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Integration of Green Infrastructure for Wellness: Urban Renewal through Biophilic Design

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ABSTRACT

Rapid urbanisation across many global cities has quietly produced environments that are efficient yet psychologically exhausting. Densification, heat islands, air pollution, and the steady erosion of everyday contact with nature have contributed to rising levels of stress, anxiety, and lifestyle-related illness. Within this context, green infrastructure (G1) is often treated as an environmental afterthought rather than as a public health strategy. This article reconsiders that position. This study aimed at examining how the integration of green infrastructure (G1), guided by biophilic design principles, can function as a catalyst for urban renewal and improved human wellness. Drawing on a structured literature review of 32 peer-reviewed sources, the article adopts a theoretical framework informed by the Biophilia Hypothesis and Attention Restoration Theory. Through comparative synthesis and thematic analysis, recurring design strategies, performance outcomes, and implementation challenges were identified. The findings suggest that integrating vegetation systems, restorative landscapes, and nature-based spatial configurations into urban redevelopment projects enhances psychological restoration, social cohesion, and microclimatic comfort. However, benefits are uneven where governance, maintenance, and socio-economic equity are neglected. Urban renewal, therefore, cannot rely on symbolic greening alone; it requires deliberate, theory-informed design integration. Ultimately, embedding biophilic green infrastructure within renewal policies offers more than aesthetic value. It reframes cities as regenerative ecosystems, capable of supporting both environmental resilience and human wellbeing.

Keywords: *Green infrastructure, wellness & public health, urban renewal, biophilic design, sustainable urban development.*

INTRODUCTION

Urbanisation continues to reshape human settlement patterns at an unprecedented scale. Current projections suggest that nearly 70% of the global population will reside in urban areas by 2050, intensifying pressure on land, infrastructure, and natural systems (United Nations, 2018). While cities remain engines of economic growth and cultural exchange, their expansion has frequently occurred through spatial sprawl and ecological simplification. Urban growth, particularly when poorly managed, accelerates biodiversity loss, increases surface temperatures, and reduces ecosystem functionality (Seto et al., 2012; Elmqvist et al., 2013). The resulting urban form often privileges built density over ecological balance, creating environments that are materially productive yet environmentally fragile.

A parallel concern lies in the gradual erosion of ecological quality within cities. Green spaces are fragmented or replaced with impervious surfaces, diminishing ecosystem services such as air purification, stormwater regulation, and thermal moderation (Tzoulas et al., 2007). The cumulative effect is not merely environmental degradation but also a decline in everyday experiential contact with nature. Scholars increasingly argue that such disconnection has measurable consequences for psychological well-being and public health (Frumkin et al., 2017). In this sense, the ecological crisis of cities cannot be separated from the health crisis that accompanies it.

Wellness has therefore moved from the margins of planning discourse to a central design priority. Urban health frameworks now emphasise preventive strategies that embed wellbeing within spatial design rather than treating illness as an external outcome (World Health Organization [WHO], 2016). Exposure to natural elements has been associated with stress reduction, cognitive restoration, and improved social

interaction, suggesting that the built environment can either undermine or enhance human resilience (Tzoulas et al., 2007; Frumkin et al., 2017). This shift reflects a broader understanding that environmental quality and human health are deeply intertwined, particularly in high-density contexts.

Green infrastructure emerges within this debate as a systemic response rather than an aesthetic gesture. Conceptually, it refers to interconnected networks of natural and semi-natural spaces designed to deliver ecological and social benefits (Benedict & McMahon, 2006). Unlike conventional grey infrastructure, which often isolates environmental functions, green infrastructure integrates vegetation, water systems, and landscape networks into the urban fabric. Its value lies not only in environmental performance but also in its capacity to structure healthier and more liveable cities.

When interpreted through the lens of biophilic design, green infrastructure gains further depth. Biophilic principles emphasise the innate human affinity for natural systems and advocate for deliberate integration of nature within architectural and urban environments. In renewal contexts, this perspective encourages more than park provision; it calls for embedding restorative landscapes, green corridors, and nature-based spatial experiences into redevelopment strategies. Urban renewal, therefore, becomes an opportunity to recalibrate the relationship between ecological systems and human wellbeing. Rather than treating green space as residual, the challenge is to position it as a foundational element of regenerative urban transformation. This study examines how the integration of green infrastructure, informed by biophilic design, can advance urban renewal strategies centred on wellness. The specific objectives were: To review existing literature on green infrastructure and wellness in urban design, to identify biophilic design strategies applicable to urban renewal projects, to assess the wellness benefits associated with green infrastructure interventions, and to propose a conceptual urban renewal framework for biophilic wellness integration.

LITERATURE REVIEW

To capture the current state of knowledge regarding green infrastructure and wellness, this review adopts a narrative synthesis approach. A targeted search was conducted across academic databases to identify relevant literature, using specific keywords such as "green infrastructure," "biophilic design," "urban renewal," "wellness" and "sustainable urban development". Thirty-two core papers were ultimately selected based on their focus on urban design, health outcomes, and sustainable development. Rather than aiming for rigid statistical certainty, this flexible, narrative style allows for a deeper thematic exploration of the literature, bringing together disparate ideas to form a cohesive picture. Through this synthesis, the reviewed literature broadly falls into four recurring themes: the conceptual evolution of green infrastructure, the psychological mechanics of biophilic design, the social friction of urban renewal, and the practical implementation barriers in specific urban climates.

2.1 The Evolving Paradigm of Green Infrastructure

Much of the existing literature struggles with a surprisingly fundamental question regarding what exactly qualifies as green infrastructure (GI). Grabowski et al. (2022) identify a persistent paradox in how GI is conceptualised across different disciplines. While ecologists and landscape architects view it as a sprawling, interconnected network providing multiple ecological functions, environmental regulatory agencies often narrow the definition down to highly specific stormwater management technologies. This fragmentation limits our understanding and application of the concept. Simply dropping an isolated patch of uniform grass or a single tree into a concrete grid does not create infrastructure. To truly deliver ecosystem services and health benefits, these elements must be strategically planned, deeply interconnected, and inherently multifunctional. Korkou et al. (2023) emphasise that multifunctionality is perhaps the most critical principle for maximising the socio-economic and environmental benefits of urban spaces. Furthermore, Wang and Xu (2024) propose that an adaptive management approach is essential to keep these interconnected green networks resilient against ongoing urbanisation and unpredictable climate shifts.

2.2 Biophilic Design as a Bridge Between Sustainability and Human Wellness

While traditional sustainable architecture has achieved remarkable gains in energy efficiency, it frequently falls short in addressing human emotional needs. Wijesooriya and Brambilla (2021) gently critique conventional Environmentally Sustainable Design (ESD) for being overly reliant on quantitative

metrics and technological fixes, which inadvertently ignore the qualitative human experience. Biophilic design steps into this gap. By operationalising the biophilia hypothesis, the idea that humans possess an innate, evolutionary affinity for natural systems, designers can craft spaces that actively produce "human energy" rather than just conserving electrical power. The wellness benefits of such interventions are gaining robust empirical backing. For example, a meta-analysis by Gaekwad et al. (2022) found that exposure to natural environments yields a medium-to-large effect in increasing positive affect and decreasing negative emotions. Yet, the literature reveals distinct methodological blind spots. Tekin et al. (2025) note a heavy reliance on subjective surveys, pointing out that experimental neuroarchitectural methods, which could map how spatial design directly influences the brain's cognitive and emotional centres, remain surprisingly scarce. Additionally, Tabassum and Park (2024) argue that without rigorous post-occupancy evaluations, it is difficult to validate whether these biophilic interventions genuinely sustain occupant comfort and satisfaction over time.

2.3 The Friction of Urban Renewal: Equity, Displacement, and Resilience

Urban renewal is often championed as a tool for economic revitalisation, but the literature exposes a darker, socially disruptive side to these projects. In rapidly developing contexts, such as Nigerian cities, Abasilim et al. (2025) document how physical renewal frequently triggers forced evictions, disproportionately displacing low-income residents and shattering existing community networks. This creates a paradox where urban upgrading inadvertently breeds profound insecurity. Recognising this tension, researchers are calling for a shift toward more inclusive paradigms. Shadar and Shach-Pinsly (2024) advocate for spatial strategies that integrate new populations without destroying the established physical fabrics that support long-time residents' community resilience. Similarly, Pineo (2022) introduces the THRIVES framework, moving away from individual lifestyle choices to highlight the structural, equity-driven factors necessary for healthy urbanism. The literature insists that true wellness cannot be achieved if the built environment continues to exclude vulnerable groups. As Selanon and Chuangchai (2023) suggest, inclusive green spaces are vital for affording populations, such as those with disabilities, equal access to the biopsychosocial benefits of nature.

2.4 Contextual Realities and Implementation Barriers

Moving from conceptual frameworks to street-level execution reveals significant practical hurdles, particularly in the Global South. Afolabi et al. (2025) investigated the use of green facades to mitigate the severe Urban Heat Island (UHI) effect in Lagos. While these systems successfully lower surface temperatures by 2°C to 5°C and reduce indoor cooling demands, their widespread adoption is severely hindered by high installation costs, heavy maintenance burdens, and a lack of local technical expertise. Furthermore, the integration of sustainable materials like Interlocking Stabilised Soil Blocks (ISSB) offers a low-carbon alternative to traditional concrete, reducing the environmental footprint of new residential architectures. However, Ibitoye (2025) notes that while ISSBs are economically and environmentally advantageous, they still face persistent challenges regarding moisture control in humid climates and public scepticism regarding their aesthetic appeal. It seems that for biophilic urban renewal to truly scale, policymakers must look beyond the theoretical health benefits and actively address these localised financial, technical, and material constraints.

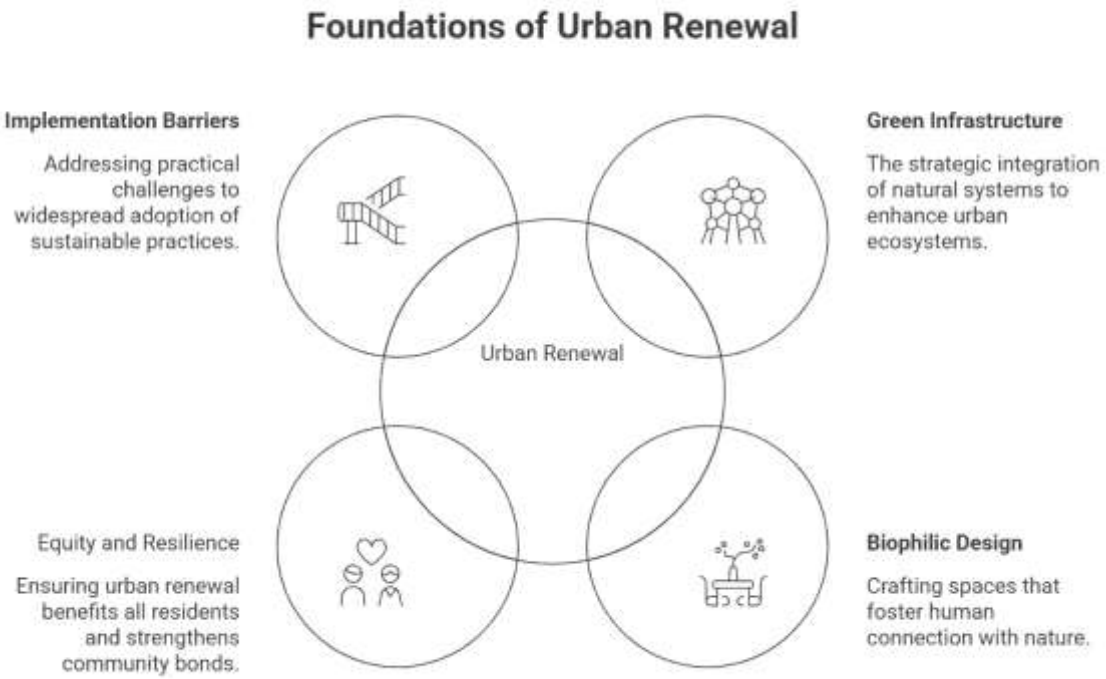
2.5 Theoretical foundation

This review is anchored in biophilic design theory, which draws from the Biophilia Hypothesis to suggest that humans possess an inherent affinity for natural systems (Wilson, 1984; Kellert et al., 2008). From this perspective, psychological restoration, reduced stress, and improved cognitive functioning are not incidental outcomes of green environments but expected responses to sustained contact with nature. Attention Restoration Theory further explains that natural settings replenish directed attention and mitigate mental fatigue, offering measurable cognitive benefits in urban contexts (Kaplan & Kaplan, 1989).

Complementing this, wellness-based urbanism reframes city-making as a public health intervention rather than a purely economic exercise. If urban form shapes daily experience, then renewal strategies must prioritise restorative environments that support emotional balance, social interaction, and ecological resilience (Beatley, 2011; Tzoulas et al., 2007). Urban renewal, therefore, should not merely replace

deteriorated infrastructure but intentionally embed nature-based systems that enhance both environmental performance and human wellbeing.

Fig 1: Theoretical Foundation Diagram
Source: Author (2026)



RESEARCH METHOD

This article adopts a structured literature review design, grounded in a clearly defined theoretical framework. The primary database used for sourcing materials was Google Scholar, selected for its broad interdisciplinary coverage of urban design, environmental psychology, and sustainability research. A total of 32 peer-reviewed studies were reviewed and synthesised. To maintain relevance and contemporary alignment with current urban challenges, the inclusion criteria limited publications to the period between 2021 and 2026. Only English language journal articles and scholarly book chapters directly addressing green infrastructure, biophilic design, urban renewal, or wellness outcomes were considered.

Studies were excluded if they focused solely on technical engineering performance without social or wellness implications, addressed rural rather than urban contexts, or lacked empirical or theoretical depth. Opinion pieces, non-scholarly reports, and duplicate studies were also removed during the screening process. The selection process prioritised conceptual clarity, methodological rigour, and relevance to developing urban settings.

Analysis was conducted through thematic synthesis. Key concepts, recurring design strategies, reported wellness outcomes, and implementation barriers were coded and grouped into analytical categories aligned with the study objectives. The review is anchored in the Biophilia Hypothesis (Wilson, 1984) and Attention Restoration Theory (Kaplan & Kaplan, 1989), which together provide the theoretical lens for interpreting how green infrastructure interventions influence psychological and environmental well-being. Rather than treating the literature as isolated findings, the analysis situates each contribution within this broader theoretical conversation, allowing patterns and tensions across studies to emerge with greater coherence.

RESULTS AND DISCUSSION

The results of this investigation reveal several critical insights into how green infrastructure, biophilic design, and sustainable construction practices intersect to drive urban renewal. By synthesising the extensive data across the selected literature, it becomes possible to group the findings into four distinct themes. These themes move from the tangible health benefits of nature integration to the socio-technical realities of executing these projects equitably.

4.1 Quantifiable Health and Psychological Restoration

The current evidence base paints a compelling picture of how natural elements directly shape human wellness. Interestingly, exposure to green infrastructure does not merely act as a visual amenity; it yields medium to large effects in reducing negative emotional states and accelerating stress recovery. This therapeutic mechanism is remarkably evident in healthcare settings. Incorporating biophilic parameters, such as natural light and indoor greenery, correlates with reduced hospitalisation times and lower perceived pain among patients, while simultaneously relieving stress for healthcare providers.

Beyond clinical spaces, the broader urban population relies heavily on these environments for mental resilience. During the COVID-19 pandemic, for instance, localised green spaces transitioned from recreational luxuries to essential coping mechanisms. There seems to be a growing consensus that architecture must move beyond simply preventing disease to actively generating health. Frameworks like Maharishi Vastu Architecture and therapeutic design theory utilise specific spatial experiences and building orientations to enhance cognitive and emotional well-being. Yet, despite this robust psychological data, practitioners are only just beginning to measure these outcomes through rigorous post-occupancy evaluations and neuroarchitectural biometric tools.

4.2 Climate Adaptation and Ecological Functionality

What the research also reveals is the profound capacity of green infrastructure to act as a climate adaptation tool. Cities are increasingly vulnerable to the urban heat island effect, but integrating nature-based solutions offers a highly functional defence. In tropical, high-density cities like Lagos, green facade systems are capable of lowering surface temperatures by 2°C to 5°C, providing critical thermal comfort and reducing indoor cooling demands.

This localised cooling effect is complemented by broader ecological networks that manage stormwater and improve air quality. However, the data suggest that isolated patches of greenery are largely insufficient to move the needle. To be truly effective, green infrastructure must be multifunctional and highly connected, bridging the gap between urban development and biodiversity conservation. Sustainable green buildings, working in tandem with these broader blue and green networks, essentially form the backbone of resilient urban environments.

4.3 The Imperative of Socio-Spatial Equity

Perhaps the most sobering finding across the literature is the persistent inequality tied to urban greening. Sustainable urban renewal frequently struggles to balance physical upgrades with social justice. In several Nigerian cities, physical redevelopment has inadvertently triggered forced evictions, stripping vulnerable populations of their livelihoods and replacing physical decay with profound social insecurity. The evidence points to a recurring "green gap" where marginalised groups, including the elderly and people with disabilities, face physical and social barriers that block their access to health-promoting natural spaces. It appears that a purely technocratic approach to spatial planning is inadequate. To mitigate displacement, researchers advocate for spatial networks that preserve existing community ties while cautiously adding new layers of functional infrastructure along neighbourhood edges. Furthermore, spatial equity must be consciously embedded into the algorithms and frameworks used to allocate green drainage assets, ensuring that flood mitigation benefits do not disproportionately favour wealthier districts while leaving others exposed.

4.4 Institutional Fragmentation and Sustainable Materialities

Finally, the findings expose significant technical and institutional hurdles that continue to limit the integration of biophilic design. A major issue is how poorly green infrastructure is defined in civic policy. In

many city plans, the concept is narrowly restricted to engineered stormwater management rather than embraced as a holistic landscape strategy. This fragmentation severely limits the potential of sustainable urban renewal, which requires an intricate balance of planning, public health policies, and social subsystems.

On a more tangible level, achieving these renewal goals relies heavily on the adoption of sustainable building technologies. The data highlights a strong comparative cost advantage in utilising Interlocking Stabilized Soil Blocks (ISSB) over traditional sandcrete in places like Southwestern Nigeria. These localised materials drastically reduce cement usage and construction time, supporting low-carbon, affordable housing that performs better thermally. Integrating these localised, sustainable materials with alternative infrastructure, such as micro-electric power grids, and culturally resonant symbolic forms, provides a highly practical foundation for biophilic renewal. Ultimately, there is a recognised need to bridge the quantitative focus of traditional environmentally sustainable design with the qualitative, human-centric benefits of biophilic architecture.

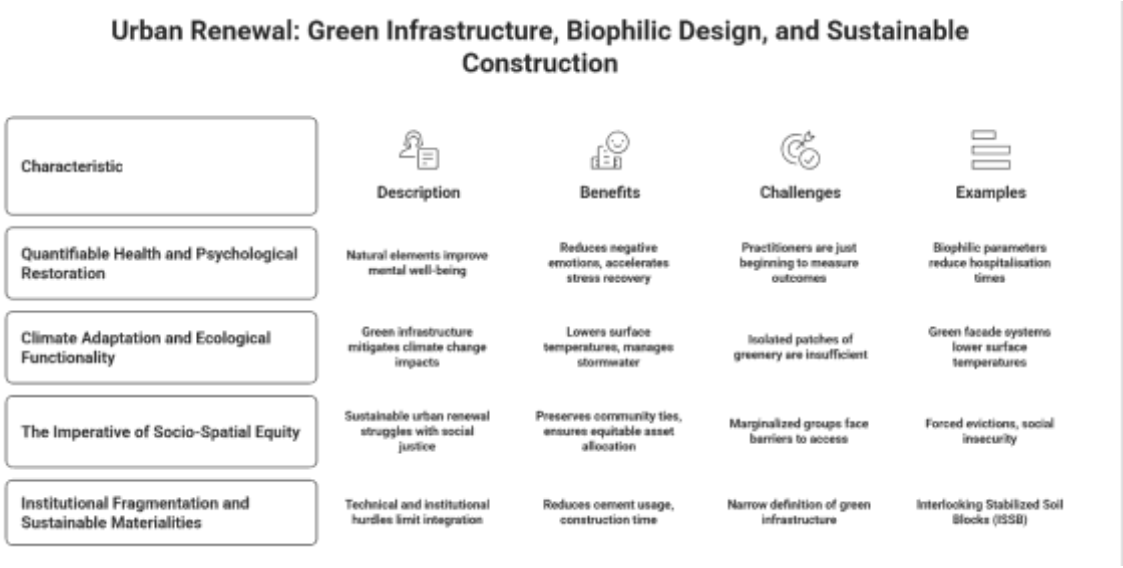


Fig 2: Diagram of results and findings showing related variables
Source: Author (2026)

Discussion

When you look at the patterns emerging across these collected studies, a fairly clear story unfolds. We seem to be moving away from seeing green infrastructure (GI) as just a glorified plumbing system. Grabowski et al. (2022) captured this paradox perfectly, noting that urban planners, particularly in the US, often reduce GI to mere stormwater management technologies. But the literature is actively pushing back against this narrow view. Researchers are arguing for a multifunctional approach that bridges ecological conservation with actual human needs (Korkou et al., 2023; Wang & Xu, 2024). It feels like the design industry is finally realising that building a technologically advanced, energy-efficient box simply isn't enough if it leaves the occupants psychologically detached from nature, a critique effectively raised by Wijesooriya and Brambilla (2021) in their assessment of traditional environmental design.

This brings us directly back to the theoretical roots of this research. The findings essentially breathe modern life into Wilson's biophilia hypothesis and established frameworks like Attention Restoration Theory. As Gaekwad et al. (2022) demonstrated, the emotional shift we experience in natural environments isn't just poetic sentiment; it is a measurable decrease in negative affect and physiological stress. Zhong et al. (2022) remind us that this is an evolutionary hangover. We are fundamentally wired to seek out these natural complexities. Yet, there is a fascinating tension here. While we intuitively know these spaces promote healing, our ability to rigorously measure these outcomes with biometric tools is still somewhat

in its infancy, often relying too heavily on subjective user surveys rather than concrete neuroarchitectural data (Tekin et al., 2025; Tabassum & Park, 2024).

Perhaps the most compelling argument that surfaced is why wellness simply has to be the anchor of any urban renewal planning. If we treat renewal merely as a physical or economic upgrade, we risk doing profound social harm. We see this play out starkly in Nigerian cities, where well-intentioned redevelopment frequently ends up displacing the exact low-income communities it was supposed to revitalise (Abasilim et al., 2025). Sustainable design fails if it isn't inclusive. Selanon and Chuangchai (2023) rightly point out that when a park lacks accessible pathways for the disabled, it is a failure of urban policy, not an individual's impairment. This is where frameworks like THRIVES step in, forcing us to view healthy urbanism through the lens of equity so that environmental upgrades do not become tools of exclusion or gentrification (Pineo, 2022).

So, what does this specific synthesis contribute beyond the existing noise? Primarily, it attempts to bridge the conceptual gap between high-level urban planning and ground-level architectural materiality. We can theorise about biophilia endlessly, but it eventually has to be built. The literature highlights that localised, pragmatic solutions are the actual building blocks of this transition. For example, adopting Interlocking Stabilized Soil Blocks (ISSB) offers a low-carbon, highly affordable alternative to standard concrete (Ibitoye et al., 2023; Ibitoye, 2025). When you combine these sustainable, earth-based materials with interventions like green facades to cool dense tropical cities (Afolabi et al., 2025), decentralised micro-electric grids for energy resilience (Ogunyemi et al., 2022), and culturally significant architectural symbols that foster a sense of place (Ogunyemi et al., 2023), you get a much more realistic picture of renewal.

Ultimately, the research points to a necessary paradigm shift. We have to stop thinking of urban renewal as a process of erasing the old to build a sterile new. Instead, it might be better approached as an act of restorative urban acupuncture. By carefully layering biophilic elements and sustainable materials into the existing urban fabric, planners can preserve vital community networks while dramatically improving public health (Shadar & Shach-Pinsly, 2024). The data strongly suggests that cities designed primarily for economic efficiency often fail their inhabitants. A truly resilient city acknowledges our deep biological craving for nature and bakes that understanding into every layer of its design.

CONCLUSION

The findings of this investigation suggest that the integration of nature into the urban fabric is not a cosmetic luxury but a fundamental necessity for a resilient future. It appears that green infrastructure functions as a critical multi-tool—simultaneously mitigating the thermal stress of the urban heat island effect while providing the psychological "fascination" required for mental restoration (Nieuwenhuijsen, 2021; Beute & de Kort, 2018). We have seen that when these systems are strategically planned, they bridge the gap between architectural performance and human wellness, moving us away from the sterile, detached environments of the past (Wijesooriya & Brambilla, 2021).

However, the research also strikes a cautionary note. For urban renewal to be truly successful, it must be inclusive. A biophilic city that prioritises high-end green aesthetics at the cost of social displacement is, by definition, unsustainable (Abasilim et al., 2025; Oscilowicz et al., 2022). Consequently, the future of urban design lies in a "health-first" paradigm where nature is treated as a universal right. By systematically weaving biological complexity, sustainable materials like interlocking soil blocks, and culturally resonant symbols into our cities, we can create environments that do more than just house people—they help them heal (Ibitoye et al., 2023; Ogunyemi et al., 2023).

RECOMMENDATIONS

To translate these findings into practice, the following recommendations are proposed:

1. Regulate multifunctional GI standards: Urban planning policies should be updated to move beyond a narrow focus on drainage. Cities should adopt mandatory biophilic quality standards that require new developments to prove their contribution to microclimate cooling and resident mental health (Grabowski et al., 2022; Tabassum & Park, 2024).
2. Prioritise equitable access: Authorities must use frameworks like THRIVES to ensure that green infrastructure is distributed based on need rather than property value. This includes prioritising "nature-deprived" neighbourhoods and ensuring all designs are physically accessible to the elderly and disabled (Pineo, 2022; Selanon & Chuangchai, 2023).

3. Validate design through quantitative health data: Future research and pilot projects should integrate wearable biometric sensors to measure real-time physiological responses to biophilic interventions. Shifting from anecdotal evidence to concrete health data will provide the necessary ROI justification for developers and policymakers (Tekin et al., 2025).

4. Adopt localised materialities: Urban renewal in developing contexts should prioritise sustainable, localised building technologies like Interlocking Stabilised Soil Blocks (ISSB). These materials offer a pragmatic path toward affordable, thermally efficient housing that aligns with both ecological and economic resilience (Ibitoye et al., 2023).

Fig 3: Diagram showing proposed recommendations
Source: Author (2026)

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