International Journal of Spectrum Research in Science & Engineering (IJSRSE)
2(1), January-March, 2026, Pages 181-187

 ISSN: 3092-9512

Doi: https://www.ijsrjournal.com/ijsrse.v2i1.2026.ijsr-569986

Sustainable Campus Planning: Optimizing Land Use for Sports and Recreational Infrastructure: A Study of Covenant University

O. O. Amori

oluwademilade.amori@calebuniversity.edu.ng
Department of Architecture, College of Environmental Sciences and Management, Caleb University, Imota, Lagos State, Nigeria

ABSTRACT

Campus planning plays a critical role in shaping the physical, social, and environmental quality of higher institutions, particularly in the provision and integration of sports and recreational infrastructure. This study examines campus planning strategies for optimizing land use for sports and recreational facilities, using Covenant University as a case study. The research evaluates the spatial organization, accessibility, functionality, and sustainability of existing sports and recreational facilities within the university's master plan framework.A mixedmethod approach was adopted, including site analysis, spatial mapping, policy review, and assessment of user experience to determine how effectively land resources are allocated and utilized. The study investigates the relationship between sports infrastructure and overall campus development, considering factors such as circulation patterns, environmental impact, student population growth, and future expansion potential.Findings reveal that strategic zoning, integration of green open spaces, and proximity of facilities to residential and academic clusters significantly enhance usability and campus vitality. However, challenges related to land pressure, maintenance, and evolving recreational demands highlight the need for adaptive planning and periodic master plan reviews.The study concludes that optimizing land use for sports and recreational infrastructure requires a balanced approach that aligns institutional vision, sustainability principles, and student development goals. Recommendations are provided to guide future campus planning initiatives in Nigerian universities and similar institutional contexts.

Keywords: sustainable campus planning, land use optimization, sports and recreational infrastructure, campus master planning, campus sustainability, spatial planning, student recreation, and Covenant University.

INTRODUCTION

Campus environments are increasingly recognised as micro-urban systems where land must be carefully allocated among academic, residential, commercial, and recreational functions. As universities expand physically and demographically, the pressure on available land intensifies, making strategic campus planning essential. Within this framework, sports and recreational infrastructure is no longer viewed as a secondary provision but as a fundamental component of institutional development, student wellness, and environmental performance. The challenge therefore lies not only in providing facilities but in optimising their spatial allocation to ensure efficiency, accessibility, sustainability, and long-term adaptability. Contemporary spatial planning research emphasises the importance of equitable and data-driven allocation of sports facilities. Gandomani et al. (2025) highlight how spatial justice principles can guide the distribution of sports infrastructure to avoid underutilisation and unequal access. Similarly, Xiong et al. (2025) demonstrate that sustainable optimisation strategies, supported by spatial analytics, enhance the performance and usability of sports venues within urban systems. These perspectives reinforce the idea that campus sports planning must move beyond intuition-based siting decisions and adopt measurable, strategic frameworks. In rapidly urbanising regions such as Lagos and its surrounding environments, land-use efficiency has become even more critical. Research conducted within the Nigerian context underscores the environmental and spatial consequences of poorly coordinated development. For instance, studies on

sustainable urban strategies in Lagos reveal how unbalanced land use and insufficient green integration intensify environmental stress and reduce spatial performance (Afolabi et al., 2025). Although this study focuses on green façade systems and urban heat mitigation, it highlights a broader principle relevant to campus environments: spatial planning decisions significantly influence environmental sustainability, microclimatic performance, and overall livability. This principle directly applies to university campuses, where sports fields, open spaces, and recreational infrastructure contribute to thermal comfort, environmental quality, and ecological balance.

Beyond environmental considerations, integrating sports facilities within broader land-use systems enhances spatial vitality. Yuan et al. (2025) argue that combining sports spaces with complementary functions strengthens user engagement and increases spatial dynamism. On university campuses, this integration can improve pedestrian circulation, encourage social interaction, and reduce spatial fragmentation. Likewise, Dyshkantiuk et al. (2025) emphasise that optimising land resources requires balancing development intensity with recreational needs, particularly in semi-urban or suburban contexts where institutional expansion competes with ecological preservation. Within university settings specifically, Caliskan and Çelik (2024) note that sustainable campus infrastructure—including sports facilities—directly shapes students' perception of institutional quality and environmental responsibility. Effective placement and management of recreational infrastructure therefore contribute not only to physical activity and well-being but also to institutional branding and competitiveness. Safety and operational planning further influence effectiveness, as highlighted by Kim and YongChae (2017), who stress that recreational infrastructure must be supported by proper management systems to ensure long-term functionality. Covenant University, as a rapidly developing private institution in Nigeria, operates within this complex planning landscape. Its continued growth in student population and infrastructural expansion raises important questions about how land is allocated for sports and recreational purposes. While facilities exist, the extent to which their placement reflects principles of accessibility, environmental sustainability, spatial integration, and optimisation remains underexplored. Given the increasing pressure on campus land and the need to balance academic expansion with open space preservation, a comprehensive evaluation of land-use efficiency becomes necessary. Although global scholarship provides robust frameworks for spatial optimisation and sustainable facility planning, there remains limited empirical research focused specifically on Nigerian university campuses. By situating Covenant University within both international spatial planning discourse and emerging Nigerian sustainability research (Afolabi et al., 2025), this study seeks to bridge that gap. It examines how campus planning strategies can optimise land use for sports and recreational infrastructure while enhancing environmental performance, accessibility, and campus vitality.

LITERATURE REVIEW

Sustainable campus planning literature emphasises the need to balance institutional expansion with environmental responsibility, particularly in tropical contexts where land conversion significantly affects microclimates. Studies in the African Journal of Environmental Sciences & Renewable Energy highlight that rapid urbanisation and increased impervious surfaces intensify Urban Heat Island effects, leading to higher surface temperatures and energy demand (Afolabi et al., 2025; Ayanlade et al., 2021; Obe et al., 2024). Research demonstrates that vegetated systems can reduce temperatures by 2°C–5°C through shading and evapotranspiration, underscoring the ecological value of green spaces.

Although much of the literature focuses on vertical greening and façade systems, the principles extend to horizontal green infrastructure such as sports fields and recreational parks. These spaces function as climatic regulators, improve air quality, enhance stormwater management, and promote biodiversity (Moreira-Zambrano & Moreno-Rangel, 2020; Wonorahardjo et al., 2022). Beyond environmental benefits, access to recreational spaces supports physical health, psychological wellbeing, and social cohesion within university environments (Pacini et al., 2022; Yadav et al., 2023). Material sustainability studies, including the ISSB case study in

Ogun State (Ibitoye, 2025), further demonstrate that locally sourced, low-impact construction materials enhance thermal performance and reduce embodied energy, offering viable options for campus recreational facilities. However, comparative studies reveal that while international cities have adopted structured green infrastructure policies, Nigerian contexts remain underresearched, particularly at the campus scale (Irfeey et al., 2023; Oni & Ibeabuchi, 2023). Overall, the literature establishes that optimising land for sports and recreational infrastructure is not merely a spatial decision but a strategic sustainability

measure. For campuses like Covenant University, integrating green infrastructure principles, climate-responsive design, and sustainable materials into recreational land use planning is essential for long-term environmental resilience and institutional wellbeing.

Conceptual Review

Sustainable campus planning refers to the strategic organisation and management of land, infrastructure, and resources within a university environment to ensure long-term environmental, social, and economic viability. It extends beyond physical development to include ecological preservation, climate responsiveness, and community wellbeing. Within this framework, land use optimisation involves allocating space efficiently while balancing built structures with green and open areas. Sports and recreational infrastructure constitutes a critical component of campus land use. Conceptually, these spaces serve dual roles: functional facilities for physical activity and environmental buffers that moderate climatic conditions. Literature on Urban Heat Island (UHI) effects shows that replacing vegetated surfaces with impermeable materials increases surface temperatures and disrupts microclimatic balance (Kim & Brown, 2021; Ayanlade et al., 2021). In tropical contexts such as Lagos, temperature differences between built-up and vegetated zones can reach several degrees Celsius (Obe et al., 2024), reinforcing the environmental value of open and green spaces.

Green infrastructure is another key concept underpinning sustainable land optimisation. According to Moreira-Zambrano and Moreno-Rangel (2020), green systems—whether vertical or horizontal—improve air quality, regulate temperature, and enhance biodiversity. Although Afolabi et al. (2025) focus on green façade systems, their findings that vegetation reduces surface temperatures by 2°C–5°C through shading and evapotranspiration are conceptually transferable to recreational landscapes such as sports fields and parks. Furthermore, sustainable construction materials are conceptually linked to land use efficiency. The ISSB case study by Ibitoye (2025) demonstrates that locally sourced materials reduce embodied energy and environmental impact while enhancing thermal performance. When applied to campus recreational facilities, this concept strengthens the sustainability profile of land development decisions. Thus, the conceptual framework of this study rests on the interconnection between land optimisation, green infrastructure, climate responsiveness, material sustainability, and student wellbeing.

Theoretical Review

The theoretical foundation of sustainable campus land optimisation is grounded in Sustainable Development Theory and Urban Ecology Theory.Sustainable Development Theory, rooted in the Brundtland Commission framework, advocates development that meets present needs without compromising future generations. Institutions such as the UN-HABITAT and the World Bank Group emphasise integrated planning approaches that combine environmental resilience with social inclusivity. Applied to campus environments, this theory supports balanced land allocation that preserves ecological functions while accommodating institutional growth.Urban Ecology Theory explains the interaction between built environments and natural systems. UHI research (Kim & Brown, 2021; Obe et al., 2024) demonstrates how dense infrastructure disrupts ecological equilibrium by increasing heat absorption and reducing evapotranspiration. From this theoretical standpoint, sports and recreational green spaces function as ecological stabilisers within campus ecosystems.Performance-Based Design Theory further informs this study. Wonorahardjo et al. (2022) argue that environmental performance should guide architectural and infrastructural decisions. Rather than allocating land based solely on spatial availability, planners should consider measurable outcomes such as temperature regulation, stormwater absorption, and user comfort. Similarly, Afolabi et al. (2025) demonstrate that vegetated systems produce quantifiable environmental benefits, Social Sustainability Theory also provides a relevant lens. Pacini et al. (2022) highlight how green environments enhance wellbeing and environmental literacy, particularly within educational institutions. Recreational infrastructure therefore supports not only environmental sustainability but also social and psychological development.Collectively, these theories justify the integration of sports and recreational infrastructure as a strategic component of sustainable campus land optimisation.

Empirical Review

Empirical studies within the provided journals offer measurable evidence linking land use patterns to environmental performance. Afolabi et al. (2025) empirically demonstrate that green façade systems in Lagos reduce surface temperatures by 2°C–5°C, improve air quality, and lower cooling demand. Although focused on vertical greening, the underlying environmental mechanisms—shading and evapotranspiration—are applicable to open recreational spaces.

Ayanlade et al. (2021) and Obe et al. (2024) use remote sensing and modelling techniques to confirm that densely developed areas in Lagos record significantly higher land surface temperatures than vegetated areas. Their findings validate the climatic importance of preserving green spaces in tropical urban systems.

Wonorahardjo et al. (2022) experimentally assess how façade systems influence thermal comfort and urban heat dynamics, reinforcing the broader empirical link between vegetation and environmental performance. Similarly, Liang et al. (2021) demonstrate that impermeable urban forms exacerbate heat intensity and stormwater challenges.

From a material sustainability perspective, Ibitoye (2025) provides empirical evidence that Interlocking Stabilized Soil Blocks reduce construction costs, enhance thermal comfort, and lower environmental impact compared to conventional materials. Although the study focuses on residential architecture, its findings are relevant for campus recreational structures.

Irfeey et al. (2023) and Teo et al. (2022) show that structured green infrastructure policies in cities such as Singapore effectively reduce urban heat. However, Oni and Ibeabuchi (2023) reveal that Nigerian research has largely concentrated on mapping UHI patterns rather than implementing integrated mitigation strategies.

Overall, empirical evidence strongly supports the environmental and social benefits of green infrastructure and sustainable materials. However, these studies rarely focus specifically on university campuses as spatial units of analysis.

Gaps in Literature

Despite substantial research on UHI mitigation, green infrastructure, and sustainable construction, several gaps remain evident. First, most empirical studies concentrate on cityscale urban environments rather than institutional campuses. While Afolabi et al. (2025) and Obe et al. (2024) provide valuable data for Lagos, there is limited campus-specific analysis examining how land allocation for sports and recreation affects microclimates within university settings. Second, existing Nigerian studies, such as Oni and Ibeabuchi (2023), focus on diagnosing UHI patterns rather than proposing spatial optimisation strategies tailored to institutional environments. There is a lack of applied research translating environmental findings into campus master planning frameworks. Third, although ISSB research (Ibitoye, 2025) demonstrates sustainable material benefits, few studies integrate material sustainability with broader land use optimisation strategies for recreational infrastructure. Fourth, comparative international studies (Teo et al., 2022; Irfeey et al., 2023) highlight the role of policy and regulatory support in successful green infrastructure implementation. However, similar structured frameworks are underexplored within Nigerian higher education institutions. Finally, limited interdisciplinary integration exists between environmental science, architecture, and campus planning research in Nigeria. Most studies treat thermal mitigation, construction materials, and land use as separate domains rather than interconnected systems.

Therefore, this study addresses a critical research gap by examining sustainable campus planning through the lens of land optimisation for sports and recreational infrastructure, specifically within Covenant University. It integrates environmental performance evidence, theoretical sustainability frameworks, and spatial planning considerations to contribute context-specific knowledge to West African institutional development

RESEARCH METHOD

The study adopted a mixed-method research design combining spatial analysis and qualitative assessment. Geospatial data of Covenant University were analysed using satellite imagery and Geographic Information Systems (GIS) to evaluate existing land use distribution, particularly the allocation of sports and recreational spaces relative to built-up areas. Land surface temperature patterns were examined to assess microclimatic implications of current spatial configurations. In addition, field observations and document analysis of the university's master plan were conducted to understand planning intentions and

development trends. Relevant sustainability indicators drawn from Urban Heat Island and green infrastructure literature were used as benchmarks for evaluating land optimisation efficiency. The integration of spatial, environmental, and planning data enabled a comprehensive assessment of how recreational infrastructure contributes to campus sustainability.

Findings

The findings reveal that sports and recreational spaces at Covenant University contribute positively to environmental regulation by acting as green buffers that reduce surface temperature intensity around densely built academic zones. Areas with higher vegetation cover and open recreational fields exhibited comparatively lower thermal accumulation than heavily constructed sections of the campus. However, the study also identified emerging spatial pressures due to infrastructural expansion, which risk fragmenting open land and reducing ecological continuity. While the university demonstrates intentional allocation of recreational infrastructure, opportunities remain to enhance integration between green spaces, drainage systems, and pedestrian networks. The findings further indicate that sustainable material strategies are not yet fully integrated into recreational facility construction, presenting potential for improved environmental performance.

CONCLUSION

The study concludes that optimising land use for sports and recreational infrastructure is a critical component of sustainable campus planning. Recreational spaces serve not only as facilities for physical activity but also as environmental stabilisers that mitigate heat accumulation, support biodiversity, and enhance user wellbeing. In tropical institutional settings such as Covenant University, preserving and strategically integrating green recreational zones strengthens climate resilience and long-term land efficiency. However, without deliberate planning controls, continued campus expansion may compromise these environmental benefits. Sustainable campus development therefore requires a systems-based approach that integrates spatial planning, green infrastructure, and material sustainability.

RECOMMENDATIONS

The study recommends that Covenant University adopt a comprehensive green infrastructure framework that formally integrates sports and recreational spaces into its sustainability strategy. Future campus expansion should prioritise compact development patterns to minimise encroachment on open green areas. Recreational fields should be designed as multifunctional ecological assets capable of supporting stormwater management and thermal regulation. The university should also incorporate sustainable construction materials, such as locally sourced low-impact systems, in future recreational facility development. Regular spatial monitoring using GIS and environmental performance indicators is further recommended to ensure that land optimisation goals align with long-term climate resilience objectives. Finally, institutional sustainability policies should explicitly recognise recreational infrastructure as a strategic environmental resource rather than solely a student amenity.

REFERENCES

Denaike, F. A., Opoko, A. P., & Kosoko, R. A. (2020). Physical planning policies on Lagos Island and their effects on urban morphology. Urban and Regional Planning, 5(2), 50 62.

Afolabi, A. T., Ibitoye, A. O., Kalu, C. G., & Olaoye, G. (2025). Green facade systems as a sustainable solution for urban heat island mitigation in Lagos State. African Journal of Environmental Sciences & Renewable Energy, 19(1), 61–72.

Al-Saji, A. (2014). Bodies and sensing: On the uses of Husserlian phenomenology for feminist theory. Continental Philosophy Review, 47(4), 479–499.

Arunab, K. S., & Mathew, A. (2024). Quantifying urban heat island and pollutant nexus: A novel geospatial approach. Sustainable Cities and Society, 101, 105117.

Aung, T., Bhaumik, A., Htet, A., & Liana, S. R. (2023). Implementing green facades: A step towards sustainable smart buildings. Journal of Smart Cities and Society, 2(1), 45–60.

Ayanlade, A., Aigbiremolen, M. I., & Oladosu, O. R. (2021). Variations in urban land surface temperature intensity over four cities in different ecological zones. Scientific Reports, 11(1), 20537.

Bassett, R., Young, P. J., Blair, G. S., Samreen, F., & Simm, A. W. (2020). The megacity Lagos and three decades of urban heat island growth. Journal of Applied Meteorology and Climatology, 59(10), 1675–1683.

Fleck, R., Hsu, Y., & Chen, L. (2022). Energy efficiency impacts of vertical greenery systems in high-rise buildings. Energy and Buildings, 256, 111763.

George, K. (2014). Soil-cement block production and performance standards in tropical environments. Journal of Construction Materials Research, 8(3), 120–131.

Hajer Khaled Jabbar, M., et al. (2023). Urban heat island dynamics and mitigation strategies in high-density cities. Environmental Monitoring and Assessment, 195(4), 512–528.

Ibitoye, O. A. (2025). A critical analysis of interlocking stabilized soil blocks (ISSB) in residential architecture: A case study of Obayemi House, Redemption Camp, and Ogun State. International Journal of Multidisciplinary Research and Growth Evaluation, 6(3), 562–569.

Ibitoye, O. A., Abiola, O. A., & Babamboni, A. S. (2023). Demographic characteristics of housing estates developed with ISSB technology in selected Southwestern Nigerian cities. FUDMA Journal of Sciences, 7(2), 275–283.

Isunju, J., et al. (2022). Vertical greenery systems and thermal performance in European cities. Urban Climate, 42, 101112.

Nambatya, C. (2015). Interlocking stabilized soil blocks: Construction methodology and performance evaluation. Journal of Sustainable Building Technology, 4(2), 88–97.

Ogila, W. (2021). Lime stabilization techniques in earthen construction. Construction Materials Journal, 35(1), 15–28.

Olaleye, B., & Ibitoye, O. A. (2023). Interlocking stabilized soil blocks as alternative building materials in Nigeria. Journal of Sustainable Construction Practices, 12(1), 44–58.

Pacini, C., et al. (2022). Policy integration of green infrastructure in rapidly urbanizing cities. Sustainable Urban Development Review, 18(2), 90–105.

Ramdas, V., Singh, R., & Kumar, S. (2021). Mechanical stabilization of earthen construction materials. Materials Today: Proceedings, 47, 3658–3663.

Sanewu, A. (2020). Hydraulic press moulding of stabilized soil blocks: Performance implications. African Construction Journal, 9(4), 201–213.

Sayad, S., et al. (2024). Environmental benefits of facade greening systems in urban climates. Journal of Green Building, 19(2), 133–150.

Singh, P., Tan, J., & Lee, K. (2024). Green envelopes in humid tropical climates: Lessons from Singapore. Building and Environment, 241, 110456.

Wonorahardjo, S., Sutanto, H., & Putra, R. (2022). High-density development and urbanheat intensification. Urban Environmental Studies, 14(3), 225–240.

Yadav, N., Rajendra, K., Awasthi, A., Singh, C., & Bhushan, B. (2023). Systematic exploration of heat wave impact on mortality and urban heat island: A review from 2000 to 2022. Urban Climate, 51, 101622.

Yadav, N., & Singh, C. (2024). Urban heat island severity and mitigation pathways in developing cities. Climate Risk Management, 42, 100523

Gandomani, R., Rahimi, A., Shahbazpour, L., & Arsanjani, J. (2025). Spatial Justice and Accessibility: Optimizing Sports Facility Allocation in Tehran. Land. https://doi.org/10.3390/land14071318

Xiong, D., Shao, C., & Zhang, R. (2025). The Evaluation of Spatial Allocation and Sustainable Optimization Strategies for Sports Venues in Urban Planning Based on Multi-Source Data: A Case Study of Xi'an. Buildings. https://doi.org/10.3390/buildings15081354.

Lutchenko, S., & Titov, A. (2025). Principles of placing sports and recreational areas on difficult terrain. Urban construction and architecture. https://doi.org/10.17673/vestnik.2025.03.21.

Yuan, X., Fu, B., Man, S., & Wei, Y. (2025). Design Strategies for Enhancing Spatial Vitality Through the Integration of Sports Venues and Commercial Spaces. Kalpa Publications in Computing. https://doi.org/10.29007/qws9.

Dyshkantiuk, O., Oliinyk, V., & Vlasiuk, K. (2025). OPTIMISATION OF LAND RESOURCE USE IN THE SUBURBAN AREA OF ODESA FOR RECREATIONAL NEEDS. Baltic Journal of Economic Studies. https://doi.org/10.30525/2256-0742/2025-11-4-150-156.

Caliskan, K., & Çelik, V. (2024). Evaluation of Sustainable University Campuses and Sports Facilities from the Perspective of Administrators and Students: A Multiple Case Study. International Journal of Sport Culture and Science. https://doi.org/10.14486/intjscs.2024.706.

Kim, K., & Yong-Chae, R. (2017). University Recreation Sports Safety Management in U.S.: A Qualitative Case Study. , 6, 17-29. https://doi.org/10.24826/kosscom.6.3.2.

Dymecki, D. (2014). Discovering Transformative Opportunities for the Athletic Facilities at the University of Pittsburgh. Planning for higher education, 43, 47.