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Systematic Spatial Analysis and Planning of The Recreation Corridor in The University of Calabar: Implications for A Healthy Academic Environment

Linus B. Akeh [a], Clement B. Anake [b], Isor I. Igah [b],

[a] Department of Geography and Environmental Science, University of Calabar, Nigeria. [b] Department of Hospitality and Tourism Management, University of Calabar, Nigeria.

ABSTRACT
Recreational spaces play a vital role in shaping healthy university environments by supporting physical activity, mental well-being, social interaction, and overall campus experience. Although the University of Calabar has a wide range of recreational facilities, they remain spatially fragmented and poorly connected. This study applied a detailed geospatial analysis to examine the distribution, density, and connectivity of recreational nodes and to evaluate their potential for the development of an integrated campus-wide recreation corridor. Nineteen recreation and social nodes were geo-referenced using GPS (WGS 84) and analysed through spatial plotting, Haversine-based geodesic distance measurement, kernel density estimation, and Minimum Spanning Tree (MST) network optimisation. Field observations further assessed land-use context, pathway condition, accessibility, and environmental quality. Results revealed a clear tri-cluster spatial structure comprising administrative-academic, student-residential-recreational, and institutional-public activity zones. Kernel density mapping identified a high-intensity recreational belt along the Malabor–Stadium–Library axis, with average inter-node distances of 120–150 metres, indicating strong walkability potential. The MST generated an efficient network of 3.17 km, representing the minimum corridor length required to connect all nodes. Central belt connections showed short links of 60–90 metres, reflecting high pedestrian integration, while peripheral connections highlighted gaps requiring pathway enhancement. Overall, the proposed corridor aligns well with existing movement patterns and offers significant benefits for active mobility, spatial equity, social interaction, campus wellness, and environmental sustainability. The study presents a practical, geospatially informed framework to guide recreation-oriented campus planning at the University of Calabar and similar institutions.

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1 Introduction

Recreation is a fundamental component of human well-being, contributing significantly to physical health, emotional balance, social interaction, and cognitive performance. Historically, recreation has been recognised not merely as leisure but as a vital human function that restores energy, stimulates creativity, and enhances productivity (Payne et al., 2010). Within university environments, its importance is heightened because campuses are inherently high-pressure settings where students and staff contend with academic demands, psychological stress, and, at times, social isolation. Studies show that access to well-planned recreational environments improves mental health, learning outcomes, student engagement, and overall campus satisfaction (Rao et al., 2023; Hu et al., 2025).

As universities expand in size, enrolment, and functional complexity, the spatial planning of recreational spaces becomes a strategic necessity rather than a cosmetic consideration. Campus environments shape movement patterns, social interaction, environmental experience, and the balance between academic life and healthy living (Akeh et al., 2023). Recreational corridors are continuous networks of open spaces, pedestrian routes, green areas, and social nodes. Recreation corridors have emerged globally as effective planning tools for enhancing campus liveability, walkability, social cohesion, and sustainable mobility (Giles-Corti et al., 2022; Nasution et al., 2023).

In many Nigerian universities, including the University of Calabar (UNICAL), recreational spaces exist but remain spatially fragmented and poorly integrated. Uncoordinated development, infrastructure expansion, and limited spatial control have resulted in scattered facilities connected by unsafe footpaths, informal shortcuts, or short vehicular trips. This fragmentation undermines physical activity, weakens social interaction, reduces environmental benefits such as shading and microclimate regulation, and raises safety concerns, particularly during evening hours. Moreover, campus planning approaches have rarely employed contemporary geospatial tools capable of systematically analysing the distribution, accessibility, and connectivity of recreational nodes (Akeh, 2022a; Akeh, 2022b).

The absence of a connected recreational network on the University of Calabar (UNICAL) campus limits

Corresponding Author: Linus B. Akeh linusarticles@yahoo.com Department of Geography and Environmental Science, University of Calabar, Nigeria.

walkability, environmental resilience, and inclusive student engagement. This study addresses this critical planning gap through an evidence-based spatial assessment that applies geospatial analysis to identify existing recreational nodes, evaluate their spatial distribution, accessibility, and connectivity in relation to key campus functions such as academic buildings, residential halls, and administrative offices, and to develop an optimised recreational corridor. Through the production of geospatial maps and spatial models, the study aims to enhance pedestrian mobility, promote wellness, strengthen campus identity, and support a more sustainable, student-centred university environment.

2 Materials and Methods

2.1 Study Area

The University of Calabar, located in Cross River State in south-eastern Nigeria, lies approximately between latitudes 4.9449°N and 4.9549°N and longitudes 8.3399°E and 8.3530°E. The institution occupies a land area of about 1.6 km², characterized by academic complexes, administrative structures, student hostels, sports fields, staff residential quarters, and significant patches of natural vegetation (Figure 1). The campus terrain is generally flat with gentle undulations, making it highly suitable for pedestrian movement and outdoor recreational activities.

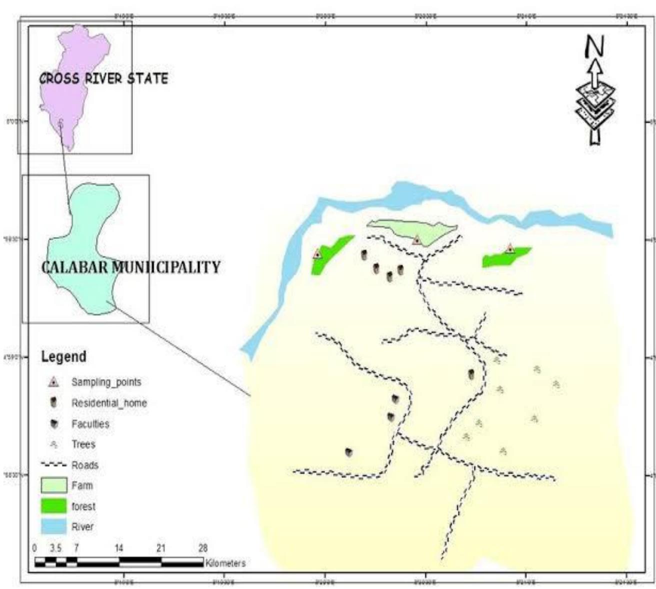

Figure 1: University of Calabar
Source: Department of Geography and Environmental Science, University of Calabar, 2025

The climatic conditions are humid tropical with high rainfall. It makes for shaded walkways, gardens, and green recreational spaces particularly important. The University's spatial configuration also includes major pedestrian flows linking the main gate, library, Senate building, hostels, and central student activity spaces. This diversity of land uses makes the campus an ideal case for analyzing recreational accessibility and corridor potential.

2.2 Data Sources

Primary data on nineteen recreational and social nodes were collected through coordinated field surveys using handheld GPS receivers (WGS 84 datum). The nodes included:

i. Formal facilities such as the stadium, sports courts, and gardens
ii. Semi-formal student leisure spaces
iii. Informal gathering areas around hostels and academic blocks
iv. Landscaped open areas used for relaxation and group activities

Complementary field observations documented pathway conditions, vegetation density, shading, seating availability, surface characteristics, lighting, and social usage patterns. Photographs and sketch maps helped refine spatial interpretation. All geographic data were stored in a GIS geodatabase for subsequent analysis.

Secondary data, including campus-based maps, land-use descriptions, and planning documents, were obtained from the Works and Physical Planning Unit.

2.3 Data Analysis

Spatial Plotting

GPS coordinates were plotted in ArcGIS/QGIS to produce the baseline map. Spatial clustering and distribution patterns were visually interpreted.

i. Distance Matrix Computation:
Using the Haversine formula, pairwise distances between all nineteen nodes were calculated. This produced a distance matrix used to assess walkability, proximity, and potential linkages.

ii. Minimum Spanning Tree (MST) Analysis:
The MST method identified the shortest, non-redundant route connecting all recreational nodes. This forms the backbone of an efficient pedestrian movement system.

iii. Corridor Modelling
In the final stage, spatial outputs were integrated through a GIS-based Multi-Criteria Evaluation (MCE) framework using a weighted overlay approach to generate a composite recreation suitability surface that guided corridor development. All thematic layers were first standardised to a common suitability scale ranging from 1 (least suitable) to 5 (most suitable) to ensure comparability

across criteria.

Kernel Density Estimation (KDE) hotspots representing areas of high recreational intensity were assigned the highest weight (0.35) due to their central importance in capturing existing user demand and activity concentration. The Minimum Spanning Tree (MST) network, which represented the most spatially efficient linkages between recreational nodes, was weighted at 0.25 to prioritise connectivity and route efficiency. Land-use proximity to academic, residential, administrative, and social zones was weighted at 0.25 to maximise functional relevance and daily accessibility. Slope suitability was weighted at 0.15, with gentle gradients favoured to support walkability, cycling, and universal access while avoiding terrain constraints.

The weighted layers were overlaid within the GIS environment to produce a composite corridor suitability map. High-suitability zones emerging from this synthesis formed the primary spatial backbone of the proposed recreation corridor. The MST network was subsequently refined to follow these high-suitability surfaces, ensuring that corridor routes balanced spatial efficiency with environmental comfort, functional integration, and terrain feasibility.

Field observations were then used as a ground-truthing mechanism to validate corridor segments by assessing pathway conditions, vegetation quality, safety, lighting, and informal movement flows. This iterative synthesis ensured that the final recreation corridor model was not only mathematically optimised but also context-sensitive and practically implementable.

Overall, the modelling process integrated spatial connectivity, user demand, functional land-use relationships, and physical terrain constraints into a coherent, evidence-based corridor system that supports accessibility, environmental quality, and diverse recreational needs across the campus.

3 Results and Discussion

Coordinates generated from the field (Table 1) were analyzed systematically and spatially.

Table 1: Coordinates of Identified Recreational Nodes in the University of Calabar

S/N	Name	Latitude	Longitude
1	Senior Staff Club	4.954575	8.340142
2	Allen Avenue	4.953505	8.339977
3	Former Senate Chamber	4.954963	8.340800
4	Bassey Hogan Parking Lodge	4.954213	8.341853
5	Besides the Animal Science Lab	4.953870	8.340388
6	Weather Station	4.952473	8.341992
7	Botanical Garden	4.952420	8.342872
8	Opposite Senate Chamber	4.952550	8.343430
9	Opposite University of Calabar Microfinance Bank (UMFB)	4.954117	8.342723
10	Black & White Field	4.950298	8.346338
11	Abraham Ordia Stadium	4.945365	8.344288
12	Malabor Square	4.946690	8.345698
13	Prayer Garden	4.945288	8.347608
14	Love Garden	4.945115	8.346798
15	Hall 8 & 9	4.944897	8.348552
16	International Conference Centre	4.948430	8.349457
17	Law Garden	4.949532	8.349835
18	Library Complex	4.949487	8.350592
19	Cameroon Area	4.948663	8.353077

3.1 Spatial Extent and Node Distribution

The mapped recreational nodes cover an area extending about 1.12 km north-south and 1.45 km east-west. The spatial centroid, located at approximately (4.9508°N, 8.3458°E), corresponds to the Malabor Square region, reinforcing its role as the campus's central social hub for students.

Node distribution shows significant spatial diversity, with clusters forming around academic, residential, and social zones. The arrangement offers substantial opportunities for integrated corridor planning.

3.2 Cluster Zones

Three dominant clusters emerged:

i. **Northwest Cluster:** Encompassing administrative and academic facilities, including the Senior Staff Club and Senate building. This cluster is characterized by formal activity and moderate recreational use.

ii. **Central Belt:** The most vibrant and densely occupied zone containing Malabor Square, Love

Garden, the Stadium, and several adjacent activity areas. KDE results confirm this as the campus's highest social intensity zone.

iii. **Eastern Cluster:** Including the library, International Conference Centre, and institutional facilities, with potential for more student traffic due to academic significance.

3.3 Minimum Spanning Tree Network

The spatial analysis revealed a distinct tri-cluster configuration on the University of Calabar Campus, comprising the administrative–academic core, the student–residential–recreational zone, and the institutional–public activity zone. The Minimum Spanning Tree (MST) analysis demonstrated that these clusters can be efficiently connected through an optimized corridor with a total length of 3.17 km, representing the shortest possible network required to link all key nodes.

Within the Central Belt, inter-node distances ranged between 60 and 90 metres, reflecting a high level of walkability, frequent pedestrian interaction, and strong spatial and social integration. These short distances support active mobility, user comfort, and ease of movement across core campus functions. In contrast, connections linking the Central cluster to peripheral zones, particularly the Eastern cluster, recorded moderate distances, highlighting areas where pathway continuity and quality require improvement.

Overall, the MST-generated network aligns closely with existing pedestrian movement patterns and provides a clear spatial framework for a connected recreation corridor. Such a corridor has the potential to significantly enhance campus mobility, promote spatial equity, encourage physical activity and wellness, and contribute to environmental sustainability by reducing dependence on motorised transport.

3.4 Density and Accessibility Patterns

Density and accessibility of recreational spaces were examined using Kernel Density Estimation (KDE) to identify spatial clustering across the campus. Each recreational node was georeferenced, and spatial intensity was calculated within a defined search radius to determine areas of high concentration. The resulting density surface revealed a pronounced cluster of recreational activity along the Malabor–Stadium–Library axis, forming a central recreational corridor with high functional interaction and demand.

Accessibility within this zone was assessed by measuring Euclidean distances between adjacent nodes using GIS proximity tools. Average inter-node distances ranged from 120 to 150 metres. This spacing aligns with established campus planning and active mobility standards, which indicate that pedestrian comfort is typically achieved within walking intervals of 100–200 metres. Such proximity facilitates continuous walking, jogging, and cycling while improving route legibility and reducing physical strain.

Recreational nodes located near student hostels recorded high usage levels, reflecting population concentration. However, connectivity in these areas was constrained by the absence of formal walkways, reliance on informal footpaths, and discontinuous pavement networks. Despite these limitations, short spatial distances between nodes maintained overall accessibility. The observed clustering suggests that targeted improvements to pathways could significantly enhance mobility without requiring complete network restructuring.

Overall, the density and distance analyses demonstrate that the spatial configuration of recreational nodes supports the development of a walkable and integrated recreation corridor.

Spatial analysis outputs were subsequently used to produce a geospatial map of recreational areas within the study site. This mapping approach provides a clear representation of recreational distribution, movement relationships, and connectivity patterns, offering insight into how distance and spatial arrangement influence campus recreational behaviour. The corridor model developed from these findings proposes a structured linkage between high-use nodes, promoting walkability and improving circulation efficiency.

Figure 2 was generated directly from the spatial and attribute data presented in Table 1 to ensure that mapped outputs reflect observed conditions rather than inferred patterns. This data-driven approach strengthens the reliability of the spatial analysis and supports evidence-based recreational planning.

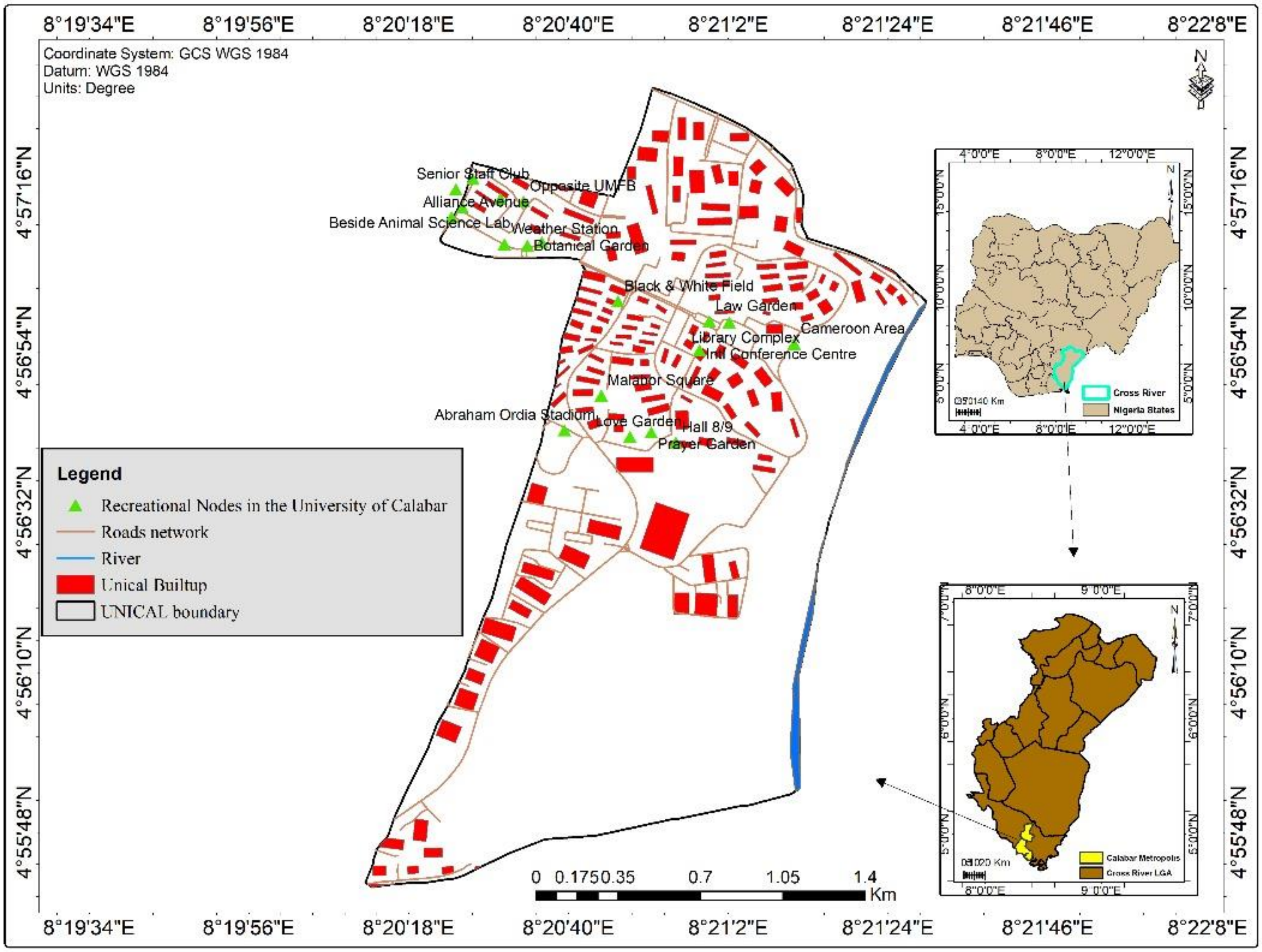

Figure 2: Geospatial map of recreational nodes and a model recreation corridor of the University of Calabar, 2025

3.5 Recreation Corridor Model

The multiphase GIS analysis produced a conceptual recreational corridor.

i. A **northeast–southwest alignment** intersecting all three major clusters.
ii. Strong integration of academic, social, and residential zones.
iii. Logical linkages supporting continuous pedestrian flow.
iv. Strategic inclusion of shaded vegetation zones to enhance comfort

This corridor provides the most efficient and contextually responsive model for strengthening campus walkability and recreational coherence.

4 Discussion of Findings

The spatial analysis reveals a structured rather than random distribution of recreational nodes at the University of Calabar, organised into three dominant clusters aligned with academic–administrative, residential–social, and institutional zones. This pattern reflects established relationships between recreational spaces and daily campus activity centres, where proximity to learning and residential environments increases usage and active mobility (Hipp et al., 2022; Rodríguez et al., 2023). The Central Belt, encompassing Malabor Square, the Stadium, and adjacent areas, emerged as the most intensive recreational zone, confirming that interconnected open spaces naturally attract higher levels of social and physical activity (Nasution et al., 2023; Villanueva et al., 2022).

Kernel Density Estimation highlighted a continuous recreational spine along the Malabor–Stadium–Library axis, suggesting strong spatial cohesion. Similar corridor-like configurations have been shown to enhance mental well-being and social interaction by sustaining prolonged exposure to green and recreational environments (Chen et al., 2021; Hu et al., 2025). The short inter-node distances within this zone (60–150 m) fall within recognised walkability thresholds, reinforcing the campus's inherent capacity to support active movement (Hunter et al., 2023; de Rezende et al., 2023). However, informal pathways in some high-use areas indicate infrastructural gaps that limit full mobility benefits.

The Minimum Spanning Tree network efficiently connected all recreational nodes within 3.17 km, consistent with studies demonstrating MST's effectiveness in creating cost-efficient green and recreational networks (Singh et al., 2022). Peripheral areas exhibited weaker connectivity, reflecting spatial inequities commonly observed in large campuses.

Overall, the findings show that UNICAL possesses strong latent recreational potential constrained primarily by fragmentation rather than facility scarcity. Strategic corridor development can transform existing spaces into a cohesive system that enhances walkability, wellness, social cohesion, and environmental sustainability.

5 Conclusion

This study identified nineteen recreational areas across the University of Calabar and developed a 3.17 km connected recreation corridor to link them. Three main zones of activity were found: the Northwest, Central Belt, and Eastern areas. Connecting these spaces will improve walking access, support healthy lifestyles, and enhance the campus environment.

University management should include the recreation corridor in the campus master plan and treat pedestrian movement and green space as core planning priorities. Clear policies should guide upgrades to walkways, lighting, seating, drainage, and landscaping along the corridor. Future building projects should be required to align with the corridor to avoid further fragmentation.

A joint implementation committee involving the Physical Planning Unit, Health Services, Works Department, and student representatives should oversee development and maintenance. Regular spatial mapping and user feedback should inform improvements.

Funding policies should encourage partnerships with government agencies, alumni, and private organisations to support tree planting, pathway construction, and long-term upkeep. By embedding the recreation corridor into campus policy and planning decisions, the University of Calabar can promote health, safety, sustainability, and a more connected academic community.

References

Akeh, L. B., Uttah, C., Aniah, E. J., Oko, P. E., Eneyo, V. B., & Abang, T. A. (2023). Impact of recreation on tertiary students' academic performance in the University of Calabar, Nigeria. World Tourism Journal, 1, 53–72.

Akeh, L. B. (2022a). Nearest neighbour analysis (NNA) of tourism organizations in southern Cross River State, Nigeria. Journal of Tourism and Heritage Studies, 11(2), 1–16.

Akeh, L. B. (2022b). Determinant variables influencing tourism employment: Empirics from destination Cross River State, Nigeria. Journal of Environmental Education and Tourism, 5(1), 118–135.

Chen, C., Luo, W., & Guo, Y. (2021). Campus green space exposure and mental health among college students. Landscape and Urban Planning, 212, 104121.

de Rezende, L. F. M., Sá, T. H., & Hallal, P. C. (2023). Built environment and active living: A global perspective. The Lancet Global Health, 11(1), e123–e132.

Giles-Corti, B., Moudon, A. V., Lowe, M., Cerin, E., Boeing, G., Frumkin, H., ... & Sallis, J. F. (2022). What next? Expanding our view of city planning and global health, and implementing and monitoring evidence-informed policy. The Lancet global health, 10(6), e919-e926. https://doi.org/10.1016/s2214-109x(22)00066-3

Hipp, J. A., Moudon, A. V., & Fox, E. (2022). Campus walkability and student well-being: A multi-campus analysis. Preventive Medicine Reports, 25, 101723.

Hunter, R. F., Cleland, C., & Parkes, J. (2023). Walking-friendly environments and physical activity in university students. Health & Place, 83, 102804.

Hu, Q., Lin, J., Li, J. & Xing, L. (2025). Exploring the effects of colleges green spaces (CGSs) exposure on mental health of students from a space–time path perspective. Ecological Indicators, 175, 113538.

Nasution, R., Nugraha, A., & Iskandar, A. (2023). Green corridors as an urban health intervention: Evidence from Southeast Asia. Cities, 141, 104478.

Payne, L. L., Orsega-Smith, E., Godbey, G. C., & Roy, M. (2010). Local park use and personal health among older adults: An exploratory study. Journal of Leisure Research, 42(1), 1–22.

Rao, V. V., Hadhramin, Z. Y. H.H., & Al-Abri, A. M. H. (2023). Investigating the Role of Recreational Facilities in Fostering Student Engagement: A Study at a University in the Sultanate of Oman. International Journal of Latest Research in Humanities and Social Science (IJLRHSS), 6(9), 43–52.

Rodríguez, D. A., Osorio, A. E., & León, C. (2023). Accessibility and active transportation infrastructure: A multi-campus evaluation. Transportation Research Part D, 118, 103642.

Singh, P., Ahmad, N., & Rijal, S. (2022). Minimum spanning tree approach in green network planning. Sustainable Cities and Society, 87, 104192.

Sun, S., Yu, X., & Meng, Q. (2023). Microclimate regulation through green corridors: Urban heat mitigation and resilience. Urban Forestry & Urban Greening, 80, 127776.

Villanueva, K., Badland, H., & Giles-Corti, B. (2022). Public green spaces and social connection: A systematic review. Health & Place, 78, 102896.

Wu, Y., He, L., & Zhang, X. (2024). Nature exposure and mental health in higher education campuses: A spatial analysis. Journal of Environmental Psychology, 92, 102266.