, and demonstrates a commitment to sustainability through initiatives such as creating green spaces, implementing green building practices on campus, managing non-renewable resource use, reducing energy consumption, and managing waste all of which serve to create healthy learning environments and foster collective awareness among students (6).

3- The cultural and social dimension of green spaces within the sustainable university campus.

University green spaces positively impact health and foster social connections among those who live, work, and spend time within them including students, faculty, and staff (7). Furthermore, students who spend more time enjoying natural scenery exhibit higher levels of interaction and engagement in various academic activities, thereby contributing to the creation of an interactive and more cohesive university environment.

Fifth: Sustainability Efficiency Scale for University Green Spaces:

Launched in 2010 by the University of Indonesia, the "Green Metric" ranking later established as a global benchmark for university sustainability was created to measure campus sustainability efforts, track institutional trends, and encourage the adoption of green practices in both current and future operations. As the only ranking of its kind dedicated to assessing green commitments, it evaluates infrastructure, green spaces, energy usage (particularly renewable sources), and the relationship between the institution and climate change. It also assesses waste management practices, including the types of waste generated and the methods used for handling and disposal.

Sixth: Indicators and standards adopted for measuring green spaces within the university campus.

A green campus represents the first step toward a university that operates from a sustainability perspective; a study by (10). highlights the growing demand for higher education institutions to lead the transition toward sustainable development by adopting green campus practices. (23) An indicator for measuring sustainability in universities; the indicators were subsequently modified in 2011. In 2012, the indicator regarding a drug- and smoke-free campus environment was removed, and 33 indicators were adopted to evaluate campuses including their green spaces. Changes continued through 2018, reflecting a growing focus on the role of universities in achieving Sustainable Development Goals; consequently, new indicators were added, such as the campus area covered by trees, shrubs, and green spaces. The current focus on the role of "green universities" is defined by six approved indicators and criteria: Setting and Infrastructure, Energy and

Climate Change, Waste, Transportation, and Education. See Tables (1) and (2).

Table (1) The six main criteria of the Global Green Metric for sustainable university rankings.

15% of the points; total of 1,500 points.	**University Infrastructure and Facilities Standard**	**The First Criterion**
200	.The ratio of open spaces to the total area of the university	1

Table (2) Sub-criteria for the infrastructure criterion in sustainable universities

Ratio of the standard to the total	**The Standard**	**NO.**
%15	Location and Infrastructure	1
%21	Energy and Climate Change	2
%18	Waste recycling	3
%10	Water	4
%18	Transportation	5
%18	Education and Scientific Research	6
%100	Renal	

Source:(17)

100	Total area of the university campus covered by trees	2
200	Total campus area covered by green spaces	3
100	Total campus area designated for water absorption	4
200	The total area of the university campus divided by the total number of individuals.	5

Source:(17)

Seventh - Diyala University and the application of sustainability principles

Diyala University is a leading academic institution in Iraq, located in Baqubah the capital of Diyala Governorate and comprising numerous faculties. The university places great emphasis on implementing sustainability programs through a wide range of activities, initiatives, and volunteer work. Notably, by adopting the sustainability guidelines set forth by the World Health Organization, the university enhances its standing and attracts researchers, academics, and organizations interested in sustainability. The following are Diyala University's key efforts in the field of sustainability:

1- Afforestation and Anti-Desertification Campaigns:

The university organized a major afforestation campaign across its various faculties to mark Afforestation Day.

2- The agricultural team at the University of Diyala:

continues its efforts to maintain the university's gardens including their plant components and to expand green spaces, thereby enhancing the infrastructure that serves both aesthetic and environmental functions.

3- **Scientific Endeavors:**

Recent studies, seminars, and symposia organized at the university have focused on topics such as green spaces and environmental sustainability. These initiatives contribute to the advancement of scientific knowledge in these fields and support the dissemination of related information.

4- Use of Clean Energy:

As part of its commitment to social development, the university is working to

promote the conservation of natural resources and encourage the adoption of new technologies and energy sources, with the aim of mitigating harmful impacts on the university environment.

5- Promoting Environmental Awareness:

The university organizes conferences and seminars designed to raise environmental awareness and discuss strategies for achieving development goals, while also addressing the challenges that hinder such progress and exploring potential solutions.

6- External Engagement:

The university collaborates with local authorities most notably the Diyala Provincial Council to address relevant regional issues. This partnership explores various areas of cooperation, including support for local development and fostering growth within the province.

Eighth: Challenges facing Diyala University regarding the sustainability of green spaces.

The key challenges facing the green spaces within Diyala University are as follows:

1- Administrative Challenges:

Administrative procedures and the level of coordination among various departments and stakeholders can influence the planning, implementation, and sustainability of green **space development projects. This, in turn, may affect project timelines and management efficiency.**

2- Urban Expansion Challenges:

The expansion of buildings and facilities within the campus can limit opportunities for creating new green spaces or enlarging existing ones—particularly if sustainable planning requirements are overlooked, or if there is a failure to strike a balance between urban growth and the preservation of vegetation cover.

3- Environmental Plans:

The absence of comprehensive environmental plans for the development, maintenance, and upkeep of green spaces leads to the implementation of unsustainable environmental projects. Therefore, an integrated and comprehensive environmental plan must be adopted one that incorporates sustainable irrigation, preserves existing plant diversity (such as evergreen trees), and enhances green spaces.

4- Lack of Specialized Expertise in Landscape Architecture and Urban Environmental Planning:

It is essential to engage professionals with scientific and design expertise in landscape architecture, natural resource management, and smart, sustainable agriculture; the absence of these specialized skills hinders effective planning and successful project development.

5- Plant Selection:

Those responsible for vegetation cover must carefully select plants that are suited to the university's environmental conditions. Given Iraq's high summer temperatures, improper selection can compromise the successful

growth of vegetation. 6- Regarding irrigation resource management:

Moving away from traditional irrigation methods which result in high water consumption—in favor of modern techniques such as drip irrigation, smart watering systems, or the use of treated water.

7- Promoting environmental awareness and cleanliness:

A lack of environmental awareness and disregard for the cleanliness of green spaces among the university community can undermine efforts to enhance these areas; this may lead to irresponsible use, negligence, and the ultimate failure of service-oriented projects.

8- University financial resources:

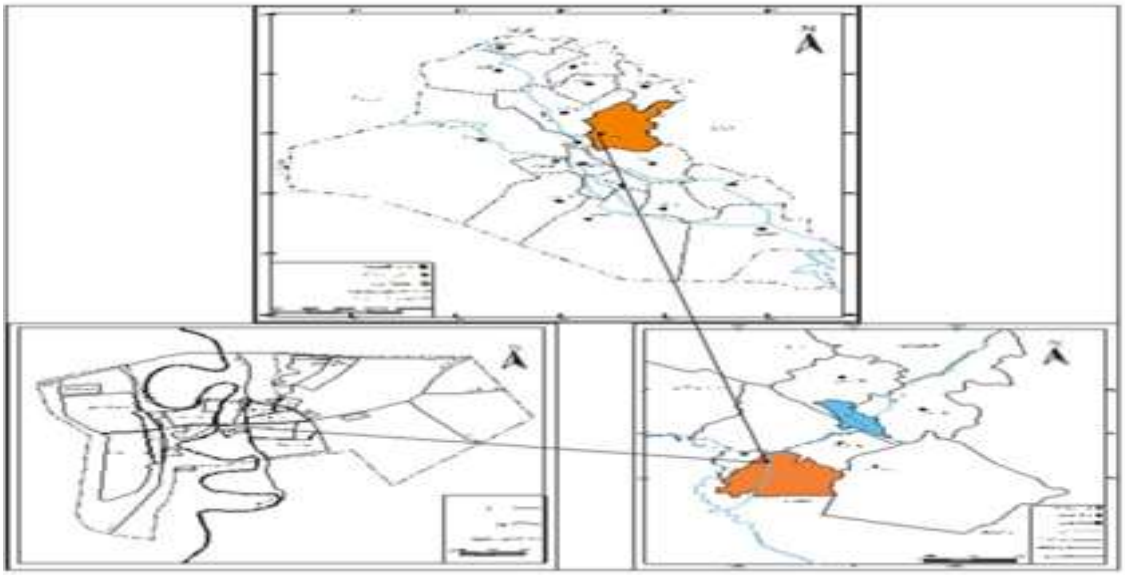
Limited or insufficient financial resources represent a major challenge to developing green spaces at Diyala University. Establishing, enhancing, maintaining, and ensuring the sustainability of green areas requires significant funding, yet allocated budgets may prove inadequate due to competing priorities regarding the development of university infrastructure.

Second axis

Study site presentation indicators

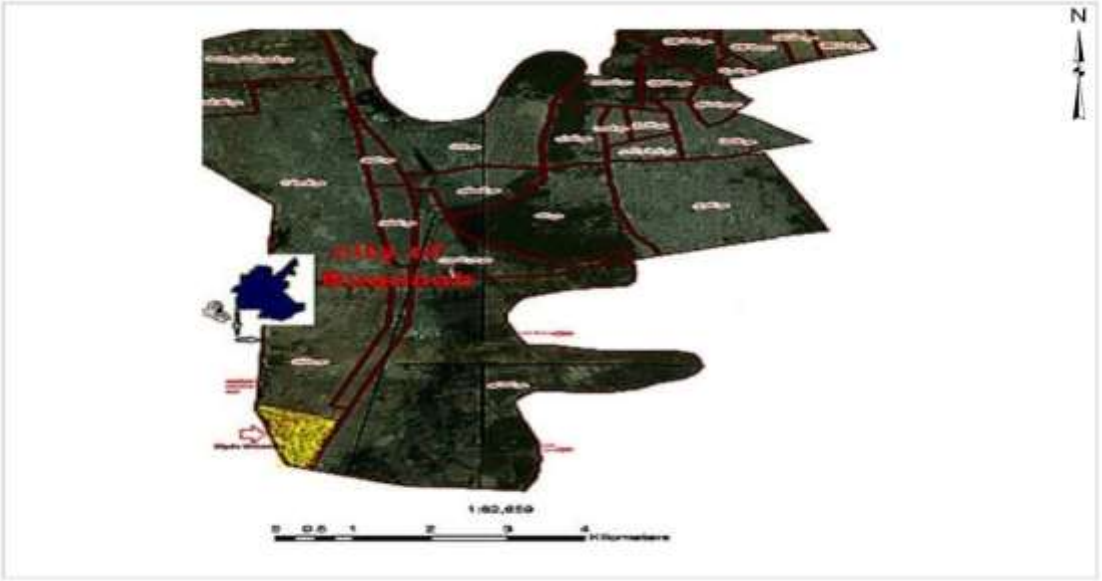
1- Astronomical and Geographical Location of Diyala University:

Diyala University was established in 1999 in the city of Baqubah the administrative center of the Baqubah District and Diyala Governorate in Iraq situated in the eastern part of central Iraq. The city of Baqubah itself lies in the southwestern part of the governorate, approximately 63 km northeast of the capital, Baghdad (see Map 1). Geographically, it is located between latitudes 33.39° and 33.47° North and longitudes 44.35° and 44.40° East (Al-Uqabi, 2017). Diyala University covers an area of 1,654,774 m² and is considered a medium-capacity university; upon the completion of all its service facilities, it is designed to accommodate 12,000 students. Notably, the university's location offers easy accessibility from all parts of the Diyala Governorate (see Map 2).



Map (1) The location of the city of Baqubah in Iraq and Diyala Governorate..

Source: Research preparation.



Map (2): Diyala University, from the city of Baqubah.

Source: (12).

2- Data collection for the study site.

Data was gathered through field surveys, a review of available architectural master plan drawings (Figure 1), site visits to the university campus, and personal interviews with relevant stakeholders.



Figure (1) Diyala University Campus Plan

Source: Diyala University website.

3: Land uses of the Diyala University campus.

The following table shows land use within the Diyala University campus.

Table (3): Table (3) Diyala University Population

The number of postgraduate students	Number of undergraduate students	Number of faculty members	Total number of university employees	Formation Name	NO.
—	___	94	2546	University Presidency	1
145	6143	205		Basic Education	2
469	6793	164		Education for Humanities	3
84	2088	197		Engineering	4
234	2744	175		Science	5
128	2005	98		Education for Pure Sciences	6
77	1650	104		Physical Education and Sports Sciences	7
44	1781	45		Law and Political Science	8
5	1381	75		Medicine	9
32	302	60		Veterinary Medicine	10
—	916	29		Fine Arts	11
18	1570	42		Administration and Economics	12
20	1866	59		Islamic Sciences	13
97	438	90		Agriculture	14
—	795	22		Al-Miqdad College of Education	15

Source: The researcher, based on official data.

3: Land uses of Diyala University.

A study conducted by (12) evaluated Diyala University in terms of landscape design and planning. The findings revealed that the actual building footprint covered only 6.8% of the area, whereas the 2010 master plan had allocated 51.6% for buildings. Open spaces accounted for 53.1% of the total area, while the circulation network occupied 6.85% and green spaces covered 30.7%. These figures indicate that the Diyala University campus is still in the early stages of developing its designated land uses; currently, the majority of the site consists of open land that has not yet been utilized for green spaces, road construction, or building development (Table 4).

Table (4) Land uses, total area, and percentage of occupied area

NO.	the site	Occupied area (m^2)	Percentage of occupied area of total area
1	Vegetation cover areas	^{2}م 333900	%30.7
2	Barren areas (open land without (vegetation cover	^{2}م 576145	%53.1
3	Circulation System (Roads and (Movement Paths	^{2}م 74418	%6.85
4	(Pitches (natural + artificial	^{2}م 27622	%2.55
5	Building area	^{2}م 74267	%6.8
6	Total campus area	^{2}م 1086352	%100

Source: (12)

4: Implementing the campus efficiency assessment form.

In this section, a goal-achievement matrix developed by the researcher based on specialized expertise in landscape engineering and repeated site visits is used to evaluate the effectiveness of the university's landscape areas. Weighted criteria were established with specific justifications, and twenty-five criteria were adopted to measure goal achievement, based on a division of the university’s master plan into three distinct zones (Figure 2). Data collection, investigation, and field observations were conducted to identify the strengths and weaknesses of the studied spaces within these zones. Finally, conclusions and recommendations were formulated to assist relevant authorities in improving the design of the university's green spaces.



Source: (12) with modifications by the researcher

Table (5) Sample Functional Efficiency Assessment Form for Green Spaces

Justifications	Weighted weights			The Element	NO
	1	2	3		
Suitable for serving the largest possible number of the university community				Location of green spaces	1
Compliant with approved campus standards and recommendations				Total green area	2
Service development, monitoring, maintenance, and continuity				Green space management	3
Provides aesthetic appeal, shade, and air purification				Trees and shrubs	4

Aesthetic, recreational, and open-space qualities; temperature reduction				Lawns and turf areas (quality and extent)	5
An environmental, psychological, aesthetic, and landscaping necessity				Flowers	6
Connecting locations and guiding movement				Pathway layout	7
An essential haven for enhancing daily quality of life				Areas for reading and relaxation	8
Ensuring visitor comfort				Shaded seating areas	9
Adds value to the site; serves as a platform for academic events and cultural activities				Amphitheater for scientific and cultural performances	10
Health benefits, leisure, and strengthened social bonds between students and staff				Tennis courts	11
Traffic organization and site safety				Parking areas	12
Cultural value; building collective awareness; preserving identity and memory				Cultural or scientific monuments	13
Soothing psychological, aesthetic, and environmental impact; breaking monotony				Water features	14
Cleanliness and public health; prevention of visual and environmental pollution				Recycling bins	15
Enhanced safety, improved night-time mobility, and aesthetic appeal				Lighting	16
Quality of life, psychological well-being, and an embodiment of environmental awareness and citizenship				Cleanliness	17
Creating a flexible environment for learning and social interaction; mood improvement; enhancing academic quality of life and health				Cafeteria, restaurant, and other services	18

Achieving visual, functional, and environmental cohesion				Spatial unity and integration	19
Campus sustainability and a stimulating educational environment				Maintenance	20
Achieving sustainability, reducing energy consumption, and ensuring a healthy environment				Energy reduction through green building practices	21
Technological advancement and the creation of a sustainable campus				Use of clean energy (solar panels)	22
Measuring environmental efficiency and plant-based pollution reduction; ensuring a healthy environment				Pollution monitoring systems	23
Environmental protection, congestion reduction, and an aesthetic, healthy, educational appearance				Public transport	24
A planning and rights-based necessity that ensures inclusivity and a fair educational environment				Accessible pathways for people with special needs	25

The questionnaire was designed by the researcher.

Weighted weights:-

1 = (Element criterion) Not found, not suitable.

2 = (the element standard) is relatively present, fairly suitable.

3 = (Element criterion) Present at a good level; highly suitable.

Table (6) Assessment of the functional efficiency of green spaces on the Diyala University campus.

(Goal Achievement Matrix)

The table was prepared by the researcher based on field visits and observations.

Following the administration of the questionnaire, the results shown in the table were obtained.

3 + 2 + 1 % 3 = 2 (Multiplying the arithmetic mean by the number of criteria).

zone	Location of green spaces	Total green area	Green Space Management	Trees and shrubs	Green spaces in terms of quality and area	Flowers	Organizing the corridors	Places for reading, study, and relaxation	Shaded seating areas	Amphitheater for scientific and cultural performances	Tennis courts	Vehicle parking lots	Cultural or scientific monuments	The element of water and its forms	Waste containers designated for recycling	Lighting	cleanliness	Cafeteria, restaurant, other services	Unity and integration of space	Maintenance work	Reducing energy consumption through green buildings	Using clean energy via solar panels	Presence of pollution-level measuring devices	Mass transit	Accessible pathways for people with special needs
A	2	2	3	2	2	1	2	2	2	1	1	2	1	2	1	2	2	2	2	2	1	1	1	1	1
B	2	2	1	1	1	1	2	1	2	1	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1
C	3	2	2	2	2	1	2	1	2	1	1	2	2	1	2	2	2	2	2	2	1	1	1	1	1

2 × 25 = 50: The arithmetic mean of the functional efficiency of green spaces for each zone.

Zone 1 (41) point. Zone 2 (30) points. Zone 3 (42) points.

The results in the table above indicate that none of the selected areas exceed the arithmetic mean. The combined performance weighting of the three areas relative to this mean reveals that the functional performance level of all green spaces on the campus under study is "poor"; consequently, they fail to meet the service requirements for which they were designed

.

Conclusions

1. The study areas within the University of Diyala campus exhibit deficiencies in their green spaces relative to planning and environmental requirements based on the assessment criteria adopted in this research.

2. The assessment reveals shortcomings in the planning of open and green spaces, particularly regarding the organization of their functional elements, which in turn impairs their operational efficiency.

3. Soil salinity and issues with water drainage serve as environmental constraints that hinder the growth of vegetation in certain study areas.

4. There is a clear need to integrate the various components of these green spaces addressing both their physical and environmental aspects to ensure their sustainability and functional efficiency.

5. Sustainability efforts on campus face challenges related to the management of modern technology, the rationalization of irrigation water, the preservation of vegetation, and the development of transportation and infrastructure.

6. The assessment matrix employed in this research provides a framework for organizing the design elements of green spaces, identifying specific shortcomings, and applying weighted values as determined by the researchers**.**

Recommendations

1. Urban Planning and Green Spaces .

The study addresses the integration of green project development and the expansion of green spaces into the urban and environmental planning of the campus, while establishing criteria for professional staffing, expertise, and environmental sustainability requirements

2. Electronic and Campus Management

A comprehensive plan for the campus must be developed, addressing issues such as soil salinity and water drainage, as well as irrigation management and the preservation of campus vegetation—all of which contribute to green sustainability and its functional objectives.

3. Sustainable Resource Management.

Efforts should focus on developing waste management systems, promoting water conservation, and utilizing clean energy sources, all as part of the transition toward a more sustainable university.

4. Sustainable Transportation.

The study explores the development of collective transport systems within the campus and encourages the use of smaller-scale modes of transport, aiming to mitigate the negative environmental impacts of vehicular traffic on the quality of the campus environment.

5. General Administration and Community Engagement. A comprehensive campus plan is essential; it should identify stakeholders, outline

implementation phases, and establish monitoring mechanisms to ensure that green projects are integrated into development planning, thereby enhancing the quality of the campus environment and its operational .efficiency

6. Awareness and Engagement .

Promoting awareness programs among students and the university community, while encouraging active participation in the preservation of green spaces and the responsible use of resources, fosters a meaningful contribution to the university's sustainability goals

References

1. Ada, C., & Karakaya, A. F. (2024). Integrating UN Sustainable Development Goals into campus planning: Pathways for higher education institutions. Gazi University Journal of Science, Part B, 12(1), 47–69.
2. Al-Bastanji, Q. F. A. Q. (2024). The importance of green infrastructure in establishing environmentally friendly cities within municipalities. Journal of Humanities and Natural Sciences (HNSJ), 5(3).
3. Al-Oqabi, M. R. Z. (2017). A study of the current status of the "Between the Two Bridges" Park in Baqubah City and the preparation of a design proposal for its development [Master's thesis, University of Diyala].
4. Al-Zuhairi, R. W., Ali, A. B., Zaman, M. R., & Khorsheed, G. K. (2026). Employing remote sensing technologies in greenbelt design and combating desertification: A case study of Baqubah district. Diyala Agricultural Sciences Journal, 18(1), 194–210.
5. Barnett-Itzhaki, Z., Tifferet, S., Berkowic, D., Arviv, T., Daya, A., Romano, G. H. C., & Levi, A. (2025). Strategies and challenges for green campuses. Frontiers in Sustainable Cities, 7, Article 1469274.
6. Belkacemi, H. (2019). L'espace vert public à Biskra entre la planification et l'application [Master's thesis, Université Mohamed Khider].
7. Dober, P. R. (2000). Campus landscape: Functions, forms, features. John Wiley & Sons.
8. Dunnett, N. (2006). Green roofs for biodiversity: Reconciling aesthetics with ecology. In Proceedings of the 4th Annual Greening Rooftops for Sustainable Communities (pp. 11–12).
9. Frizon, J. A., Eugénio, T., & Frizon, N. N. (2024). Green campus and student proactivity initiatives: The importance of a participatory approach. International Journal of Sustainability in Higher Education, 25(6), 1279–1296.
10. Geok, T. K., Shah, A., Goh, G. G. G., & Zeb, A. (2024). The links between sustainability dimensions and green campus initiatives in mountain universities. Journal of Infrastructure Policy and Development, 8(9), Article 7653.
11. Ismail, R. W. M. (2021). Evaluation of planning and design principles for a sustainable natural landscape on the Diyala University campus [Doctoral dissertation, University of Baghdad].
12. Lee, J. H., & Huang, R. (2023). Financial mechanisms for green university transformation. Journal of Educational Administration, 61(2), 234–256.
13. Morelli, J. (2020). Environmental sustainability: A definition for environmental professionals. Journal of Environmental Sustainability.
14. Qiu, J., Nassauer, J. I., Ahern, J., Huang, L., Reed, J., Ding, S., Guo, J., Liu, Z., Ou,

W., Ouyang, Z., Shi, P., Tao, Y., Yang, R., Zheng, X., & Wu, J. (2025). Advancing landscape sustainability science: Key challenges and strategies for integration with landscape design and planning. Landscape Ecology, 40, Article 25.
15. Sevval, E., & Çalışkan, E. B. (2026). Master plan compliance of Turkish university campuses: A functional land use assessment via satellite imagery. Journal of Polytechnic, 29(5), 290503, 1–21.
16. Silva, L. B., De Almeida Rocha, T., Albuquerque, T. P., De Fatima Silva, V., De Freitas, M. F., & Jacovine, L. A. G. (2024). Carbon balance in educational institutions: Greenhouse gases emission and carbon removal inventory. In World sustainability series (pp. 321–339). Springer.
17. UI GreenMetric. (2023). UI GreenMetric World University Ranking guidelines. University of Indonesia.
18. UIGWURN. (2023). Green Metric World University Ranking: Innovation, impacts and future direction of sustainable universities. University of Indonesia.
19. Waer, H., & Gamage, K. T. (2021). Barriers to implementing green university initiatives: A case study approach. Sustainability, 13(8), Article 4256.