

BARCELONA 2025

Livable Cities

AMPS Proceedings Series 46.1

AMPS PROCEEDINGS SERIES 46.1

Instituto Universitário de Lisboa

16 – 18 July, 2025

Barcelona. Livable Cities

The Urban Experience: From Social Policy to Design

ARCHITECTURE_MEDIA_POLITICS_SOCIETY
Amps

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AMPS PROCEEDINGS SERIES 46. ISSN 2398-9467

INTRODUCTION

Barcelona. Livable Cities

The Urban Experience: From Social Policy to Design

Barcelona is seen as one of the world's most livable cities. Ranked particularly high for its renowned cultural scene, lifestyle, architecture, outdoor parks and beaches, it is also Europe's third most progressive city for start-ups. Supporting alternative modes of work through its Workation program, it is also attracting entrepreneurs with the digital nomad's visa. However, it is also a city that suffers from unaffordable housing, uncontrolled tourism, noise pollution and over density. It has a high cost of living, has experienced gentrification and has pockets of social deprivation. In such contradictions and paradoxes, it is a microcosm of cities the world over – a place where notions of 'livability' are far from consistent.

How Barcelona, or any other city, responds to this situation is complicated, and often contested. For architects and urbanists, affordable housing may be a question of planning. For sociologists, improvements to the built city are community concerns. For health professionals, air pollution relates to public wellbeing. For environmental activists, urban density is a resource issue. For cultural theorists, the arts and tourism are matters of heritage. For the business sector they are issues of finance. For engineers, transport may be a question of infrastructure. For residents, it's a question of equity and access.

Using the city of Barcelona as an example then, the papers in these conference proceedings explore how cross-disciplinary readings of cities the world over shed light on what makes the places we inhabit 'livable'. They encourage debates around community participation; research projects on design and planning; investigations into urban infrastructure and case studies on smart cities. They offer critiques on accessibility and social justice, examinations of local and migrant cultures, and studies of transport, urban heritage, public health…. and more. In this particular volume, emphasis is placed on sustainability, cities and the role of design.

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SETTING PRIORITIES FOR RESILIENCE TO NATURAL DISASTERS IN CITIES IN EAST AFRICA

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INTRODUCTION

Cities in Africa face a high risk of disasters such as floods and landslides, which have devastating consequences, particularly for vulnerable groups like the elderly, women, and children. These households often have limited resources to mitigate and recover from such catastrophes. The lack of basic infrastructure and services, poor urban planning, inefficient land use, and low levels of accountability significantly contribute to the disaster risk in urban areas, increasing the vulnerability of city dwellers.

Prioritizing risk reduction strategies and ensuring that authorities are held accountable through transparent, responsive, and proactive governance is crucial. This paper discusses the hazards, vulnerabilities, capacities, and underlying drivers of disasters in East African cities, focusing on coastal cities like Dar es Salaam and Mombasa, as well as inland cities such as Nairobi, Kampala, and Juba.

DISASTER RISKS IN CITIES IN EAST AFRICA

The Climate change, rapid urbanization, and natural disasters are increasingly impacting cities in East Africa.[1] A major concern is flooding in coastal cities such as Dar es Salaam and Mombasa, exacerbated by rising sea levels and heavy rainfall.[2] If sea levels rise by just 0.33 meters, it is projected that 17% of Mombasa's land area (approximately 4,600 hectares) could be submerged, affecting sandy beaches, cultural sites, and commercial activities Drainage issues in cities like Kampala and Nairobi further contribute to flooding, yet coordinated solutions remain scarce.[3] In Kampala, the area built up in flood-prone zones increased by 6% between 1975 and 2014, with key roads covering 63 kilometers. In Kampala's built up areas in flood prone zones saw a 6% increase between 1975 and 2014, with the major roads covering 63 kilometers.[4]

Recent events highlight the severity of these risks. In Nairobi, severe flooding in 2024 resulted in over 500 deaths and displaced thousands, with similar flooding events occurring in 2023 and 2020, particularly in informal settlements.[5] Kampala, Uganda, faced significant flooding in 2019, which caused at least eight deaths and affected over 500 households, while earlier floods in 2010 and 2006 displaced hundreds and disrupted urban life.[6] Kampala suffered significant flooding in 2019, leading to at least eight deaths and impacting over 500 households. Dar es Salaam also faced devastating floods in 2011, resulting in 40 deaths and displacing over 10,000 people. At the regional level,

cyclones in 2024 and El Niño-driven floods in 2023 have intensified flooding across Kenya, Tanzania, Ethiopia, Somalia, and South Sudan, contributing to significant displacement, with South Sudan reporting 281,000 internally displaced persons, Kenya 40,000, Tanzania 38,000, and Uganda 23,000. In 2023, El Niño-induced flooding in Ethiopia, Kenya, and Somalia claimed at least 130 lives, while 2020 floods in South Sudan alone affected 800,000 people, and recent regional floods displaced over 1.2 million people.[7]

Cities located in mountainous terrain, such as Kampala and Nairobi, are highly susceptible to landslides. Soil erosion from urban expansion and land clearance for settlements obstructs drainage channels, which in turn increases peak water flows.[8] Cyclones pose a significant threat to coastal cities in Mozambique, as they disrupt urban mobility and housing systems and have regional implications. Droughts and heatwaves, particularly in Juba and Nairobi, intensify the risks of drought.

The vulnerability is enhanced by socio-economic and structural factors. In Dar es Salaam and Kampala, more than half of the urban population lives in informal settlements, which are usually situated in risky areas such as wetland or steep slopes.[9] Due to the absence of proper infrastructure, such as water and drainage systems, settlements are more susceptible to disasters. Recovery efforts are hampered by insufficient financial resources and land tenure, which disadvantage many women, children, and elderly families.[10] Additionally, effective disaster risk management is hindered by governance issues such as inadequate institutional coordination and limited accountability, which contribute to these vulnerabilities.

Causes and impacts of natural disasters in the cities in East Africa

Causes

Rapid urbanization and poor planning

East Africa's cities are among the fastest-growing in the world, with cities like Kampala and Dar es Salaam expanding at rates exceeding 4% annually. Unregulated urban sprawl often extends into flood-prone wetlands and steep slopes, increasing exposure to natural hazards.[11] More than half of Dar es Salaam’s population lives in informal settlements that are poorly planned. Unregulated urban sprawl often extends into flood-prone wetlands and hilly regions, thereby increasing exposure to natural hazards. In Dar es Salaam, more than half of the urban population lives in informal settlements that are often built without regard for planning.[12]

Inadequate infrastructure

Substandard drainage systems, unpaved roads, and inadequate housing amplify disaster risks. Kampala frequently experiences localized flooding due to challenges in runoff management, while Mombasa’s port facilities are at risk from rising sea levels due to outdated infrastructure.[13]

Climate change

Floods, cyclones, and droughts are increasingly common due to changing precipitation patterns, rising temperatures, and rising sea levels. In Dar es Salaam, the urban heat island effect worsens energy consumption and environmental stress.



Figure 1. Floods in Tanzania. Source: The Tanzania Times, April 12, 2024.

Colonial legacies and governance challenges

Urban planning in cities like Nairobi and Dar es Salaam is rooted in colonial-era racial zoning, creating lasting inequalities. Weak governance, with over-centralized institutions and limited community engagement, further hinders effective disaster risk reduction (DRR) efforts.[14]

Environmental degradation

Urban expansion, sand mining, and quarrying contribute to soil erosion and disturbances in natural drainage systems, exacerbating flood risks, particularly in coastal cities like Mombasa.[15]

Impacts

Human and economic losses

In Dar es Salaam, the 2024 floods caused the death of at least 155 individuals, left numerous thousands homeless and destroyed crucial bridges.[16] The impact of floods on mobility and livelihoods in informal settlements such as Kibera is felt in Nairobi. Between 2021 and 2023, four East African countries incurred economic losses of up to $30 billion due to droughts and floods, with smaller economies suffering disproportionately long-lasting impacts. These disasters strain public resources, as governments divert development funds to emergency response and recovery, slowing progress in other sectors and increasing fiscal pressure. A significant humanitarian funding gap exacerbates these challenges, with international aid covering less than 5% of the region's $53.3 billion climate crisis needs, underscoring the need for sustainable financing mechanisms to support resilience-building efforts.'

Health risks

Waterborne diseases such as cholera and malaria are further spread by flooding.[17] The health crisis in informal settlements in Juba was increased by floods, which were caused by inadequate sanitation.[18] Precarious people are particularly vulnerable to the urban heatwaves that affect public health in Nairobi and Kampala.

Infrastructure damage

The damage to infrastructure is a common problem for hospitals and roads. In Kampala, 4% of workplaces and 6% of hospitals are situated in areas that are prone to flooding.[19] The rise in sea levels poses a threat to the stability of Mombasa's port facilities, which endangers regional trade.

Social inequities

Women and children in impoverished households experience extended recovery times due to limited resources. Older people living in informal settlements face displacement and loss of their livelihoods.[20]

Environmental degradation

Flooding and landslides exacerbate soil erosion and waterlogging, significantly reducing the viability of agricultural land. Sea-level rise in Mombasa results in the release of salt from the coastal ecosystems.[21]

PRIORITIES FOR PROMOTING RESILIENCE TO NATURAL DISASTERS IN CITIES IN EAST AFRICA

Developing resilient urban infrastructure and effective land-use policies is a priority for East African cities. Plans should be tailored to each city's unique challenges, incorporating local expertise and ensuring community involvement. Therefore, the major priorities for promoting resilience to natural disasters in cities in East Africa are:

Urban and Land Planning for Disaster Resilience

Effective urban planning is crucial for reducing disaster risks and building resilience. This involves several key strategies:

Guided urbanization

To prevent future development from becoming hazardous, it’s essential to avoid building in floodplains and on steep slopes. This strategy promotes safer urban growth by prioritizing risk-aware land use and ensuring communities are moved to secure locations, thereby enhancing a city’s overall resilience. By identifying high-risk areas, cities can guide growth toward safer zones. For example, Kampala Capital City Authority's (KCCA) City Resilience Scan identified flood-prone areas, enabling more targeted planning. Dar es Salaam could use a similar approach to relocate informal settlements from low-lying areas.[22]

Leveraging informality

Informality shouldn’t be seen as only a problem but also as a potential source of innovation and adaptive practices. In many African cities, over 80% of economic activity and land tenure arrangements are informal.[23] Formal systems should work to integrate informal settlements into urban planning, providing secure land ownership and essential services. The success of Nairobi's Mukuru Special Planning Area demonstrates how participatory planning can improve informal settlements. Embracing informality fosters inclusive urban development by leveraging community-driven solutions to improve living conditions and economic opportunities.

Green infrastructure for climate resilience

Using nature-based solutions, such as ecological infrastructure conservation, helps mitigate flood risks and regulate the climate. For instance, in peri-urban Dar es Salaam, 18 green infrastructure schemes have been identified that could provide 47 ecosystem services.[24] Despite these schemes facing legal and institutional hurdles, cities should prioritize promoting green spaces and sustainable urban drainage systems (SUDS), as seen in some Ugandan cities. These solutions boost urban resilience by leveraging natural systems to reduce flooding and improve environmental sustainability, even when faced with regulatory challenges.

Community-driven resilience

Participatory planning such as involving communities in decision-making, enhances resilience and accountability. While a UN-Habitat program in Dar es Salaam faced challenges with sustained community participation in waste management, Nairobi's youth climate champions in Mathare show the potential of community-led initiatives with support from local authorities.[25] This approach strengthens urban resilience by empowering communities and fostering inclusive, locally driven solutions for sustainable development.

Policy and legal frameworks

Creating robust policy and legal frameworks is crucial for building resilience and maintaining accountability. Priorities include:

Bridging policy gaps in urban disaster management

Municipal master plans must integrate disaster risk reduction and urban policies.[26] Although the Sendai Framework for Disaster Risk Reduction (2015–2030) promotes local-level disaster risk reduction (DRR), many East African cities lack their own risk management legislation. This gap in localized legislation hinders effective disaster preparedness and response. For example, Kampala's flood assessment inventory, supported by the World Bank, demonstrates the value of data-driven policies in addressing urban risks. Strengthening local frameworks can enhance resilience and align with global standards.[27]

Strengthening institutional coordination

Over-centralized governance systems, such as those in Dar es Salaam, limit the capacity of local authorities to implement climate adaptation measures.[28] This excessive centralization inhibits the responsiveness of municipal governments, delaying the implementation of localized and contextually appropriate strategies. Empowering local authorities with greater autonomy and resources is crucial. Decentralized systems can enhance the effectiveness of urban climate adaptation.

Building capacity through local leadership

Capacity-building can be achieved through decentralized governance and capacity-build, respectively, to increase resilience. A landmark initiative in Tanzania from 2010–2015, which included the establishment of a partnership with ICLEI and other international organizations, highlights the importance of local leadership.[29] Decentralized governance empowers local authorities to tailor resilience strategies effectively. The Tanzanian initiative showcases how partnerships with global organizations like ICLEI can strengthen local capacity. Such efforts foster sustainable urban development and climate adaptation.

Early warning & preparedness

Investing in early warning and preparedness systems is crucial for ensuring that vulnerable populations receive timely, understandable alerts about floods, droughts, landslides, and other severe weather events.[30] This enables early and anticipatory action. Effective systems should integrate local knowledge, traditional communication methods, and community engagement to broaden the reach and relevance of warnings.

Robust early warning systems require multi-stakeholder coordination, involving government agencies, meteorological services, disaster management offices, NGOs, and community leaders.[31] Regional platforms and initiatives should be established to ensure universal access to early warning

information, recognizing their vital role in saving lives, protecting property, and supporting sustainable development amid increasing climate-related hazards.

Socio-economic resilience

Socio-economic resilience is the capacity of individuals, households, and communities to cope with, adapt to, and recover from various shocks such as floods, droughts, and economic downturns, while sustaining or enhancing their well-being.[32]
Building socio-economic resilience involves several key strategies:

Economic Empowerment

Promoting livelihood diversification and expanding economic opportunities are crucial. This can be achieved through inclusive labor markets and by supporting small businesses, which helps households absorb shocks and recover quickly.
Equitable Access to Services**.** Providing equitable access to basic services, including healthcare, education, clean water, sanitation, transportation, and energy, is vital for improving both quality of life and overall resilience.

Social Cohesion and Inclusion

Fostering social cohesion and inclusion, especially for marginalized groups like migrants, displaced persons, women, and youth, strengthens solidarity and enables collective action during crises.

Transparent Governance

Transparent and responsive governance is essential for delivering social protection, facilitating economic recovery, and ensuring accountability. This requires collaboration among local authorities, civil society organizations, and the private sector.

Knowledge Sharing

Cross-city dialogues and networks, such as LEARN, can facilitate the exchange of best practices, research, and community knowledge. This helps in developing context-specific and innovative solutions to urban resilience challenges.

Flood-resilient infrastructure

Investments in flood barriers, dams, and storm water management systems can mitigate flood risks. For instance, Tanzania's 14- megawatt hydroelectricity generator, serving rural areas, shows the potential of infrastructure investment.[33] Mombasa requires upgraded drainage systems to address sea-level rise and urban flooding,[34] building on the success of such interconnected infrastructure investments. These targeted interventions not only reduce flood vulnerabilities but also promote equitable access to reliable services. By integrating climate-adaptive designs, cities like Mombasa can safeguard communities and foster long-term sustainability. Coordinated regional efforts ensure these solutions are scalable and impactful across diverse urban contexts.

Sustainable Urban Drainage Systems (SUDs)

SUDS, such as permeable pavements and retention ponds, can manage storm water effectively. Kampala's pilot SUDS project aims to control bi-annual floods caused by precipitation runoff.[35] Scaling SUDS across cities requires municipal funding and technical expertise to ensure effective implementation. These systems promote environmental sustainability by mimicking natural water cycles. Investment in training and resources can enhance local capacity for SUDS adoption. Widespread use of SUDS strengthens urban resilience against climate-driven flood risks.

Emergency healthcare infrastructure

Floods and landslides increase demand for acute trauma care and infection treatment. East African cities, including Juba, lack robust prehospital emergency care systems.[36] Expanding emergency healthcare infrastructure, as recommended by the Kenya Red Cross, can save lives during disasters. Strengthening these systems enhances urban resilience to climate-related crises. Investments in mobile clinics and trained personnel can bridge critical gaps in care. Such measures ensure equitable access to life-saving services during emergencies.

Transport and Connectivity

Resilient road networks are vital for disaster response. The Mombasa-Nairobi-Kampala corridor, while relatively developed, requires upgrades to withstand floods.[37] Dar es Salaam's Bus Rapid Transit system, despite implementation challenges, improves urban mobility and can support evacuation efforts during crises. Upgraded infrastructure along key corridors ensures reliable connectivity in adverse conditions. Integrating climate-resilient designs strengthens the capacity for rapid response and recovery. These improvements collectively bolster urban safety and accessibility across East African cities.

CONCLUSION

Rapid urbanization, climate change, and socio-economic disparities are escalating the frequency and intensity of disasters in East African cities. As a result, effective urban resilience strategies are no longer optional but essential. Regional cooperation, exemplified by the recent Uganda-Kenya joint urban resilience meeting, underscores the importance of cross-border collaboration and shared learning in addressing these common challenges. When paired with innovative financing and inclusive governance, such initiatives can drive sustainable and adaptive urban development, ultimately transforming East African cities into resilient socio-economic hubs.

This study has highlighted the range of hazards—including floods, droughts, and fires in informal settlements—that disproportionately impact marginalized communities. These complex and often under-recognized threats are frequently neglected in policy and planning, despite their severe consequences for urban populations. Existing disaster governance approaches are often constrained by limited resources, inadequate infrastructure, and insufficient community engagement, which collectively undermine effective risk mitigation.

RECOMMENDATIONS

While disaster management in East African cities has shown improvement, several key areas still require attention. The following recommendations aim to address these gaps:

Develop a comprehensive regulatory framework

Establish clear standards for land use, building codes, environmental protection, and urban planning. This framework should guide cities in prioritizing investments and interventions where they are most needed.

Create an institutional framework for disaster risk management

Design an institutional structure to coordinate disaster risk management across various levels of government and sectors. This framework should define roles, foster collaboration, enable data sharing, and support capacity building for local governments.

Prioritize infrastructure development

Focus on upgrading essential infrastructure, including drainage systems, roads, water, and sanitation facilities. Incorporate nature-based solutions, such as wetlands restoration and green spaces, ensuring alignment with urban planning and environmental sustainability goals.

Implement sustainable funding mechanisms

Establish funding mechanisms that provide consistent financial resources for infrastructure upgrades, early warning systems, and community-based projects, ensuring long-term sustainability.

Promote public awareness and education

Enhance public understanding of disaster risks and preparedness through education campaigns. This will encourage safe building practices, foster social cohesion, and ensure the accountability and sustainability of disaster resilience initiatives.

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EDGES OF POSSIBILITY: SPECULATIVE URBAN DESIGN AFTER THE FLOODWALL

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INTRODUCTION

The climate crisis is escalating.[1] Rising sea levels, intensifying storms and increasingly unpredictable rainfall patterns are placing mounting pressure on urban systems and infrastructure. As of 2022, nearly 900 million people, or approximately 11 percent of the global population, lived in low-lying coastal zones, a figure that is projected to exceed one billion by 2050. This move towards urbanisation will exacerbate the risks from coastal flooding.[2] In response, cities across the world are grappling with the spatial and social challenges of building localised flood resilience.[3]

Traditionally, flood defences comprise hard infrastructure such as walls, levees, and embankments designed to exclude water. While such systems can provide localised flood mitigation, they are also criticised for their rigidity and functional singularity. Such structures can disrupt hydrological processes, degrade ecosystems, and alter sediment flows, often transferring risk elsewhere. They also tend to sever ecological and visual continuity, restrict public access to waterfronts, and produce lifeless buffer zones that divide rather than connect communities and landscapes.[4]

In response to such limitations, nature-based and multifunctional approaches to flood resilience have gained prominence. Green infrastructure, such as wetlands, floodable parks, vegetated berms and tidal corridors, not only reduces flood risk but can also enhance biodiversity, improve urban microclimates and offer civic amenities.[5] When flood protection is approached as a design opportunity, and integrated into the built environment with the aim of coexisting with water, it can enhance not only resilience but also the spatial quality, ecological function, and community identity of places.[6] Keilehaven Tidal Park in Rotterdam offers us a compelling example. Its stepped terraces slow and store tidal flows, easing pressure on drainage systems, while inviting public use, as illustrated in Figure 1. In this project people walk, sit, and observe tidal rhythms and reclaim the river's edge as civic terrain.[7]



Figure 1. Keilehaven Tidal Park, Rotterdam, photographs by Nuala Flood

The East Side Coastal Resiliency (ESCR) project, in New York City, also integrates flood protection with civic amenities. It was envisioned as part of the broader "Big U" concept which was developed through the Rebuild by Design competition. The ESCR safeguards Lower Manhattan's east side using a combination of elevated parkland, berms, floodwalls, and deployable gates. It also incorporates pedestrian pathways, seating, landscaped gardens and recreational spaces which are designed to enhance day-to-day public life.[8] The ESCR project offers valuable lessons, in how flood infrastructure can double as public space, and also in how design process shapes outcomes. The implementation phase was marked by revisions and contested trade-offs. Community concerns escalated when a revised plan, which prioritised construction logics and technical feasibility, led to the removal of over 1,000 mature trees in East River Park. While city officials defended the changes on engineering grounds, critics argued that the revised scheme disrupted ecological continuity and sidelined earlier, substantial community co-design efforts. These controversies underscore the importance of sustaining collaborative and adaptive processes throughout a project's lifecycle, not only during initial visioning and design.[9] Despite these tensions, this project remains a globally significant precedent, illustrating both the potential and the challenges of embedding civic and ecological value into large-scale climate adaptation infrastructure.



Figure 2. East Coast Resiliency Project (ESCR), New York, photographs by Nuala Flood

Against the backdrop of these evolving flood resilience approaches, Belfast's newly constructed tidal floodwall is examined, before exploring how speculative and participatory design might help recover some of its latent civic and ecological potential.

CASE STUDY: THE BELFAST TIDAL FLOOD ALLEVIATION SCHEME

Belfast is exposed to tidal flood risk. In recent years, the city has experienced a number of "near miss" events, most notably in January 2014, when emergency sandbagging was deployed along the harbour and riverside in response to a tidal surge. Prior to the construction of new flood defences, approximately 560 residential properties and 460 non-residential properties were considered at risk under then present-day sea levels. Without intervention, projections indicated this number could rise to around 3,400 by 2065 and 7,900 by 2115 due to climate-driven sea level rise.[10]

In response, the Belfast Tidal Flood Alleviation Scheme (BTFAS) was developed, a capital works project completed in late 2024 at an estimated cost of £33 million. The scheme is designed to offer long-term protection against 1-in-200-year tidal surge events and forms part of the broader Living With Water in Belfast Plan, a twelve-year, multi-agency strategy for integrated drainage, sewerage, and flood management.[11] The flood defences are engineered to remain effective well into the mid-21st century, accounting for projected sea level rise through the 2080s.[12]

The scheme extends approximately 8.5 km along the River Lagan and includes a combination of permanent and temporary defences tailored to the riverbank's varied topography and land use. Core components include reinforced concrete flood walls, which are predominantly clad in red brick, with short sections finished in yellow brick or black granite to reflect adjacent materials. Transparent glass flood walls are used in civic-facing areas near the city centre. Where accessways intersect the

floodwall, at roads, slipways, or towpaths, demountable post-and-plank barriers and hinged gates are sometimes utilised. In most areas, the floodwalls are set back behind the riverside path, allowing continued access and largely uninterrupted river views.

Unlike emerging precedents such as Rotterdam's Keilehaven Tidal Park or New York's ESCR project, both of which integrate public amenities and green infrastructure with flood mitigation, BTFAS was not conceived as multifunctional infrastructure. Moreover, participatory flood governance in Belfast has historically been limited to late-stage consultation, with community input largely sidelined in major infrastructural schemes. [13] This context raises important questions about how civic and ecological value might still be recovered within the context of this scheme, not through retroactive critique alone, but through forward-looking, codesigned processes that treat communities as legitimate partners in shaping climate-resilient public space.

Interpreting the Belfast Tidal Flood Alleviation Scheme

The BTFAS has redefined the edge of the River Lagan. It has inserted a continuous linear element into the city's landscape. While its engineering purpose is explicit, its impact on public space, ecological health, and spatial legibility is less clear. Kevin Lynch's concept of legibility, that is how easily a city's elements can be understood and emotionally navigated, offers a useful lens for analysing how it intersects with public space. This section uses his five elements of urban imageability, including paths, edges, nodes, districts, and landmarks, to examine how the floodwall shapes the human spatial experience along the Lagan.[14]

Paths are the channels through which people move and experience the city and they help shape orientation and flow. The Lagan towpath is one of Belfast's most recognisable linear routes. In many sections, the floodwall runs on the landward side of the path, preserving this path's riverfront continuity. However, several formerly porous cross-streets now end abruptly at a solid wall, breaking both visual and physical connections, as illustrated in Figure 3. These interruptions weaken the path's clarity as a coherent spatial experience. The towpath's surface also lacks variation. Its uniform material and detailing offer few cues to signal transitions or reinforce direction. Such differentiation is essential to legibility, and without it, paths risk becoming monotonous, and potentially disorienting.



Figure 3. Path disruptions and uniform surface along the riverfront: while the towpath remains largely uninterrupted, cross-street connections are severed by the floodwall, diminishing spatial legibility, photographs by Nuala Flood; images digitally edited to highlight the floodwall

Edges are linear boundaries that separate one area from another. Clear, legible edges help structure urban form when they are integrated and active and not used merely as barriers. BTFAS introduces a new and dominant edge condition to the city, as illustrated in Figure 4. In certain civic zones, glazed panels maintain views across the river, supporting a sense of openness. In other places, however, the wall asserts a heavy visual presence, casting shadows and reinforcing a defensive stance.



Figure 4. Shifting edge conditions along the BTFAS: glazed panels offer openness in civic areas, while solid brick walls create visual and psychological barriers, photographs by Nuala Flood; images digitally edited to highlight the floodwall

Nodes are focal points at intersections of movement or activity where spatial awareness is heightened. Along the Lagan, potential nodes exist where bridges meet riverside paths or where streets align axially with the river. Yet few have been treated as civic moments. At Governor's Bridge, for instance, as illustrated in Figure 5, a natural point of pause and drama remains unenhanced by the floodwall. Here, the infrastructure reads as functional but not as place.



Figure 5. Inactivated node at Governor's Bridge: a natural point of spatial convergence, left unmarked by the floodwall, photographs by Nuala Flood; image digitally edited to highlight the floodwall

Districts are larger areas with a distinct character. They are legible when internal coherence and clear boundaries reinforce local identity. Along the Lagan, the riverside transitions through civic, residential, post-industrial, and recreational zones. In principle, the floodwall could have supported these distinctions by incorporating variation in materials, planting, or integrated public amenities. While there are occasional changes in cladding and finishes, the wall remains largely consistent in height, material palette, and alignment.

Landmarks are visual anchors that help people navigate, orient, and form lasting impressions of a place. The Lagan corridor contains several such features, including bridges, parks and historic buildings, but the floodwall rarely acknowledges or frames them. It does not highlight views, mark entry points, or engage in cultural storytelling. Without interpretive, artistic, or ecological gestures, the wall functions as background infrastructure that is prominent, but does not meaningfully contribute to the city's legibility.

The BTFAS is spatially legible in the most literal sense: it is continuous and traceable. Yet its legibility is infrastructural rather than experiential or spatial. It enables orientation through its presence but does little to enrich the city's imageability, meaning its capacity to be felt, remembered, and meaningfully navigated. Its visibility could have been an asset. Instead, it marks a line and a missed opportunity.

Acknowledging the unfulfilled ecological edge

BTFAS project literature frames environmental concerns primarily in terms of mitigation by preserving views, replanting trees, and using materials sympathetic to the local context. These measures soften the wall's visual impact but do little to enhance biodiversity or ecological function.

Although environmental stakeholders were consulted and compensatory planting followed vegetation removal, there is no indication that the scheme was conceived to enhance ecological infrastructure.
The contrast with projects like ESCR project and Keilehaven is telling, not because Belfast attempted and failed to deliver multifunctional flood infrastructure, but because such ambitions were never seriously pursued. With physical flood protection now provided, but civic and ecological opportunities left unrealised, the question becomes: what next? The following sections explore how speculative and participatory design might help recover this latent potential by restitching public life, biodiversity, and a renewed sense of place along Belfast's tidal edge.

REIMAGINING THE RIVER EDGE THROUGH SPECULATIVE URBAN DESIGN

Describing the participatory design methodology

Public CoLab 2023 was a five-day design-intensive workshop hosted by Queen's University Belfast, developed to critically re-engage architecture students with the River Lagan following completion of the BTFAS. The initiative invited students to reimagine the riverside, and in particular areas reshaped by the floodwall, as an inclusive, biodiverse, and publicly engaging urban space.
The design brief asked students to reframe the floodwall, not as a finished engineering solution, but as a catalyst for civic and ecological renewal. Centred on the question, "What if we could reconnect the city to the river through a reimagined and regenerative Lagan corridor?", the brief invited small, strategic interventions, or acts of *urban acupuncture*, to spark longer-term transformation.[15] Projects engaged the wall as a built reality, but not as a fixed or final condition.
Each of the eleven student teams was assigned a specific stretch of river and tasked with developing site-specific design proposals. The methodological framework combined situated design, regenerative thinking, and environmental systems analysis.[16] Students conducted on-site observations, mapping, and spatial analysis, while addressing more-than-human futures, including birds, aquatic species, mammals, and riverbank ecologies.
The process was supported by interdisciplinary input. Contributors included an ecologist from Lagan Valley Regional Park, environmental planners from Belfast City Council, representatives from DfI Rivers and members of the activist group Save Our Lagan who opposed the wall on grounds of environmental destruction. These collaborators gave insights into river ecology, policy constraints, infrastructural logic, and real-world redevelopment pressures. Public CoLab 2023 thus positioned design education as a civic and environmental tool, offering students the opportunity to engage in speculative futures that respond to climate adaptation infrastructure in conversation with public officials.
Projects were developed iteratively through research, drawing, mapping, and scenario-building. Final proposals were presented through site-responsive visual storytelling, comprising mappings, rendered perspectives, and speculative inhabited sections, which were then curated into a publication.[17]

Presenting the speculative interventions

The student proposals developed through Public CoLab 2023 present a diverse range of speculative responses to the spatial and ecological disruptions introduced by the BTFAS. Two projects in particular, Floating Esplanade and Swimmer and Seals, stand out for their direct engagement with the altered riverscape. Both explore how public space and green infrastructure might be retrofitted into the gaps left behind by engineered flood infrastructure.
Floating Esplanade, illustrated in Figure 6, addressed the issue of severance along the riverside. Students observed that the floodwall had cut across what was once continuous public space, particularly narrowing or obstructing sections of the towpath. They identified key points where the wall disrupted spatial legibility and comfort. Their response proposed a floating, modular esplanade

moored to the riverbank, restoring the width of the riverside walk and introducing new functions, such as birdwatching platforms, gathering areas, and seasonal planting beds. Adaptable to tidal variation, the esplanade served as both civic space and ecological infrastructure. Crucially, the design did not oppose the wall's presence but worked with it by shifting public life onto the water rather than accepting its loss.

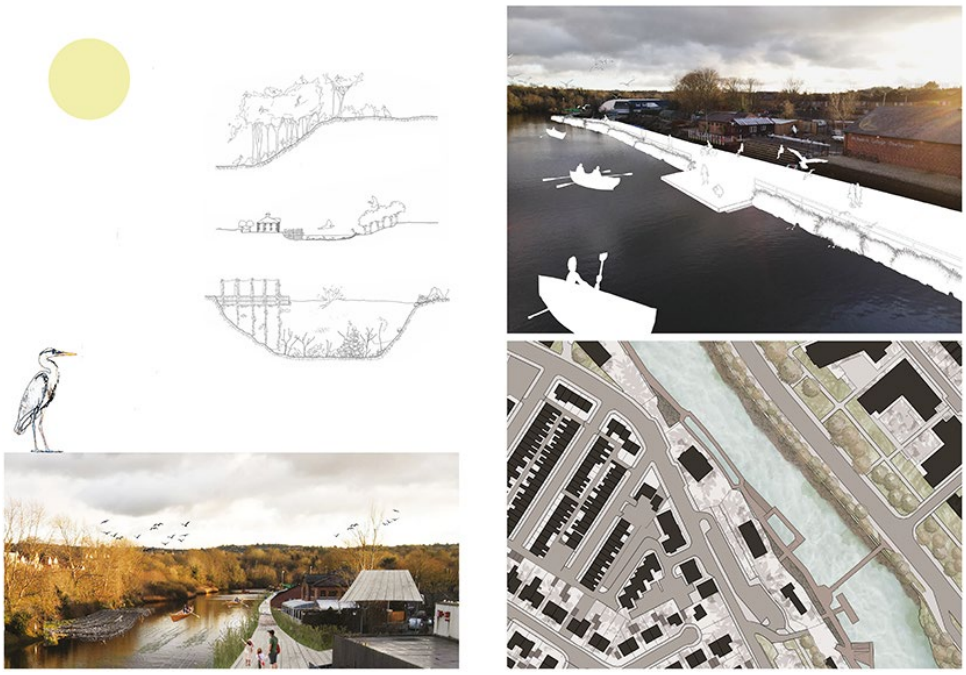


Figure 6. Speculative design proposal to extend public space via a floating esplanade[18]

Swimmer and Seals reimagined a stretch of the river's edge as a shared habitat for humans and non-humans. Informed by discussions with a behavioural ecologist from Lagan Valley Regional Park, the students proposed a retrofit that integrated a contained swimming pool, filtration planting, and resting platforms for riverine mammals. Rather than conceal the floodwall, the design embraced it, embedding planting at its base and incorporating a rewilded edge condition. The pool functioned both as a recreational amenity and a performative element by filtering river water, revealing tidal fluctuation, and drawing people into more embodied engagement with the river. Vegetated shelves and wetlands formed ecological buffers and playful spatial thresholds. The scheme combined climate adaptation, sensory experience, and interspecies care, repositioning the Lagan as a site of ecological and social renewal.



Figure 7. Speculative design proposal to activate the river's edge with swimming facilities and multispecies resting platforms[19]

Across all eleven project teams, shared themes emerged: reclaiming public space lost to engineering, greening the river corridor, and supporting biodiversity through careful redesign of edges and

transitions. Proposals employed landform sculpting, tactile materials, and non-linear circulation to invite both human and more-than-human life. Drawing from regenerative design theory and contemporary urban thinking, students framed their interventions not as additions, but as essential adaptations that treat the floodwall not as a boundary, but as an infrastructure to be inhabited, negotiated, and reimagined.

Together, these speculative futures expand the conversation on urban climate adaptation. While the BTFAS offers tidal flood protection, Public CoLab 2023 reveals what was excluded from its brief: the emotional, ecological, and civic life of the riverfront. The student projects propose that retroactive interventions can reanimate severed landscapes and spark broader reimaginings of the city's river edge.

CONCLUSION

As climate adaptation infrastructure becomes increasingly embedded in urban space, the question facing cities is no longer whether to build flood defences, but what kind and how they might enhance multispecies liveability.

This paper advocates for a forward-facing and regenerative approach that builds on the existing infrastructure, not to critique what was excluded, but to suggest what might still be added. Rather than simply raising barriers, cities can adapt their environments in ways that generate spatial, social, and ecological co-benefits.

Retrofitting the floodwall could involve planting schemes along its base to soften its presence, support biodiversity, and improve the microclimate. The integration of seating, lighting, and public art could humanise its edges, while new ramps, crossings, and steps could restore interrupted movement and enhance spatial legibility. Public programming, such as community gardens, temporary art installations, or walking trails, could help reanimate the riverfront as a civic corridor.

Drawing on Public CoLab 2023 proposals, underutilised segments of the Lagan corridor offer opportunities for targeted interventions as instances of urban acupuncture. Residual spaces at the junctions of flood infrastructure and street edges, under-bridge zones where amenities taper off, and narrow walkways could all be reimagined as active civic spaces. Floating structures might extend the public realm beyond the hard edge of the floodwall, while micro-wetlands or water gardens could enrich biodiversity and reconnect people with dynamic water processes. Such interventions need not be large or costly, but they should be deliberate, iterative, and grounded in community input and long-term reflection.

Regenerative design offers a broader lens for guiding these efforts by aligning human and ecological systems in mutually supportive ways. This perspective moves beyond mitigation toward repair. Retrofitted habitats, intertidal planting, and inclusive programming could transform Belfast's riverfront into living infrastructure: a corridor that evolves over time and deepens people's connection to place. Water, in this future, is not merely a threat to be contained, but a defining feature of the urban landscape.

This next stage of adaptation requires collaboration between government departments, architects, ecologists, engineers, artists, communities and students as civic agents. Public CoLab 2023 offers a locally grounded prototype for such work, to co-imagine a more livable, inclusive, and regenerative future for a walled waterfront.

NOTES

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ESTABLISHING A SUSTAINABLE URBAN LIVING WITH RESIDENTIAL WATER PRESERVATION IN WESTERN NEWFOUNDLAND AND LABRADOR, CANADA

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INTRODUCTION

Although Canada is rich in freshwater resources, it continues to record some of the world's highest levels of per capita water consumption.[1] A serious issue exists with residential water consumption in the province of Newfoundland and Labrador. Residents of this province consume around 470 litres each day, which is more than twice the national average of 220 litres.[2] It is important to point out that in small urban centres like Corner Brook, such systems, with flat billing and old infrastructure, put added strain on local water services and make sustainability harder to work toward. As issues related to water sustainability continue to grow, devices such as household water meters are now seen as key solutions for managing today's water use and improving long-term planning. Such technologies enable the adoption of consumption-linked tariff systems while reinforcing demand-side approaches designed to minimize waste and promote equitable allocation of resources. For small communities, acceptance of these measures usually depends on shared social attitudes, the prevailing economy, and how the change is understood locally. This research focuses on identifying the core drivers behind varying levels of household support for water meter implementation in the city. This study applies to a binary logit model to estimate how factors such as income, job status, environmental awareness, and views on pricing fairness affect willingness-to-accept (WTA). Using data collected from a region where water use is significantly above average, this research helps shape policies that merge the technical side of infrastructure renewal with active participation from residents, while also supporting long-term sustainability goals. This study also adds to the underexplored literature on water governance in smaller Canadian municipalities. By offering empirical evidence from a high-consumption region, the study helps develop policies that connect infrastructure improvements with public engagement and long-term sustainability goals.

Background

As population growth, urbanization, and climate change intensify, the resulting pressure on urban water systems has become a growing global concern.[3] Climate change affects both quality and quantity and timing of water supply.[4] These concerns hold particular weight in Canada, where water consumption per person is among the highest worldwide. The 2019 UN World Water Development Report warns that by 2050, global water demand will grow by a 20–30%, urging governments and

citizens alike to adopt strategies that balance supply and demand sustainably.[5] Nearly 50% of residential water consumption, largely from toilets and showers, makes up a major share of municipal water demand.[6] Studies have found that factors including household size, education level, income, infrastructure quality, and attitudes toward water use can significantly influence consumption patterns.[7] Evidence from prior studies points to the role of residential metering in tracking household water use and delivering crucial insights for water governance and policy planning. Water meters, especially smart meters, not only enable real-time usage tracking and leak detection but also serve as green technologies that encourage conservation.[8] Across the country, water use appears to be shaped more by economic incentives than by geographic conditions.[9] Municipalities across the Atlantic Canada provinces have implemented a variety of metering strategies. For example, Halifax Water in Nova Scotia has turned to advanced metering infrastructure to identify leaks faster and improve service for residents.[10] A 13% reduction in water consumption was achieved across the Prince Edward Island province through the introduction of a mandatory residential metering program in 2015.[11] These examples show that well-implemented metering policies can result in substantial conservation benefits. Even though there are similar concerns, in Western Newfoundland, the city of Corner Brook still operates with flat-rate billing and has not yet adopted universal household metering.[12] Although Canada's broader policy framework, such as the Canada Water Agency and the Canada Water Act , emphasizes water governance for sustainability, there is little research on the economic and behavioral factors influencing water conservation at the household level in the province of Newfoundland and Labrador.[13] In 2008, Sabau and Haghiri contributed to this area by applying a logistic regression model to examine household participation in water quality programs in western Newfoundland.[14] Education and income were found to positively influence conservation decisions, emphasizing the inclusion of socioeconomic aspects in water governance research. While their analysis offered valuable insights into participation in water quality initiatives, the topic of household willingness to adopt water meters remains underexplored. This leaves a clear research gap, especially since Corner Brook still uses flat-rate billing and does not have residential water metering. To address this gap, the current study applies a binary-choice logit model, as done by Sabau and Haghiri, to assess the extent to which households in Corner Brook are open to installing water meters. By analyzing household-level data and the effects of demographic, economic, and attitudinal factors, this research contributes to sustainable urban water management scholarship and supports future policy planning in Newfoundland and Labrador.

METHODOLOGY

A binary-choice logit model is used to estimate parameters and assess various factors affect the openness of Corner Brook households to installing water-use meters. The logit model, suited for binary outcomes, is applied here to whether households answered "Yes" or "No" to installing water meters and looks at what factors influence their Willingness to Accept (WTA). This model is perfect for predicting probabilities between 0 and 1[15], and it matches the binary outcomes in this study. Cokluk emphasizes that logistic regression's central function is the classification of individuals into specific categories,[16] a process that supports the objectives of the present study. In addition, this method supports model construction by estimating how dependent and independent variables are related, while minimizing variability to improve model accuracy. In logit regression, as in linear regression, the model can be built with one or several independent variables.[17] While linear regression is used to predict continuous values, logit regression is designed for binary outcomes.[18] After evaluating both models, the logit model was ultimately adopted because of its capacity to address categorical dependent variables. The importance of this model is in demonstrating the influence of different factors on decision-making processes. In addition, one useful feature of the logit model is

that it gives odds ratios, which make it easier to see how things like age, educational level, and job status affect the chance of adoption. Alongside delivering reliable analytical outcomes, this technique offers clear benefits for policymakers and other stakeholders working to craft strategies and incentives for adoption. The regression model takes the following functional form:

$$\Omega_i = \log\left(\frac{\pi_i}{1-\pi_i}\right)$$

The probability of residential water meter installation for household i is expressed in the model as π_i. While $(1-\pi_i)$ shows the likelihood of choosing not to proceed with installation. The log odds (Ω_i), we can link the probability to the different factors that have an impact on it. In this model, the log odds reflect the influence of several determinants of water meter adoption.

$$X_i'\gamma = \gamma_0 + \gamma_1 x_1 + \gamma_2 x_2 + \gamma_n x_n + \varepsilon_i$$

In the equation, income, family size, education level, and environmental awareness are among the independent variables X_i. Moreover, the intercept term γ_0 represents the baseline probability. Coefficients γ_1 to γ_n in the model reflect the influence of individual factors on installation probability. Any remaining unexplained variation is captured by the random error term ε_i. The dependent variable takes the value 1 for respondents willing to accept water meter installation (WTA_{IWM}) in their home and 0 otherwise. The probability that households throughout Corner Brook municipality will accept a domestic water meter installation is estimated with the regression model explained below.

$$\begin{aligned} WTA_{IWM} = {} & \gamma_0 + \gamma_1 gen2 + \gamma_2\, age2 + \gamma_3\, age3 + \gamma_4\, mari \\ & + \gamma_5\, Fsz2 + \gamma_6\, Fsz3 + \gamma_7\, edu2 + \gamma_8\, emp2 + \gamma_9\, emp3 + \gamma_{10}\, inc2 \\ & + \gamma_{11}\, inc3 + \gamma_{12}\, wpfam2 + \gamma_{13}\, wmgmtc2 + \gamma_{14}\, wmca2 \\ & + \gamma_{15} wmsource2 + \gamma_{16}\, costcompare2 + \gamma_{17}\, costcompare3 \\ & + \gamma_{18}\, costcompare4 + \gamma_{19} awusage2 + \gamma_{20} bwmrwc2 + \gamma_{21} infwm2 \\ & + \gamma_{22} infwm3 + \gamma_{23} wcedu2 + \gamma_{24} rhwmi2 + \gamma_{25} rhwmi3 + \gamma_{26} finc2 \\ & + \gamma_{27} satisfwp2 + \gamma_{28} govincent2 + \gamma_{29} effectivewmc2 + \varepsilon_i \end{aligned}$$

The analysis of these coefficients allows for identifying the key factors that strongly influence whether households decide to adopt water meters. This information is crucial for policymakers to develop efficient water management policies and overcome the challenges of introducing a metered water pricing system. Table 1 shows details information about the variables used in the model. This table also shows what sign is expected for each of the explanatory variables.

Variable Name	Description	Expected sign
WTA IWM	1 = accepted water meter installation; 0 = refused	____
gen	1 = male; 0 = female	-
age1	1 = under 30 years old; 0 = otherwise	+
age2	1 = between 30–65 years old; 0 = otherwise	+
age3	1 = 65 years or older; 0 = otherwise	+
marit	1 = married; 0 = not married	+
fsz1	1 = 1-person household; 0 = otherwise	-
fsz2	1 = 2-person household; 0 = otherwise	-
fsz3	1 = 3-person household; 0 = otherwise	-
edu	1 = college/university education; 0 = otherwise	+
emp1	1 = employed; 0 = not employed	+
emp2	1 = unemployed; 0 = otherwise	-
emp3	1 = retired; 0 = otherwise	-
inc1	1 = annual income < $54,999; 0 = otherwise	-
inc2	1 = annual income $55,000–$79,999; 0 = otherwise	-
inc3	1 = annual income ≥ $80,000; 0 = otherwise	+
wpfam1	1 = familiar with water pricing structure; 0 = not familiar	+
wmgmtc1	1 = confident in managing water use; 0 = not confident	-
wmca1	1 = aware of water meter cost; 0 = not aware	+
wmsource	1 = not aware of where to purchase/install water meter; 0 = aware	-
costcompare1	1 = believed paying more for water than other regions; 0 = otherwise	+
costcompare2	1 = believed paying less for water than other regions; 0 = otherwise	-
costcompare3	1 = believed paying roughly the same for water as other regions; 0 = otherwise	-
costcompare4	1 = unsure about paying more or less than other regions; 0 = otherwise	-
awusage	1 = aware of high water use in Newfoundland and Labrador; 0 = otherwise	+
bwmrwc1	1 = did not believe meters reduce household water use; 0 = otherwise	-
infwm1	1 = saw government incentives as a reason for installation; 0 = otherwise	+
infwm2	1 = saw environmental concerns as a reason for installation; 0 = otherwise	+
infwm3	1 = saw cost savings as a reason for installation; 0 = otherwise	-
wcedu	1 = not open to water conservation education; 0 = otherwise	-
rhwmi1	1 = viewed possible bill increase as a reason to hesitate; 0 = otherwise	-
rhwmi2	1 = viewed installation cost as a reason to hesitate; 0 = otherwise	+
rhwmi3	1 = viewed property damage or modifications as a reason to hesitate; 0 = otherwise	-
finc	1 = unwilling to contribute financially for a water meter; 0 = otherwise	-
satisfwp	1 = satisfied with current water pricing system; 0 = otherwise	-
govincent	1 = did not believe in government incentives for installation; 0 =	+

	otherwise	
effectivewmc	1 = believed meters are effective for water conservation; 0 = otherwise	+

Table 1. Variable Definitions and Expected Signs for Regression Analysis[19]

EMPIRICAL ANALYSIS

Data Description

In this research, a structured telephone survey was administered to gather primary data from homeowners residing in the City of Corner Brook during January to March 2024. This survey set out to identify the demographic, socio-economic, attitudinal, and behavioral elements shaping decisions on installing water metering systems. A small pilot survey was conducted prior to the main data collection to evaluate the clarity and effectiveness of the questionnaire. The data obtained during the pilot phase were removed from the further analysis. In total, 380 calls were made, of which 100 residents completed the survey, yielding a response rate of approximately 26.3 percent. Respondents who had already installed water meters or were not homeowners were excluded from the analysis. The survey focused exclusively on households not yet equipped with metering devices and collected information regarding their awareness, satisfaction with water pricing, and perceptions of fairness in the existing flat-rate billing system. Among the respondents, 69 percent stated they did not want have water meters installed, while 31 percent expressed a willingness to consider the system. Additionally, 71 percent of the individuals surveyed said they were unaware of the current water pricing system in the city. Responses about installation costs and logistics further revealed this lack of familiarity.

Table 2 indicates that 92 respondents were unaware of the purchase and installation costs of a water meter, while 94 percent did not know where to obtain one or access related services in their locality. Similarly, 78 percent of respondents did not know that this province is ranked among those with the highest average daily household water consumption in Canada. When asked about influences on adoption decisions, 46 percent cited government incentives, such as tax rebates, as the primary motivator. Environmental concerns and cost savings were also mentioned by 29 percent and 25 percent of participants, respectively. On the other hand, 59 percent of those surveyed cited a potential water bill increases top worry about installing a household water metering system, followed by 36 percent who were concerned about adoption costs, and 5 percent who worried about possible damage to their property (Table 2).

Variable Name	Frequency	Mean	S.D.
Gender			
gen1 (Female)	52	0.52	0.5021
gen2 (Male)	48	0.48	0.5021
Age			
age1 (Under 30 years old)	20	0.2	0.4020
age2 (Between 30 and 65 years old)	67	0.67	0.4726
age3 (65 years and older)	13	0.13	0.3380
Marital Status			
marit1 (Single)	51	0.51	0.5024
marit2 (Married)	49	0.49	0.5024
Family Size			
fsz1 (1 member)	22	0.22	0.4163
fsz2 (2 members)	35	0.35	0.4794
fsz3 (3 members or more)	43	0.43	0.4976
Education			
edu1 (Completed High School or lower)	44	0.44	0.4989
edu2 (Completed College or University degree)	56	0.56	0.4989
Employment Status			
emp1 (Employed)	82	0.82	0.3861
emp2 (Unemployed)	6	0.06	0.2387
emp3 (Retired)	12	0.12	0.3266
Annual Household Income			
inc1 (Below $54,999)	24	0.24	0.4292
inc2 (Between $55,000 and $79,999)	17	0.17	0.3775
inc3 ($80,000 or above)	59	0.59	0.4943
Familiarity with Water Pricing Structure			
wpfam1 (No)	71	0.71	0.4560
wpfam2 (Yes)	29	0.29	0.4560
Confidence in Managing Water Consumption			
wmgmtc1 (No)	28	0.28	0.4513
wmgmtc2 (Yes)	72	0.72	0.4513
Awareness of Water Meter Cost			
wmca1 (Yes)	8	0.08	0.2727
wmca2 (No)	92	0.92	0.2727
Knowledge of WM Purchase/Installation			
wmsource1 (Yes)	6	0.06	0.2387
wmsource2 (No)	94	0.94	0.2387
Perception of Water Costs Compared to Other Regions			
costcompare1 (Paying more)	11	0.11	0.3145
costcompare2 (Paying less)	27	0.27	0.4462
costcompare3 (About the same)	13	0.13	0.3380
costcompare4 (Not sure)	49	0.49	0.5024

Awareness of NL's High Water Usage			
awusage1 (Yes)	22	0.22	0.4163
awusage2 (No)	78	0.78	0.4163
Belief in WM Reducing Household Consumption			
bwmrwc1 (Yes)	85	0.85	0.3589
bwmrwc2 (No)	15	0.15	0.3589
Influential Factors for WM Installation			
infwm1 (Government incentives (e.g., tax rebate))	46	0.46	0.5009
infwm2 (Environmental concerns)	29	0.29	0.4560
infwm3 (Cost savings)	25	0.25	0.4352
Openness to Water Conservation Education			
wcedu1 (Yes)	48	0.48	0.5021
wcedu2 (No)	52	0.52	0.5021
Reasons for Hesitation on WM Installation			
rhwmi1 (Potential increase in water bills)	59	0.59	0.4943
rhwmi2 (Installation cost)	36	0.36	0.4824
rhwmi3 (Property damage or modifications)	5	0.05	0.2190
Willingness to Contribute Financially to WM			
finc1 (Yes)	57	0.57	0.4976
finc2 (No)	43	0.43	0.4976
Satisfaction with Current Water Pricing System			
satisfwp1 (No)	11	0.11	0.3145
satisfwp2* (Yes)	89	0.89	0.3145
Government Incentives for WM Installation			
govincent1(Yes)	87	0.87	0.3380
govincent2 (no)	13	0.13	0.3380
Effectiveness of WMs for Water Conservation			
effectivewmc1 (disagree)	42	0.42	0.4960
effectivewmc2 (agree)	58	0.58	0.4960
interested in installing WM			
WTA IWM (Interested in installing WM) (Yes)	31	0.31	0.4648
WTA IWM (Not interested in installing WM) (No)	69	0.69	0.4648

Table 2. Descriptive Characteristics of the Survey Sample[20]

Estimation Result

In cross-sectional regression estimation, one category per categorical variable was set as the reference to control for multicollinearity. The reference groups provide the baseline for evaluating the effects of alternative categories. The estimation results are summarized in Table 3. This study, employing binary logistic regression to assess drivers of willingness, looks at the factors that shape respondents' choices about implementing household water metering within Corner Brook. The applied model here is supported by a McFadden pseudo-R squared value of 0.599. The findings indicated that some factors demonstrated a positive and significant effect on the willingness to adopt household water metering. From the data, it was evident that age is closely linked to the likelihood of adopting water

metering systems. Respondents aged 30–64 are 42 percent more likely to agree to installation (p-value 0.023), while those aged 65 and over are 94 percent% more likely (p-value 0.017) than individuals under 30 years of age. This strong positive association confirms that willingness to accept water meter installation increases with age. Household size also plays major factor in their decision to instal water meter in their premises. The likelihood of agreeing to install a water metering system is 44 percent lower (p-value 0.001) for two-person households and 26 percent lower (p-value 0.024) among families of three or more members, relative to single-member households. The analysis indicates that household size has a negative association with adoption willingness, as larger households anticipate greater financial burdens. Contrary to the initial hypothesis, having a post-secondary degree is linked to a 44 percent reduction in the probability of adopting a residential water metering system than to lower education levels (p-value 0.000).

In other words, higher education may be associated with a deeper understanding of structural challenges or a greater inclination to question how the system operates. In terms of employment status, retired respondents are 35 percent less likely to be interested in installing a meter than those employed (p-value 0.046), suggesting that fixed-income households may be more sensitive to potential cost increases. Awareness of installation and water meter equipment purchasing costs is positively associated with interest in installation. Households aware of these costs were 39 percent more likely to accept installing a meter (p-value 0.096), showing how access to information can guide decisions. This analysis also showed that awareness of this region's high residential water consumption had a significant effect on their willingness to install meters in their home. Those who knew this information were 40 percent more likely to support meter adoption (p-value 0.002), showing how public education can drive conservation-oriented behavior. Satisfaction with the existing water pricing system indicates a negative impact. People who were happy with the existing pricing system were 61 percent less interested to want a metering system installed in their own properties (p-value 0.032). This shows that when people are comfortable with flat-rate billing, they are less likely to move toward conservation tools. Believing that water meters truly work to reduce consumption seems to encourage more households to consider installation. Respondents who believed that meters help conserve water were 19 percent more likely to support installation (p-value 0.068), underscoring the influence of perceived environmental benefits on household decision-making. The estimation indicates that the slope coefficients for several explanatory variables are statistically insignificant at conventional levels. Therefore, the findings confirm that both demographic and attitudinal variables significantly shape the economic evaluation and acceptance of water metering systems in the region of the study. The results may serve as a useful reference for both municipal and provincial policymakers to improve adoption rates in small urban municipalities.

Variable Description	Variable Name (Model)	Estimate (p-value)	Change in Probability (p-value)
Gender_2	gen2	0.0208 (0.793)	0.0197 (0.793)
Age_2**	age2**	0.4457 (0.044)	0.4225 (0.023)
Age_3**	age3**	0.9914 (0.034)	0.9397 (0.017)
Marital Status_2	marit2	0.0281 (0.855)	0.0267 (0.856)
Family size_2 ***	fsz2***	-0.4617 (0.008)	-0.4377 (0.001)
Family size_3 **	fsz3**	-0.2770 (0.050)	-0.2626 (0.024)
Education_2***	edu2***	-0.4596 (0.003)	-0.4357 (0.000)
Employment Status_2	emp2	-0.2804 (0.245)	-0.2658 (0.228)
Employment Status_3**	emp3**	-0.3713 (0.072)	-0.3520 (0.046)
Annual Household Income_2	inc2	-0.0728 (0.638)	-0.0691 (0.636)
Annual Household Income_3	inc3	0.0669 (0.630)	0.0635 (0.629)
Familiarity with the W Pricing Structure_2	wpfam2	0.1575 (0.295)	0.1493 (0.280)
Confidence in Managing W Consumption_2	wmgmtc2	0.0935 (0.336)	0.0887 (0.322)
Awareness of WM Cost _2*	wmca2*	0.4122 (0.122)	0.3907 (0.096)
Knowledge of WM Purchase/Install-2	wmsource2	-0.1974 (0.486)	-0.1872 (0.480)
Perception of W Costs vs. Other Regions_2	costcompare2	-0.1756 (0.299)	-0.1665 (0.285)
Perception of W Costs vs. Other Regions_3	costcompare3	0.0542 (0.866)	0.0514 (0.866)
Perception of W Costs vs. Other Regions_4	costcompare4	-0.1053 (0.490)	-0.0999 (0.485)
Awareness of NL's High W Usage_2***	awusage2***	0.4176 (0.013)	0.3959 (0.002)
Belief in WM Reducing W Consumption_2	bwmrwc2	0.3923 (0.186)	0.3719 (0.161)
Influential Factors for WM Install_2	infwm2	-0.0612 (0.526)	-0.0581 (0.520)
Influential Factors for WM Install_3	infwm3	-0.1589 (0.276)	-0.1507 (0.257)
Openness to W Conservation Education_2	wcedu2	-0.1896 (0.132)	-0.1798 (0.107)
Hesitation for WM Install_2	rhwmi2	0.1015 (0.315)	0.0962 (0.300)
Hesitation for WM Install_3	rhwmi3	-0.2893 (0.251)	-0.2743 (0.235)
Willingness to Contribute Financially_2	finc2	0.1917 (0.140)	0.1818 (0.117)
Satisfaction with the W Pricing System_2**	satisfwp2**	-0.6468 (0.055)	-0.6131 (0.032)
Government Incentives for WM Install_2	govincent2	0.669 (0.377)	0.6342 (0.372)
Effect of WM on W Conserv_2*	effectivewmc2*	0.2039 (0.092)	0.1933 (0.068)
Binary outcome: WTA IWM (willingness to adopt) Sample size = 100 McFadden R-squared (Pseudo R–squared).: 0.5986 LR Chi-square: 72.272 Log-Likelihood: -24.228 Degree of freedom: 29 Note:*Significant at 10% level; **Significant at 5% level; ***Significant at 1% level;			

Table 3. Binary Logit Model Results for Water Meter Installation Willingness[21]

SUMMARY AND CONCLUSION

In this research, the focus was on the factors that shape whether households in the city of Corner Brook, Newfoundland and Labrador, are open to installing residential water meters, given the city's fixed annual water fee that offers no financial incentives to save water. Through a binary choice (logit) model that was applied to primary survey data, the analysis revealed several significant predictors of willingness, both positive and negative. Notably, older residents and people with knowledge of both installation costs and high regional water use showed stronger support for adopting meters. Belief in the conservation benefits of water meters also played a key role. Lower levels of support were found among larger households, the more educated, retired residents, and those expressing satisfaction with the present pricing structure. The evidence indicates that adopting residential water metering in smaller urban areas like Corner Brook will require not only physical infrastructure changes but also carefully planned public communication. Efforts to educate the public should address gaps in knowledge about installation costs and emphasize the environmental benefits as well as the potential long-term savings. Providing financial incentives, targeted senior support programs, and transparent rate structures could help older and retired residents address concerns about affordability and fairness. From this perspective, based on the findings of this paper, people's behaviour is an important factor when it comes to making cities sustainable. Water governances are defined not only by infrastructure but also by how well residents are informed, engaged, and empowered to participate in adaptive governance. Climate change is adding strain; in areas with old infrastructure and flat-rate charges, that strain is becoming critical. In such situations, using water meters together with planning that reflects community priorities can help improve resilience. Grounding the work in both household choices and local context leads to a stronger, more equitable, and better-informed approach to sustainable living in cities.

POLICY RECOMMENDATION

The results indicate critical elements that influence how households in Corner Brook decide on the adoption of water meters. To support sustainable water use and improve uptake, several targeted policy strategies are proposed. Given the higher likelihood of adoption among individuals aged 65 or older, targeted outreach should promote user-friendly monitoring and financial benefits, using approaches consistent with their preferences. Households with more members and people experiencing financial limitations, such as retired or unemployed individuals, are generally less receptive to adopting water meters. Offering rebates, subsidies, or lowering residential tax incentives could make adoption easier. Many respondents lacked awareness of the province's elevated residential water use and the expenses involved in meter installation. Public education campaigns should tackle both issues by offering region-specific consumption data, clear pricing information, and instructions on how to access installation services. Given that certain respondents expressed environmental motivations, policies could highlight the conservation benefits of water meters and their role in limiting waste. By switching to tiered or usage-based rates, water conservation incentives could improve, especially when people are educated on the long-term savings. Overall, these recommendations aim to inform local policy by addressing economic, informational, and behavioral barriers, ultimately encouraging broader adoption of residential water meters and supporting sustainable water management in the city of Corner Brook.

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OFF GRID DWELLING: A TACTICAL SOLUTION FOR SHAPING A SUSTAINABLE FUTURE

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INTRODUCTION

Our planet is witnessing a significant increase in greenhouse gas (GHG) concentrations, with emissions doubling between 1970 and 2010. If current trends persist, the global temperature is expected to increase by 3°C by 2100. Emissions from energy use make up about 60% of GHG emissions worldwide, highlighting the urgent need for initiatives to decrease reliance on non-renewable energy sources.[1] Operational buildings, particularly during their post-occupancy phase, make up about 31% of worldwide primary energy use and are responsible for 21% of greenhouse gas emissions. Of these emissions, 57% are indirect CO2 from offsite electricity and heat generation, 24% are direct CO2 emissions produced on-site, and 18% come from the manufacturing of cement and steel used in building construction and refurbishment. Notably, residential buildings are responsible for 70% of this operational energy use within the sector, underscoring their pivotal role in reducing ongoing emissions and promoting sustainable energy practices as we work toward the 2050 net-zero target.[2]

In Australia, the residential sector significantly influences energy use and carbon emissions, a trend likely to continue with the ongoing population increase in both regional and urban areas – from 17.6 million in 1993 to 26.6 million in 2023, and expected to reach 37 million by 2050.[3] For example, to accommodate this ongoing growth, approximately 1.2 million new homes are expected to be built between 2024 and 2029, resulting in higher carbon emissions from residential buildings.[4] As it stands today, residential buildings account for about 25% of total electricity consumption and 12% of Australia's overall energy use.[5] While this data encompasses all housing types, its impact varies across building typologies. Mass-produced and older housing stock, which often lacks energy-efficient features, contributes significantly to rising consumption and energy poverty—especially for low-income households. Prefabricated housing, when properly designed, offers a pathway to reduce operational energy use through higher performance standards and controlled production. Similarly, custom homes offer opportunities for tailored sustainable solutions, though often at a premium. Understanding these distinctions is key to addressing energy equity and achieving net-zero housing solutions. In this context, off-grid housing models present a compelling alternative—integrating renewable energy systems, water autonomy, and low-impact design to reduce dependence on external utilities and provide long-term resilience against rising energy costs.

WHY RESEARCH OFF-GRID?

An off-grid house is a self-sufficient and autonomous system that meets the household's daily energy needs without dependency on government-provided grid facilities and infrastructure.[6] In the Global South, off-grid living often refers to informal settlements inhabited by people of lower social and economic status and located at the city's fringe.[7] In the developed countries of the Global North and Australia, however, off-grid houses are often occupied by the middle-class and, in some cases, well-off individuals who have either chosen this living arrangement to address environmental and/or social concerns or have been forced to adapt it due to the unavailability of grid facilities in their area.[8] By living off the grid, these individuals liberate themselves from the socio-political power impositions that grid-dependent households face, including the consequences of energy costs, a lack of control over their energy use, and energy disruptions during natural disasters. Off-gridders depend on renewable energy and are aware of and connected to the natural resources in their local environment. They are capable individuals who can generate their own energy through tactics that emerge from everyday creativity.[9]

Exploring off-grid solutions, including their socio-economic and environmental benefits, appears essential in Australia, especially as PV systems and energy storage options for residential use become more available, popular and affordable. Statistics show that over 4 million Australian homes now have solar panels.[10] Since 2015, the installation of batteries has risen sharply, primarily driven by the involvement of global companies such as Tesla, LG Chem, and Samsung in Australia's renewable energy market. From just 6,750 in 2016, the number of batteries in residential homes rose to 20,789 in 2017 and approximately 57,000 by 2023.[11] This swift growth in renewable energy options has highlighted the vulnerabilities of grid supply and raised concerns about a potential "death spiral" for the grid, underscoring the importance of off-grid homes as a viable alternative in future scenarios.[12] Additionally, in recent years, in affluent countries such as Australia, a growing number of people, communities and grassroots movements have been questioning and distancing themselves from the popular consumerism culture. Many have already selected off-grid living as an "alternative", simpler and more independent and affordable living style.[13] The grid's inefficiencies during rising natural disasters have also increased interest in safer, more reliable structures, making off-grid housing a viable option. Critical examples include the 2022 flood and 2025 Cyclone Alfred in Queensland, which resulted in extensive power outages affecting around 25,000 and 270,000 homes for more than 24 hours, respectively.[14]

OFF-GRID IN LITERATURE

Scholarships on off-grid living in the global north represent a small body of literature, with the majority of works published on the topic focusing on the economic and environmental benefits and drawbacks of such structures. Zhengen Ren et al. have analysed the feasibility of converting a fully electric house into an off-grid system under current and future climate change conditions. They concluded that large battery systems are necessary for these houses to operate properly.[15] Rajab Khalilpour and Anthony Vassallo focus on the economic aspects of off-grid living and conclude that widespread disconnection from the grid might not be realistic in developed countries.[16] Jhud Mikhail Aberillaa et al. explored the environmental effects of small off-grid systems for remote rural electrification. They argued that PV systems are environmentally more sustainable when installed individually for households.[17] Missing in these publications is the social importance of such living and its impact on community well-being and sustainable behaviours.

There is however an emerging body of literature analysing the social aspects of off-grid living in developed nations. For example, in Canada, Jonathan Taggart and Phillip Vannini offered a comprehensive social analysis of switching to off-grid involving 600 participants in their research.

They argue that off-grid living is a different type of habitation that requires a unique set of "material practices" and tactics.[18] In the US context, Eileen M. Smith-Cavros and Arianna Sunyak advocated for off-grid living, highlighting its potential to shape intra-community social interaction and foster "connected and healthy neighbourhoods and societies."[19] In Australia, Heather Lovell and Phillipa Watson characterised off-grid living as an example of "scarce data," advocating for the gathering of both qualitative and quantitative data to understand why individuals opt for off-grid lifestyles. They emphasise that social, situated, and context-driven analysis of off-grid living is just as significant as its environmental implications.[20] The significance of off-grid living as a means to shape more sustainable and healthier communities also underscores the need for architects to engage in the design of off-grid structures. This involvement is crucial since architects can serve as "a peaceful instrument of social transformation, a means of instigating a new lifestyle," while also being key players in crafting designs with environmentally and socially impactful forms and strategies.[21]

ARCHITECTS AND OFF-GRID DESIGNS

In the decades after the Second World War, architects from the US, the UK, Australia, and most countries in Western Europe found an extraordinary political, economic, and social agency to construct the built environment through novel design approaches. Some architects were employed by government bodies in the public sector, while others contributed future-focused ideas to the design of new housing.[22] In Australia, this era became known as the "golden age" in architecture. It was a time when the concept of "architect-designed suburban homes" emerged amid a growing optimism about the future. However, in the late twentieth century, the decline of the welfare state led to a market-driven neoliberal regime. Australia witnessed a shift in design and planning regulation from a prescriptive philosophy to a performance-based approach, in which all planning controls became guidelines. These new changes decreased architects' involvement in public and housing design projects and replaced them with large developers who thereafter became known as the "primary agents of change", prioritising profitability over the qualities of good design and care for the local.[23]

However, as Finn Williams pointed out, architecture has increasingly shifted away from solely relying on commercial commissions in recent years. This change arises from growing concerns regarding sustainability, the aesthetics of energy, social justice, community and individual well-being, as well as the importance of good design, which promotes the importance of reconnecting buildings to a wider environmental and social agenda.[24] Consequently, the role of architects as "agents" capable of steering society towards more sustainable and human-centric futures has become increasingly critical. Off-grid housing represents a category of structures where architects' involvement can not only improve its environmental adaptability, but also contribute to its gradual social acceptability. Firstly, given the self-sufficient nature of off-grid structures, ensuring their unique integration within the surrounding environment is imperative to maximise the benefits derived from natural resources. Architects, with comprehensive training in passive design strategies, are essential for creating context-specific structures in which "the aesthetics of use" can override the aesthetics of form.[25] Secondly, in contrast with the comfort of urban living, living off-grid can pose challenges unless the building is thoroughly adapted and designed to accommodate its occupants' distinct needs, lifestyles, and cultures. Thus, a "need-based approach" in design is highly preferable, and architects with the expertise to translate abstract concepts into tangible spaces are well-positioned to facilitate this process.[26]

In contemporary practice, architects play a decisive role in shaping the feasibility of autonomous living. Early design choices around siting, orientation, roof form, and glazing establish the building's energy profile long before technical systems are specified.[27] Passive strategies such as zoning, cross-ventilation, and incorporation of thermal mass lower heating and cooling demand, reducing the size

and cost of renewable systems required to achieve autonomy. Figures 1-3 demonstrate how the early site analysis and design intent are informed through passive design strategies and initial sketches to capture ideas and abstract concepts. Crucially, architects can translate clients' ambitions for independence, resilience, and quality of life into spatial and material outcomes that work in tandem with energy infrastructure.[28] This ability to mediate between abstract aspirations and tangible performance outcomes highlights why architectural agency is indispensable in the off-grid sector. Off-grid autonomy cannot be achieved through renewable systems alone; it requires deep understanding of building performance and how spatial configuration influences daily practices.

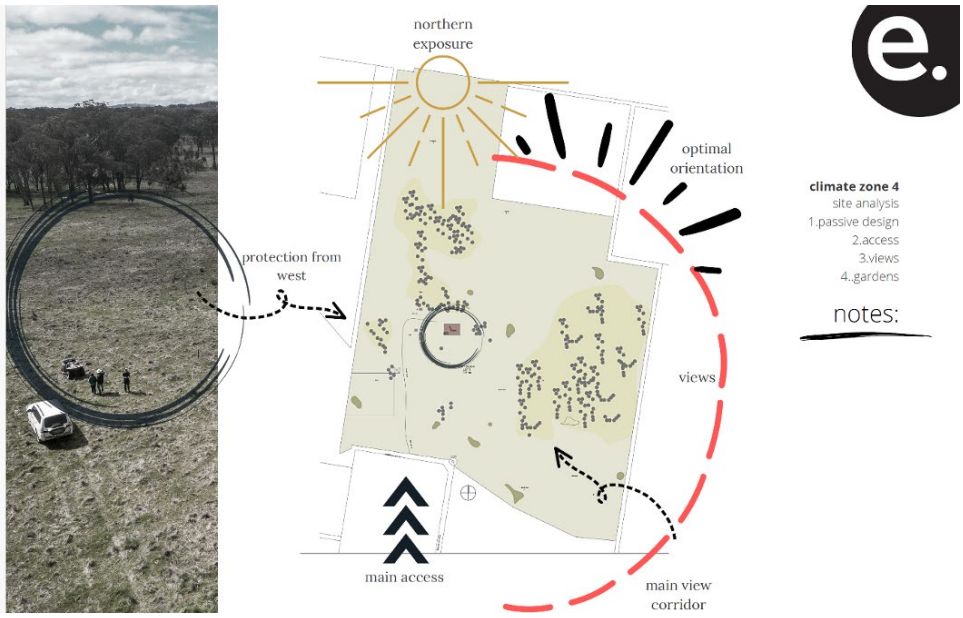


Figure 8. Site analysis for an off-grid dwelling in Climate Zone 4. The diagram illustrates key passive design considerations including optimal northern orientation, solar access, and protection from westerly exposure. Main site access and view corridors were mapped to balance functional entry points with framed outlooks, while garden zones and vegetation were integrated for shading and microclimate benefits. Courtesy of Epic Architecture.

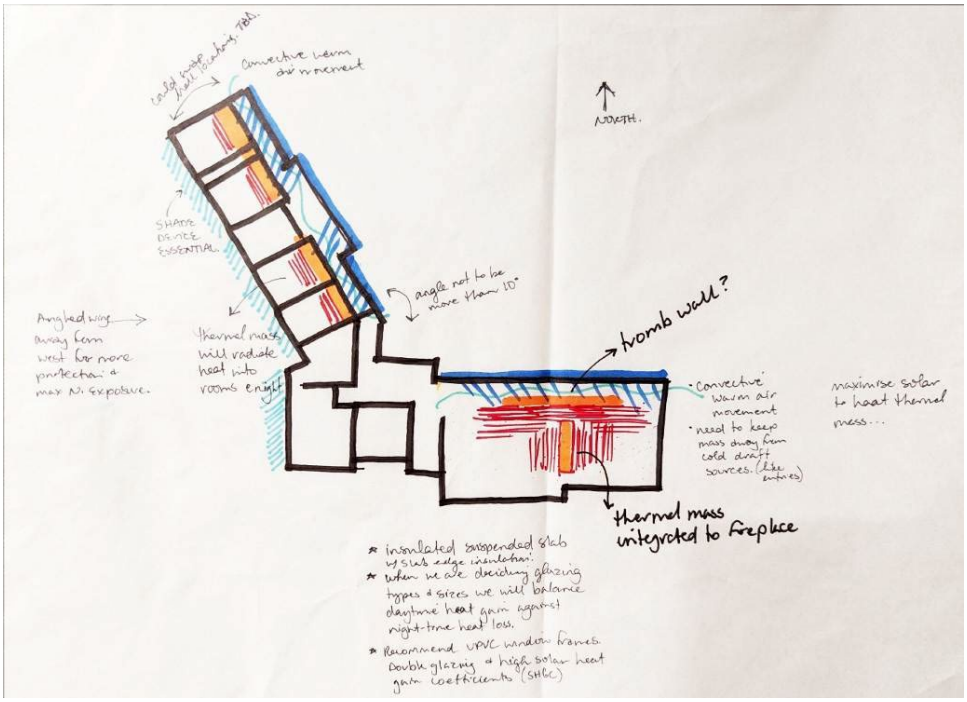


Figure 9. Hand sketch used as a design communication tool to convey passive design intentions, such as solar orientation, ventilation, and thermal mass integration. The combination of drawing and annotation makes abstract concepts tangible, enabling clients to visualise architectural intent while simultaneously learning how passive strategies support comfort and sustainability. This reflective process strengthens collaboration and empowers clients to make informed design decisions. Courtesy of Epic Architecture.

ARCHITECTURAL AGENCY IN OFF-GRID HOUSING: EXAMPLES FROM ARMIDALE

In practice, architect-designed off-grid dwellings demonstrate the critical role of architectural thinking in translating lifestyle values into high-performing, resilient buildings. Two recent off-grid projects in the New England and Hunter regions of NSW, designed by Epic Architecture, showcase how site-responsive design and passive strategies can support not only autonomy but also long-term behavioural and lifestyle change.

The first project, Congewai House, is a modular eco-pod residence developed for a family seeking energy independence, low environmental impact, and an integrated work-from-home lifestyle. Located on a remote rural site without access to grid infrastructure, the design incorporates passive solar orientation, thermal mass, cross-ventilation, and operable shading devices. A rooftop PV system with battery storage, rainwater harvesting, and composting waste solutions ensures full utility autonomy. Internally, the plan balances zones for sensory retreat, family connection, and focused work, addressing the household's specific neurodiverse needs. The resulting layout promotes environmental awareness, sensory comfort, and daily functionality showcasing sustainability as a lived experience, not just a technical goal.



Figure 10. 3D visualisation of an off-grid dwelling where architectural agency translates client needs into spatial outcomes, balancing sensory retreat, family connection, and focused work. Courtesy of Epic Architecture.

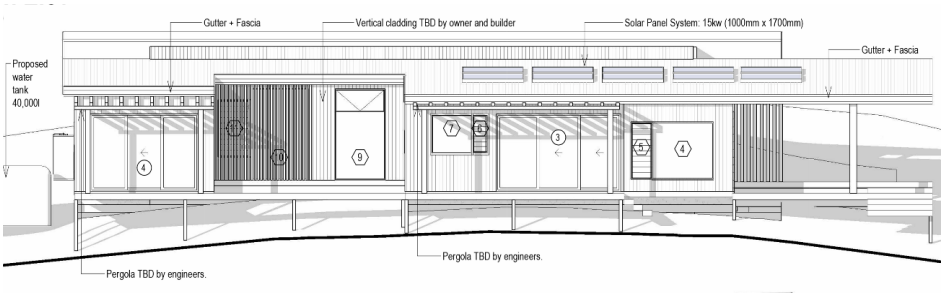


Figure 11. North elevation of Congewai House, a modular eco-pod designed for energy independence through passive solar orientation, cross-ventilation, and integrated renewable systems. The design ensures full autonomy with rooftop PV, rainwater harvesting, and waste solutions, supporting a low-impact, off-grid lifestyle. Courtesy of Epic Architecture.

The second case study, Armidale Strawbale House, is a custom designed off-grid home constructed using compressed strawbale panels. Designed for a semi-retired couple, the project emphasises a strong sense of place and physical connection to their land and working farm. The home is zoned to flexibly accommodate extended family visits while scaling down for day-to-day living, incorporating energy zoning. Generous openings frame landscape views, creating seamless visual and spatial links to the surrounding property. The thick, insulating strawbale walls and passive solar design strategies maintain thermal comfort, while the prefabricated construction method reduced build time and material waste. The design prioritised emotional connection to land and long-term liveability as much as technical autonomy.



Figure 12. Sectional perspective of the Strawbale House, where generous openings frame views and connect interiors to the landscape. Thick strawbale walls, passive solar strategies, and prefabricated construction balance thermal comfort, reduced waste, and long-term liveability alongside full off-grid autonomy. Courtesy of Epic Architecture.

Within the architectural process of Congewai House and the Armidale Strawbale House, design strategies were developed through close dialogue with clients to ensure their values were embedded in the built form. Abstract ideas, such as the need for sensory retreat, the desire for flexible family gathering spaces, or the importance of a deep connection to land, were translated into architectural moves including pod-based layouts, adaptive zoning, and framed views of the surrounding landscape. These choices not only enhanced livability but also moderated energy demand, enabling smaller and more efficient renewable systems to be installed without compromising reliability. The presence of an architect was therefore critical, as it ensured holistic autonomy, balancing technical, environmental, and emotional needs while supporting clients in adopting more sustainable everyday practices. In both cases, the results extended beyond meeting technical requirements. Living within these architect-designed environments encouraged clients to become more mindful of how they used energy, water, and resources in daily life. The architectural process thus functioned as a catalyst for behavioural change, demonstrating that well-considered design can embed sustainability into everyday routines while also strengthening household resilience.

CONCLUSION

In conclusion, the transition toward off-grid housing presents a vital opportunity to address the urgent environmental, social, and economic challenges tied to residential energy consumption. With buildings contributing significantly to global emissions and the Australian housing sector projected to expand rapidly in the coming decades, rethinking how homes are designed and powered is essential for meeting net-zero targets. Off-grid models, by prioritising renewable energy, water autonomy, and resource-conscious design, offer not only technical solutions but also pathways toward greater resilience, independence, and social well-being. Importantly, these systems move beyond reducing emissions; they encourage occupants to develop deeper awareness of their energy and resource use, fostering more sustainable everyday practices. As demonstrated by case studies in Armidale, architects play a central role in this transition, ensuring that off-grid housing is not only environmentally effective but also socially meaningful, contextually responsive, and adaptable to diverse lifestyles. Looking forward, off-grid housing must be understood as an emerging typology demanding sustained architectural innovation and policy engagement. As climate impacts intensify, distributed autonomous housing becomes increasingly relevant. Realising this potential requires architects to engage in policy dialogue and advocacy. Well-designed off-grid housing meets rigorous environmental standards while enhancing occupant wellbeing. Yet scaling beyond affluent communities requires addressing barriers in financing and regulation. Building codes remain grid-centric, creating regulatory friction. Insurance, lending criteria, and property valuation frameworks have not adapted to reflect off-grid homes' asset value. Architects must engage with policymakers and energy regulators to reshape these frameworks.

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BUILDING EQUITABLE URBAN FLOODING RESILIENCE: LESSONS FROM PUNE, NAIROBI, AND CALI

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INTRODUCTION

Urban flooding poses growing challenges in cities around the world, involving difficult choices about resource allocation and who and what gets protected. Climate resilience is inherently a political and economic issue rather than purely technical. Cities such as Pune, Nairobi, and Cali exemplify this challenge in post-colonial contexts. These dynamic urban centers face dramatic economic and demographic growth alongside mounting flood risks and environmental pressures. These cities are actively working to transcend their colonial legacies, drawing on global development funds, expertise from NGOs and consultants, and climate resilience frameworks that hold genuine promise for improving local conditions and protecting vulnerable populations.

The Rockefeller Foundation's 100 Resilient Cities program, ARUP's technical frameworks, and other Global North interventions have brought valuable resources, knowledge, and institutional capacity to cities that face mounting climate pressures with limited fiscal resources. Important infrastructure improvement, from enhanced drainage systems to early warning networks, have resulted in tangible benefits to urban residents.

We argue that achieving equitable urban flooding resilience requires moving beyond capitalocentric approaches that prioritize external expertise and recognizing local knowledge and community-based economies that build more just and effective flood adaptation.

COLONIAL LEGACIES, GLOBAL CAPITAL, AND RESILIENCE DISCOURSE

The concept that cities are "machines for capital circulation" challenges mainstream notions of resilience. Often, flood adaptation prioritizes profit over humanitarian goals. Large, capital-intensive infrastructure investments for flood mitigation secure profitable areas for further development, often while shifting risk to marginalized communities.[1] The "levee paradox" exemplifies this dynamic. Resilience infrastructure ostensibly protects but preserves "a development and economic growth paradigm, whereby as much land as possible is made available for development as cheaply as possible."[2] Such dynamics create a "high-risk, high-cost development paradigm that benefits developers" while creating new vulnerabilities.

Post-development theory, particularly Escobar's critique, reveals how urban resilience discourse transforms into 'development' rhetoric. Experts position vulnerable communities as problems requiring technocratic management. Global North frameworks dominate this process. As a result, top-

down solutions override local knowledge and agency. This pattern echoes colonial practices of devaluing indigenous ways of life for supposed progress and safety. When flooding in informal settlements is attributed to "inadequate solid waste management," narratives blame victims rather than questioning why municipal services systematically fail in these areas. This reproduces colonial logic where marginalized populations were framed as disorderly problems requiring removal to make way for more "rational" urban order.

As Gibson-Graham demonstrate, capitalism represents just one form of legitimate economic activity. Resilience planning reveals this bias toward “capitalocentrism” through its systematic preference for large-scale, formal, capital-intensive projects legible to state and market actors. Meanwhile, planners frequently ignore, devalue, or actively destroy small-scale, informal, cooperative, and non-monetized "diverse economies" foundational to marginalized communities' survival and adaptive capacity.

Diverse economies already function as crucial resilience assets, though they remain invisible to capitalocentric planning. "Micro-governance models" in Cebu "ensured inclusive participation, especially of women, and increased knowledge and acceptance of urban water interventions."[3] These non-market, cooperative governance forms produce social inclusion, knowledge-building, and effective water management because they operate outside capitalist logic.

PHYSICAL AND HYDROLOGICAL CONTEXTS

Pune, Nairobi, and Cali, because of their distinct histories of economic and physical development, have approached the challenges posed by water in diverse ways. Each faces specific water threats, but their responses are not simply technical interventions into geographic realities. Instead, political and economic philosophies set the standards for legitimate and desirable adaptations.

Pune's relationship to water has been profoundly shaped by the 1961 Panshet dam failure, when poor design led to the deaths of nearly 1,000 people. Since the tragedy, Pune leaders have focused primarily on controlling rivers through large-scale engineering projects.

In Nairobi, rapid urban growth in the absence of adequate state provision has compounded the problems of flooding. As documented, "poor sewerage and drainage, illegal building in river zones, haphazard planning, and corrupt and inefficient state regulation unable to keep up with the city's formidable pace of construction all make Nairobi's issues with flooding far from a natural security concern"[4]

In Cali, major flooding risks stem from the cyclical shifts caused by the El Niño–Southern Oscillation (ENSO) and "La Niña." Past responses have focused on large-scale structural projects such as the Jarillón dike and the Master Sewer Plan.[5]

Each city under study frames flooding primarily as a technical problem best managed through regulations and large-scale engineering projects. This technocratic approach parallels governance patterns that focus on property development over ecological protection or social equity.[6] Following Gibson-Graham, an alternative approach would frame hydrological systems as commons maintained through community stewardship. This approach highlights inclusive micro-governance and household-level risk reduction.[7] Such strategies would focus on enhancing equity for vulnerable populations.[8]

SOCIOEONOMIC VULNERABILITIES AND DISPLACEMENT RISKS

Expensive urban resilience projects do not always translate into reduced vulnerability for urban residents. Such projects are not politically neutral and may serve as conduits for dispossession rather than empowerment of vulnerable groups, as illuminated by Harvey, Escobar and Gibson-Graham.

Harvey's Accumulation by Dispossession: Seizing Assets Under Guise of Public Good

Contemporary urban ‘green’ and adaptation projects that displace marginalized residents embody the concept of 'accumulation by dispossession' advanced by Harvey in 2012. Recent studies show that green infrastructure projects like the CAU Cañaveralejo river restoration in Cali could improve urban resilience, flood control measures and provide other environmental and social benefits but may also trigger 'green gentrification' that displaces lower-income residents in situ without adequate compensation.[9] Many are pushed to resettle to the urban periphery, deepening social vulnerability and destitution.[10] Policies aimed at promoting climate resilience can inadvertently deepen inequalities across social groups rather than addressing the root causes of vulnerability.[11]

Escobar's Blaming the Poor: Masking Systemic Vulnerabilities

Public authorities and media often frame residents of informal settlements as 'informal encroachers' who are responsible for their own risk.[12] This scapegoating justifies the state's systematic failures in providing essential municipal services, land tenure and affordable housing.[13] In Nairobi, government reports and urban planning initiatives have systematically marginalized informal settlements by leaving them 'off the map' and denying them basic municipal services and disaster support.[14] Such systematic neglect led to frequent flooding in settlements like Kibera and Mukuru, where residents with no access to formal housing or services were blamed for encroaching on flood-prone riverbanks.[15] Policies to promote resilience often focus on short-term actions rather than addressing the underlying causes, depicting a pattern that holds vulnerable populations responsible for their exposure rather than tackling systematic failures.

Gibson-Graham's Informal Economies as Assets: Overlooked Resilience

The mainstream urban resilience framework typically frames informal economies and settlements as problems to be solved, prioritizing formal technocratic interventions instead. However, through the lens of Gibson-Graham, informal economies and community-driven practices have a dynamic but undervalued role in countering environmental shocks. These systems generate social capital, local knowledge, economic opportunities and adaptive capacity that the formal sector might fail to provide. For instance, informal recyclers and waste pickers in Cali and Pune provide critical services by removing solid waste and debris that would otherwise block stormwater systems.

In Kibera, informal settlers and community-based organizations have developed hybrid 'green-blue-grey' infrastructure that works with informal stormwater drains and waste collection along with small-scale greening, to reduce flood risk and improve water quality.[16]

COMMUNITY-LED NONCAPITALIST RESILIENCE STRATEGIES

Alternative resilience strategies rooted in community economies, cooperative principles, and social ties are not merely theoretical constructs and are already being practiced across urban contexts. These efforts highlight different ways of relating to each other and the environment, often existing within and sometimes against larger systems of capital and state power.

Gibson-Graham's concept of "community economy" provides a framework for understanding these alternatives. A community economy operates where decisions are guided primarily by ethical considerations of social and ecological well-being rather than profit maximization.[17]

In resilience contexts, community economies foster robust social ties and collective capacities, promoting shared responsibility for well-being and environmental stewardship. The "micro-governance models" in Gorakhpur, India, and Cebu, Philippines, exemplify community economies in

action, ensuring "inclusive participation, especially of women" in decision-making processes related to urban water services and disaster reduction.[18]

Citizen science and local knowledge integration represent another pathway. Pune's proposed project to "Develop methods for citizens science and community-based participatory groundwater management" embodies a policy shift valuing local communities as expert partners.[19] Their intimate, lived knowledge of local environments, often rooted in traditional ecological practices, constitutes a critical resilience asset.[20]

Community-led strategies represent "alternatives to development" rather than variations of it. By empowering broad stakeholder participation and fostering deep citizen involvement, as highlighted in Pune's strategy, these approaches directly counteract neoliberal ideology that shifts responsibility to individuals and communities without addressing systemic issues. They ensure resilience strategies remain "deeply rooted in the local context" and responsive to specific community needs and vulnerabilities, fostering more just and equitable relationships between people and their environment.[21]

COMPARATIVE ANAYSIS

A systematic comparison of government resilience documents with media coverage across Pune, Cali, and Nairobi reveals consistent discourse gaps that expose urban climate resilience as fundamentally political rather than technical.

Donor Influence & Spatial Bias

All three cities adopt remarkably similar language reflecting their foreign-funding and 100 Resilient Cities partnerships. Government documents emphasize "comprehensive multi-dimensional approaches," "integrated planning," and "multi-stakeholder frameworks." Pune's strategy, explicitly supported by 100RC, highlights "structural and non-structural measures" with "proactive planning," while Cali frames "comprehensive strategy for risk reduction and sustainability" through 100RC's "bouncing forward" approach.[22]

Media coverage reveals how this universalist language masks local political priorities and creates different outcomes depending on governance capacity. In Pune, media criticizes river restoration projects for prioritizing commercial development over ecological restoration.[23] Cali's media coverage reveals more a focus on infrastructure despite social inclusion rhetoric, and a contrast between the official government metrics highlighting 5,300 residents with reports of ongoing conflicts with residents. In contrast, Nairobi represents a distinct pattern of weak governance, with media coverage emphasizing local government failures.[24]

Hydrological Context & ROI Logics: When Nature Meets Capital

While donor-driven resilience frameworks impose similar holistic planning rhetoric across the case study cities, implementation varies based on local hydrological contexts and historical path dependencies. These physical differences shape distinct return-on-investment logics that consistently privilege engineering fixes over social-ecological approaches.

Pune's focus on structural solutions such as dams and embankments reflects 1961 dam failure trauma. Yet media coverage criticizes development priorities, revealing how engineering logic displaces ecological concerns.[25] This exemplifies Harvey's spatial fix; large capital investments in river control enable profitable riverfront development while displacing risk.

Nairobi lacks a storm water master plan and some have called for the construction of dams and dykes as a more permanent solution.[26] Yet media narratives expose governance failures such as neglected infrastructure and poor maintenance, exposing how basic service neglect creates chronic vulnerability.

This demonstrates Gibson-Graham's capitalocentrism underinvestment in informal areas because they don't generate returns.[27]

Cali faces large-scale, cyclical climatic events through El Niño and La Niña phenomena. **The** centerpiece response **is** the massive Plan Jari Mainstream flooding resilience projects function as "spatial fixes," which are large, capital-intensive infrastructure investments that absorb surplus capital and secure profitable areas for further development, often while displacing risk to marginalized communities. llón levee reconstruction, a spatial fix that has required enormous capital while physically restructuring land alongside the Cauca River. While government rhetoric emphasizes detailed risk assessments, early warning systems, and social inclusion for affected populations, media coverage reveals the contradictions inherent in applying engineering solutions to cyclical climate phenomena.[28] Reports consistently highlight how progress has been undermined by illegal reinvasions, budget issues, and illegal dumping. The recurring "reinvasions" of levee areas reflect how displaced communities return to familiar territories during climate cycles, creating ongoing conflict.[29] This tension reveals a mismatch between spatial fixes and the adaptive capacity needed for cyclical climate threats.

Pune's focus on structural solutions such as dams and embankments reflects 1961 landmark dam failure trauma, framed as a "build back better" approach.[30] Media coverage highlights the negative consequences of rapid urbanization and criticizes development priorities, revealing how engineering logic displaces ecological concerns.[31] This exemplifies Harvey's spatial fix; large capital investments in river control enable profitable riverfront development while displacing risk.

Nairobi frames flood vulnerabilities as requiring infrastructure investment and enforcement of land-use regulations, thus treating it as a planning problem. Officials note the lack of a storm water master plan and have called for the construction of dams and dykes as a more permanent solution.[32] This contrasts with media narratives that expose governance failures such as neglected infrastructure and poor maintenance, exposing how basic service neglect creates chronic vulnerability. This underinvestment in informal areas that don’t generate profits reflects Gibson-Graham's capitalocentrism.[33]

Cali faces large-scale, cyclical climatic events through El Niño and La Niña phenomena, which create recurring floods and landslides. Official government documents refer to adaptive strategies that aim to address community trust issues. However, the centerpiece response remains the massive Plan Jarillón levee reconstruction, a spatial fix that has required enormous capital while physically restructuring land alongside the Cauca River. While government rhetoric emphasizes things like detailed risk assessments, early warning systems, and social inclusion for affected populations, media coverage reveals the contradictions inherent in applying engineering solutions to cyclical climate phenomena.[34] Reports consistently highlight how progress has been undermined by illegal reinvasions, budget issues, and illegal dumping.[35] This tension reveals a mismatch between spatial fixes and the adaptive capacity needed for cyclical climate threats.

Governance, Fragmentation & Transaction

The structure of municipal governance dramatically impacts cities' ability to implement cohesive resilience strategies, with fragmentation increasing transaction costs, such as time, money, and political will, while creating systematic openings for inequitable outcomes.

Pune explicitly acknowledges fragmentation as a core problem and has called for improving processes and capacities for more integrated development planning.[36] The Resilience Strategy acknowledges that Pune and its twin city "are managed by their respective Municipal Corporations and are highly independent," making coordination "challenging."[37] For example, competing jurisdictions between development authorities and municipal corporations create enforcement inconsistencies, with

residents citing 'overlapping roles' in construction permissions and property tax collection.[38] Media coverage suggests that this fragmentation leads to inconsistencies in enforcement and regulation. As a result, communities seeking protection face higher transaction costs while developers often exploit fragmented oversight to push projects even in risky flood zones.

Nairobi in turn exemplifies how governance fragmentation creates opportunities for external actors to fill policy vacuums, leading to uncoordinated interventions rather than a cohesive, systemic strategy. Media reports point to large projects delayed by corruption and bureaucracy while communities bear the costs of coordination failures.[39] The absence of strong municipal capacity enables competing donor projects to shape urban policy incrementally, with each intervention negotiated separately, a clear example of the project-by-project approach that Harvey identifies as enabling uneven development.

Cali maintains a more centralized approach, with its centralized resilience office integrated across agencies of the municipal government.[40] However, this case illustrates that this can create different transaction costs. Media coverage highlights the ongoing conflicts with residents that have spurred "insurgent planning practices" that draw on local culture and traditions of resistance.[41] Technocratic centralization may reduce coordination costs for government but increase them for communities. Progress remains undermined by illegal reinvasions because centralized planning fails to account for community needs and local knowledge.

From this analysis, several lessons emerge. Cali's centralized coordination offers lessons for overcoming fragmentation while Pune and Nairobi demonstrate the risks of technocratic capture. The government-media gaps across all three cities highlight the need for participatory mechanisms that go beyond consultation toward genuine co-production. Finally, the persistence of informal alternatives across contexts points toward untapped potential for institutionalizing diverse knowledge systems as partners rather than obstacles in resilience planning.

POLICY RECOMMENDATIONS FOR EQUITABLE AND EFFECTIVE URBAN RESILIENCE

Blend Efficiency (ROI) With Justice (Vulnerability)

Future resilience polices must eliminate the false dichotomy of either investing in areas with high return on investment (ROI) such as business districts versus informal settlements. Instead, an integrated framework that prioritizes both efficiency and social justice should be adopted. Postcolonial cities like Cali, Nairobi and Pune have historically prioritized formal areas for traditional investments, neglecting informal settlements that are disproportionately susceptible to floods. A blended approach could yield transformative social benefits even if short-term economic returns are lower.

Strengthen Participatory Planning

Institutionalizing bottom-up participatory planning processes ensures marginalized communities have roles in designing, implementing and monitoring resilience strategies. Evidence from Nairobi shows that community-driven maps and participatory data have been crucial in identifying flood risks in informal settlements. If all three cities address systematic fragmentation, exclusion of marginalized communities, and weak institutionalized participation, they will realize participatory planning's full potential.

Value and Institutionalize Diverse Knowledge Systems

If municipal agencies and NGOs establish institutional frameworks that value and incorporate local, indigenous and experiential knowledge systems alongside technocratic expertise in resilience governance, they will have a more comprehensive understanding of emerging challenges. Nairobi demonstrates how citizen-generated data and local community knowledge exposed vulnerability that were overlooked by 'official' flood risk models.

CONCLUSION

The cities under study face ongoing challenges in transcending colonial and neocolonial legacies to fully respect local knowledge and prioritize the quality of life of all residents, particularly those in informal settlements. The tension between capitalocentric spatial fixes and community-based diverse economies persists, manifesting in contradictory approaches within the same urban contexts. While large-scale engineering projects may serve development interests, smaller-scale interventions like community-managed storm drain maintenance, solar power provision to informal settlements, and resident-based early warning systems reflect emerging recognition of local capacity and knowledge.

The path forward requires neither wholesale rejection of external resources and expertise nor uncritical acceptance of imported frameworks. Instead, it demands nuanced approaches harnessing global resources while centering local agency, knowledge, and priorities. As these cities continue to grow and adapt, their experiments in balancing top-down resilience investments with bottom-up community strategies offer valuable lessons for urban climate adaptation globally.

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URBAN DENSIFICATION AND ECOSYSTEM SERVICES: A COMPLEX TRADE-OFF

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INTRODUCTION

At a time when the effects of climate change are already visible, policymakers are doing efforts to build resilient and sustainable urban environment. This can follow different strategies, and have impacts in different aspects of citizens' life,[1] e.g., noise, pollution, temperature, stress, amount of exercise, travel time, health or risk of flooding. Natural elements (i.e. ecosystems) are often threatened by environmental alterations, particularly in urban microclimates,[2] with consequences that often go unnoticed. Consciously integrating these elements into public spaces in our cities enables us to evaluate their contribution to urban planning goals.[3]

Ecosystem services (ES) are the direct and indirect contributions that ecosystems – known as natural capital – provide to human well-being and quality of life.[4] Thus, they express the utilitarian value of biodiversity.[5] Within urban areas, we speak of urban ecosystem services.[6] A city's capacity to support these services is heavily dependent on its urban form.[7] Despite the traditional advocacy of compact cities, urban compactness can lead to adverse environmental consequences due to overcrowding and excessive land use, resulting in pollutants that exceed the carrying capacity of the environment. There is evidence that it compromises human well-being and urban sustainability.[8] The shortage of space within cities and the increasing compactness of the hinterlands affects the supply of ES needed to sustain urban dwellers.[9] A study by Iungman et al.[10] classified 946 European cities according to their urban configuration, and found compact cities to have lower CO2 emissions per person but a higher harmful environmental exposure and a higher mortality, compared to green, low-density developments. Building natural, green spaces might be the solution to overcome the rise in mortality.[11] An integrative assessment of Ecosystem services provides a quantitative analysis of benefits, including the consideration of trade-offs, costs and benefits of available solutions. Only by integrating the assessment of ES in the planning process can we achieve compact-green urban environments.[12] However, multiple barriers prevent cities from implementing greening processes.[13]

In this sense, it is utterly relevant to find the best ways to effectively integrate urban ES into the planning of compact cities. I have reviewed academic and grey literature, with the aim to answer the following questions: (i) what ES are most critical and most assessed in compact urban environments? (ii) to which extent are ES already considered in compact urban planning? (iii) how is the provision of ES affected by densification policies? (iv) how can the spatial assessment provide useful information for practitioners?

METHODOLOGY

For the systematic literature review, the search of peer-review papers was limited to the last 15 years. The papers were retrieved through a search on Google scholar at the end of April 2025 using following strings: “ecosystem services”, “compact urban”/”compact city”/”densification”. Review papers were excluded. The preliminary abstract screening left us with 81 papers. This was followed by a full-text screening to identify the articles containing a spatial, non-monetary quantification of ES. After the screening I obtained 33 papers which were considered for the analysis.

The papers were analyzed making use of 7 categories that included the number of ES mapped, if both supply and demand were considered, the methodology, the type of data used, the mapping scale utilized, the size of the study area and whether trade-offs and synergies were considered.

A complementary, non-systematic review of grey literature was also carried out with the scope of assessing the level of penetration of urban ES academical knowledge into urban planning in compact, green cities. Eight European cities were selected that define themselves as compact and green in their own official websites. Their climate action plans -or similar documents- were retrieved and analyzed in May 2025, paying particular attention to the use of the ES paradigm in urban planning. Further, I assessed the availability of open data published by the cities´ municipalities that could be relevant for the assessment of ES´ supply.

LITERATURE REVIEW FINDINGS

Almost the totality of the reviewed publications mapped more than one ES in their study area. Despite there being an international classification with proposed indicators for each ES,[14] many studies used alternative nomenclature or indicators.

The most generally adopted classification of ES divides them into regulating services (which control the natural conditions and processes), provisioning services (which include material, tangible products obtained from ecosystems), cultural services (the non-material benefits people obtain from natural environments, such as through spiritual enrichment, cognitive development, reflection, recreation, and aesthetic experiences) and supporting services (the fundamental processes that are necessary for the production of all other services).[15] In total I found 23 different ES mapped in dense urban environments, of which more than half classify as regulating services. The rest are supporting, provisioning and cultural services. The most often researched ES are Microclimate regulation and air purification, both regulating services. They are followed by the ES recreation (cultural) and food supply (provisioning). The most recurrent supporting service is habitat quality. This is aligned with the priorities set in the grey literature, as will be discussed later. The complete chart of ES mentioned in the reviewed papers is presented in Fig. 1. None of the studies considered ecosystem disservices. This is consistent with the findings from other studies, which have found that despite their relevance, ecosystem disservices are largely disregarded.[16]

Although each of the reviewed studies included a well delimited study area, the assessments were carried out in study areas of diverse location, extension and urban significance. The size of the study area varied significantly, with the most common boundary (9 out of 33 studies) being that of the town or city. Seven papers assessed ES in areas smaller than the town municipal boundaries, while 3 studies had several cities as case study. Six studies considered a metropolitan area beyond the administrative boundaries of the city and 8 studies assessed even larger areas.

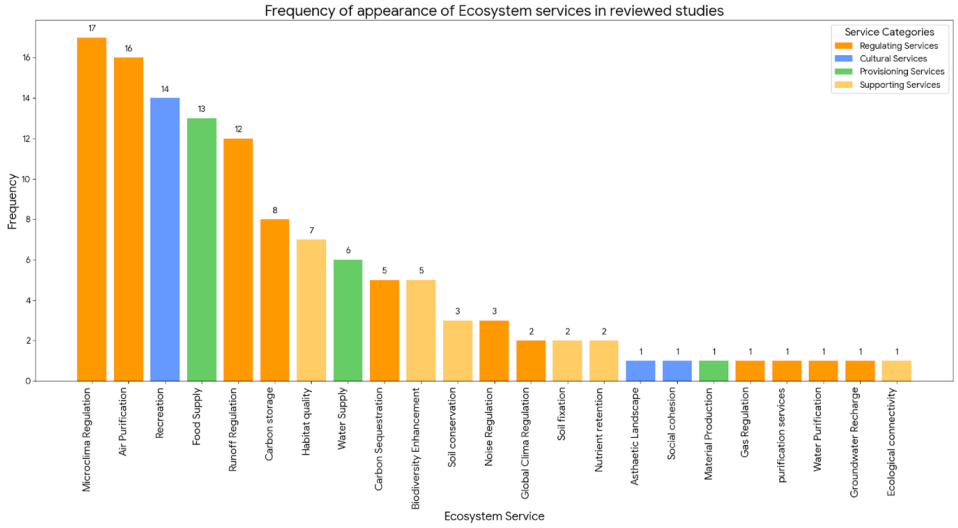


Figure 1. Frequency of appearance of Ecosystem services in the reviewed literature (Own data).

The most researched cities were Wuhan (China), Barcelona (Spain) and Rome (Italy). Altogether 17 studies were focused in Europe, 13 studies were focused in Asia (predominantly in China) and 2 in North America. Additionally, I found a comparative study which included one city in Europe and one in Asia. It should be noted that Asian-focused studies tended to have larger study areas, while the ones in North America considered sub-urban study areas.

Assessment and Quantification approaches

The vast majority of the reviewed studies (30) combined official or open-source socioeconomic data with remote sensing data or maps derived from such sources, i.e. land use/land cover maps. Of these 30, three completed the data with their own measurements or site visits, and another one with data from a green inventory map. For the remaining three articles, one used data from green inventory map that had to be completed with site visits. The other two were based on analysis detailed on other papers and thus did not explain the origin of their data.

The mapping resolution is directly related to the quality of the data used and to the usability of the results. This way, site visits or the use of detailed green inventories result in higher mapping resolutions. Nine of the studies mapped the data with a resolution of 10 m or less, which is sufficient for an analysis street by street. Ten papers used a resolution between 10 and 50 meters or divided the area in blocks. Other 9 studies divided the study area in neighborhoods or in a 100 to 1000 m grid. Other two studies, both assessing urban agglomerations in China, considered only data clustered at the regional level. The remaining 3 papers had multi-scale assessments.

Planning integration strategies

The reviewed literature found urban compactness to be negatively correlated with several urban ES, such as food production, habitat quality,[17] stormwater retention, heat mitigation[18] and air regulation.[19] Ran et al[20] found relationships between urbanization and carbon storage or food production to be U-shaped rather than linear, with statistical thresholds that could be very significant for urban planning. While in general dense urban fabric and high buildings are linked to mismatch conditions,[21] small-scale studies have shown high supply values in peripheral neighborhoods.

Land use changes can have a great impact on some ES.[22] Redevelopment strategies affection to local climate is not always negative;[23] while leapfrogging expansion can disrupt the stablished ES´ supply-demand balance,[24] green compact urban growth can reduce the loss of ES due to global warming.[25]

Some important factors affecting the supply of ES in urban environments are: building density, entropy of land use, land development,[26] forest land proportion, slope, the normalized difference vegetation index, elevation and temperature.[27]
The literature highlighted the necessity for multi-scale analyses[28] and multi-level ecological protection.[29] Specific scale effects for ES´ supply and demand were identified by Luo et al.[30] Aggregated data in large scales can be helpful to establish priorities, but a higher level of detail is with the level of detail needed to understand the supply of some ES in cities.[31] An example is the ES air purification: since vegetation takes more pollutants when concentrations are high, trees situated near emission sources are more efficient.
ES´ supply is dependent on structure, composition and management of green infrastructure.[32] While large patches of green and blue areas relevant for cultural ESs, trees, especially when clustered, are very relevant for air pollution and water flow regulation.[33] Some synergies were found between the ES microclimate mitigation, air purification and carbon storage, as well as between recreation and tun-off retention,[34] however, recreation seemed to compete with other ES for space in urban environments.[35]
Many studies stressed the importance of considering the supply and demand of ES in urban planning,[36] and its relevance for achieving the United Nations´ sustainable development goals (SDG), particularly the SDGs 11, 13 and 15.[37] Transdisciplinary teams are necessary for effectively applying the knowledge gained from the assessments.[38]

Grey Literature

I analyzed the urban sustainability plans or similar official documents for a selection of European cities: Amsterdam, Barcelona, Copenhagen, Helsinki, Leipzig, Lisbon, Milan, and Paris.
Helsinki shows a strategic ambition to be green and compact at both regional and municipal level. While the city´s website contains indicators for the UN's Agenda 2030 Sustainable development goals, which are effectively aligned with urban ES,[39] the region has a “sustainable urban living program”.[40] It is important to note that the city publishes relevant data on its Open Data map service[41] in GIS format, which has the potential to facilitate the calculation of both the supply and demand for various urban ES. Leipzig adopts a very similar approach: the city´s “energy and climate protection program”[42] recognizes the importance of reforestation and street greenery for CO_2 neutrality. Pollution and noise data and a tree inventory[43] can be found in the city´s website. Additionally, the Helmholtz Centre for environmental research published a map with blue-green interventions across the city.[44]
The cities of Barcelona, Milan and Paris are also making progress in this area. The three cities publish data for current pollution,[45] urban green infrastructure[46] and planning goals, even though their degree of geographical coverage is limited. They identify coldspots for urban ecological processes and provide indicators for demand, which is highly beneficial for establishing planning priorities.
Finally, the cities of Amsterdam, Copenhagen and Lisbon have all recognized the importance of green infrastructure, or nature-based solutions (NbS), and have set objectives that are consistent with the vision for a green, compact city.[47] However, I could not find any further detailed information for the valuation of ES indicators, or online data concerning their urban green infrastructure.

SYNTHESIS AND DISCUSSION

Land use/Land cover maps and the normalized difference vegetation index derived from remote sensing are a valuable input for the assessment of urban ES,[48] but their resolution is too coarse and they typically don´t differentiate between vegetation types, which can have a central role in some regulating services, such as air quality.[49] Thus, it is difficult to reflect the diversity of green

infrastructure and the ES associated to them when using indicators based on remote sensing. Derkzen[50] found trees to be the main source of benefits from ecosystems in urban areas. Nevertheless, it is unclear whether private trees and greenery should be included in official inventories and assessments, given that municipal authorities have no control over their accessibility and maintenance. In addition to that, there is a trend for the inclusion of NbS in urban planning, but their associated benefits can rarely be accounted for with large scale resolutions. The most appropriate scale often depends on the ES studied or the purpose of the study; local planning requires local, fine-grained data, which is not always available and requires more time-consuming techniques.[51] More detailed resolution could take into account small ES providing areas which are often overlooked in regional assessments. These areas might have a relevant impact in terms of ES flow and unsatisfied demand in the urban core.[52]

Alternative methodologies exist that create or use basic data in order to assess the supply of ES with existing model software, such as Envimet or i-Tree eco.[53] It is yet to be seen if the automation of GIS-based data, together with the rise of artificial intelligence tools like ARIES, could make data availability and assessment less resource-intensive. Such tools would be of great help for the level of assessment needed in local planning but were not found among the reviewed literature.

Experts agree that an evaluation of the integration of green infrastructure in compact urban environments by assessing the supply and demand of ES should be integrated in practitioners' common practice. Microclimate regulation, air quality and recreation were the most researched services, which was reflected as well in the grey literature, although no explicit mention of urban ES could be found there. While some practitioners still use thumb rules such as a minimum percentage of green cover in each district, the amount and quality of data gathered and published by municipalities keep improving, making more adapted evaluations possible.

While studies focusing on either supply or demand are useful, it is the mismatches that provide us with the full picture. Nevertheless, when supply and demand values are calculated in different units, a mismatch calculation is not always meaningful. Adopting a standardized approach to indicators and methods would make it easier for practitioners to use the framework and help overcome this problem.

Last but not least, the impact of different redevelopment strategies on the balance of ES supply and demand has been the subject of research in many of the reviewed articles. While central urban areas tend to be cold spots for ES, mainly due to a lack of space, their green areas are particularly vulnerable to climate change. Although vacant lots within the city can contribute to several urban ES,[54] experts generally recommend infill redevelopment and green space sparing in order to protect agricultural spaces outside the city limits. The creation of compact, efficient urban spaces that incorporate consolidated ecological areas is a promising to overcome mismatches in the supply and demand of ES.

CONCLUSION

I conducted a systematic review of academic literature to investigate how the supply and demand of ES are affected by compact urban environments. This was complemented by a review of grey literature to evaluate the transfer of knowledge and data availability. A total of 33 papers mapping ES in dense or densified urban environments were found and assessed, as well as the official websites and sustainable development documents for 6 compact green cities in Europe. Regulating services (particularly microclimate mitigation and air purification) were found to be the most often researched ES. In general, urban compactness affected ES negatively, with some important factors being building density, entropy of land use, land development, forest land proportion and slope. However, there are thresholds, trade-offs and synergies to consider. Most studies were mapped with a spatial resolution of at most 10 meters, which is insufficient for analysis at street level. The review of grey literature

revealed that municipalities and regions recognize the importance of natural processes for planning goals, and most of them publish relevant high-resolution data.
There is a need for analysis of ES´ supply and demand at small scale, which could use data made available by municipalities, e.g., tree inventories. An integration of this assessment would be key for achieving the United Nations´ sustainable development goals and maintain human well-being.

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ELECTRIC VEHICLES IN MOTION: TRANSFORMING URBAN FREIGHT DISTRIBUTION WITH BATTERY AND HYDROGEN TECHNOLOGIES

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INTRODUCTION

Urban freight transport is one of the most complex and impactful components of metropolitan mobility systems, responsible for significant shares of greenhouse gas (GHG) emissions, air pollutants, congestion, and competition for curb space.[1] In dense city cores, delivery fleets are increasingly constrained by access regulations, scarce loading and unloading zones, and environmental policies aimed at reducing the external costs of goods movement.[2]

Recent research has highlighted the growing role of service trips, deliveries coupled with on-site activities such as installation, maintenance, or reverse logistics, as a distinct category within urban logistics, with unique operational profiles and curbside occupation patterns.[3] These operations typically require longer dwell times than standard freight deliveries, further exacerbating congestion and land-use pressures in high-density areas.

The decarbonisation of this sector is a strategic priority within the European Green Deal framework, which aims for a 90% reduction in transport-related GHG emissions by 2050.[4] Zero-emission vehicles (ZEVs), including battery-electric vehicles (BEVs) and fuel cell electric vehicles (FCEVs), represent key technological pathways.[5] BEVs offer high efficiency and low local emissions for short to medium routes, but operational constraints, limited range under real-world load profiles, long recharging times, and reduced productivity in multi-shift operations, can make them unsuitable for intensive daily missions exceeding 200 km.[6] In such cases, hydrogen-powered FCEVs provide extended range, rapid refuelling, and operational flexibility.[7]

Studies carried out in the Rome metropolitan area have shown that integrating vehicle technology choice with service pattern redesign, for example decoupling delivery from installation, can reduce parking time by over 25%, improve fleet productivity, and enhance packaging recovery logistics.[8] Micro-hubs combined with cargo e-bikes have emerged as an effective complement to light commercial vehicles (LCV)-based distribution, particularly in scenarios where reducing curbside occupancy and integrating reverse logistics are priorities.[9]

Building upon this body of work, this paper proposes an integrated evaluation of BEV and FCEV deployment for urban service trips in scenarios with daily routes exceeding 200 km. The study merges insights from prior assessments of electric and hydrogen powertrains, operational models for service trip decoupling, and strategies for integrating packaging waste collection into last-mile operations.

The objective is to quantify environmental, operational, and curbside-use impacts under different vehicle technology and service organisation configurations, providing guidance for fleet managers and policymakers seeking to accelerate the transition to zero-emission urban logistics without compromising service levels.

BACKGROUND

Urban Freight Transport Challenges

Urban freight transport accounts for 15 to 20% of urban vehicle traffic and over 20% of transport-related GHG emissions, with significant contributions to noise, congestion, and competition for curb space.[10] Freight activity in metropolitan areas is expected to grow by nearly 80% by 2030, driven by e-commerce and just-in-time distribution models that increase delivery frequency and reduce storage space at retail outlets.[11] While these trends improve service levels for end customers, they exacerbate environmental and operational challenges, particularly in dense city cores where curbside loading zones are scarce or non-existent.[12]

Studies in European cities show that 3 to 5% of urban land is dedicated to freight and logistics activities, and the expansion of last-mile operations further intensifies competition for road space. In this context, service trips, deliveries coupled with on-site services such as installation or maintenance, introduce longer dwell times and greater space occupancy than standard freight deliveries, magnifying congestion and safety issues.

Electrification Pathways in Urban Logistics

Battery electric vehicles are increasingly deployed in last-mile operations, offering high energy efficiency, zero local emissions, and reduced noise pollution. However, their operational suitability declines for high-utilisation routes above 200 km per day, especially under heavy loads and in multi-shift operations, due to range limitations, recharging times, and potential impacts on service scheduling. Moreover, BEV adoption requires coordinated investment in charging infrastructure, including both depot-based and opportunity charging solutions, which can be challenging in constrained urban areas.[13]

Several pilot projects in European cities demonstrate that BEVs perform optimally when integrated into Urban Consolidation Centres or micro-hubs, enabling shorter distribution legs, higher drop densities, and improved load factors. Nevertheless, for logistics segments requiring longer daily ranges without downtime, battery solutions may face operational and economic barriers.

Hydrogen Integration for Long Urban Routes (>200 km)

Hydrogen FCEVs offer operational advantages for urban routes exceeding 200 km, including rapid refuelling and extended range, while maintaining zero tailpipe emissions. In mixed urban and peri-urban service patterns, FCEVs can replace diesel light commercial vehicles without compromising route completion rates or payload capacity.[14] Case studies from the retrofitting of diesel LCVs to hydrogen powertrains highlight significant GHG reductions and the feasibility of integrating refuelling within existing depot-based operations.

For urban service trips, hydrogen enables continuous operation without the charging downtime associated with BEVs, making it particularly suitable for high-mileage fleets operating in time-critical contexts. Moreover, the coupling of hydrogen deployment with renewable energy-based electrolysis supports broader decarbonisation targets.[15]

Service Trips and Operational Models

The concept of decoupling delivery and service tasks, such as using a van for heavy goods transport and cargo e-bikes for packaging collection, has been shown to reduce parking time by over 80% in Rome case studies. This model leverages micro-hubs for last-mile transhipment, allowing LCVs to complete their delivery routes more quickly while cargo e-bikes handle secondary tasks in congested areas.

Reverse logistics integration, particularly for packaging waste, further enhances load factors and resource efficiency. By shifting part of the curbside activity to smaller, more agile vehicles, operators can mitigate the negative impacts of freight on urban space allocation, improve safety, and align with emerging packaging waste collection regulations.[16]

Policy and Infrastructure Considerations

The European Green Deal and associated urban mobility frameworks call for a 90% reduction in transport-related GHG emissions by 2050. To achieve this, cities are adopting low-emission zones, vehicle access regulations, and infrastructure investments that prioritise zero-emission mobility.[17] Fleet decarbonisation in urban freight will require coordinated policy action, blending technology adoption with operational reorganisation, infrastructure deployment, and regulatory enforcement.[18]

METHODOLOGY

The methodological framework integrates operational modelling, vehicle technology assessment, and curbside-use analysis to evaluate four service patterns for urban freight operations, including a hydrogen FCEV option designed for extended-range missions. The approach builds on empirical results from Rome-based case studies and extends them to inter-urban scenarios requiring greater autonomy.[19] This procedure is adapted from Comi et al., which formalises Service Patterns 1, 2, and 3 as VRPs, with a single stage model for Patterns 1 and 2 and a two stage model with precedence constraints for Pattern 3, and here it is extended to Pattern 4 by parameterising FCEV operations.[20]

Operational Model and Service Patterns

The analysis considers the following service patterns:

- *Service Pattern 1* – Status Quo (ICE LCVs): Delivery and on-site service are performed entirely by diesel-powered LCVs. This serves as the baseline for comparison.
- *Service Pattern 2* – BEV LCVs: Identical operational organisation to pattern 1, but substituting internal combustion engine (ICE) LCVs with BEVs. This reflects a direct technological shift without service reorganisation.[21]
- *Service Pattern 3* – BEV LCVs with Decoupled Service Trips: Delivery is performed by BEV LCVs, while on-site service and packaging collection are carried out using cargo e-bikes deployed from strategically located micro-hubs. This decoupling significantly reduces LCV dwell time, optimises curbside use, and enables reverse logistics for packaging waste.[22]
- *Service Pattern 4* – FCEV LCVs with Decoupled Service Trips for Extended Range:

Evolution of pattern 3, this scenario maintains the decoupled delivery-service structure — LCVs transport goods to customer areas or micro-hubs, cargo e-bikes perform installation and packaging collection — but replaces BEV LCVs with hydrogen fuel cell LCVs. It is designed for inter-urban or metropolitan-scale missions where the required daily distance exceeds 200 km, making mid-shift BEV recharging impractical.

FCEV LCVs enable:

- Full payload capacity and consistent performance over long distances.
- Rapid refuelling compatible with planned depot stops.

▪ Integration of micro-hubs even when located far from the main logistics centre.

In dense urban zones, cargo e-bikes preserve the curbside and reverse logistics advantages of pattern 3, while the hydrogen-powered LCVs ensure operational continuity on extended routes.[23]

To visually summarise the different operational configurations and their main features, the four service patterns are illustrated in Figure 1.

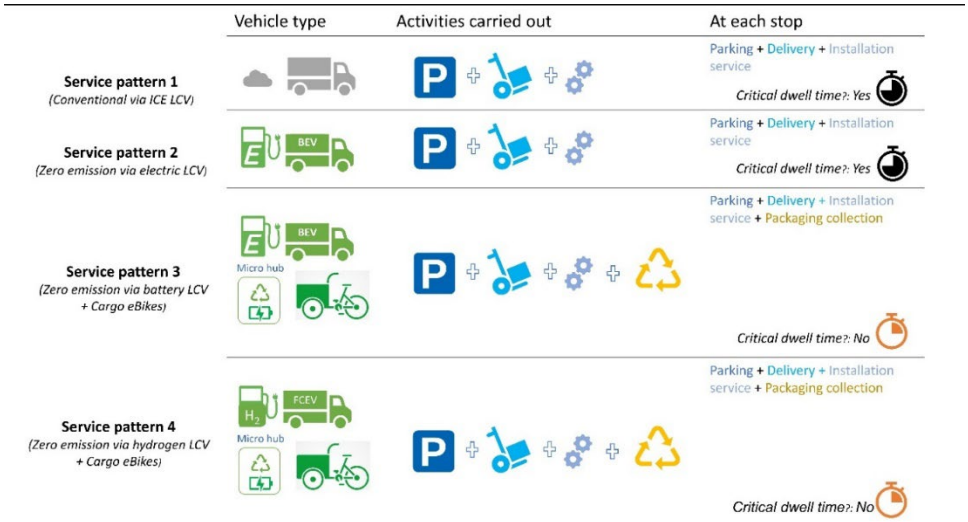


Figure 1. Operational models for urban service trips. Service Pattern 1: ICE LCV performing both delivery and installation. Service Pattern 2: BEV LCV performing both delivery and installation. Service Pattern 3: BEV LCV with decoupled operations via cargo e-bikes from micro-hubs, enabling delivery, installation, and packaging collection. Service Pattern 4: FCEV LCV with decoupled operations for extended-range missions (>200 km/day), integrating cargo e-bikes for last-mile activities.

VRP Formulation and Simulation Framework

All service patterns are modelled using a Vehicle Routing Problem (VRP) formulation. For patterns 1 and 2, a single optimisation problem is solved for the LCV fleet, minimising total travel time and distance while satisfying time window constraints.[24]

For patterns 3 and 4, the problem is decomposed into two sequential VRPs to reflect the decoupling of delivery and service activities:

1. An LCV routing problem delivering goods from depots to customers or micro-hubs.
2. A cargo e-bike routing problem handling on-site service and packaging pick-up from micro-hubs.[25]

In Pattern 4, the first VRP is executed by hydrogen fuel cell LCVs, enabling extended-range missions without intermediate charging while preserving the same curbside reduction benefits as Pattern 3. Vehicle parameters, including propulsion type, payload, energy storage or fuel capacity, and consumption rates, are taken from manufacturer data and prior test campaigns.[26] For the FCEV scenario, performance values are derived from retrofit testing and published operational trials, ensuring realistic hydrogen consumption and range.[27]

Performance Metrics Calculation

The environmental and operational indicators used in this study are derived from empirical measurements and validated simulation data available in the project datasets.[28] CO_2 emissions avoided in each service pattern are calculated as the difference between the baseline tailpipe emissions of the ICE LCV configuration (Pattern 1) and the corresponding scenario, according to:

$CO_{2\ avoided} = (EF_{ICE} \times d_{total}) - (EF_{scenario} \times d_{total})$

Where EF is the emission factor (gCO_2/km) and d_{total} is the total route distance in km. For BEVs and FCEVs, tailpipe emissions are zero; well-to-wheel (WTW) factors are used when accounting for the upstream energy supply mix.[29]

Energy consumption for BEV and cargo e-bike operations is obtained from logged consumption data (kWh) and simulation outputs.[30] For FCEV operations, hydrogen consumption (kg) is converted into kWh equivalent using the lower heating value (LHV) of hydrogen (33.33 kWh/kg) to allow direct comparison with BEV energy demand.

Curbside occupation time for LCVs is calculated as the sum of all dwell times during service stops. Reductions in curbside time are expressed both in absolute terms (minutes saved per day) and as a percentage compared to the ICE baseline:

Time reduction (%) = $[(T_{ICE} - T_{scenario}) / T_{ICE}] \times 100$

where T is the total daily LCV dwell time. Cargo e-bike operations are assumed to have negligible curbside occupation impact compared to LCVs.[31]

All calculations are based on operational profiles from the Rome case study and extended to the high-mileage scenarios modelled for Pattern 4. Energy mix and hydrogen production pathways are taken from the project's validated datasets.[32]

Performance Indicators

Indicators are grouped into:

- *Environmental:* Tailpipe CO_2 for ICE; well-to-wheel (WTW) emissions for BEV and FCEV, using the Italian electricity mix and renewable hydrogen supply.[33]
- *Operational:* Total travel distance, energy/fuel consumption, and service points per shift.
- *Curbside Use:* Total parking time, based on average dwell times of 27 minutes for conventional operations and 5 minutes for decoupled configurations.

Data Sources and Constraints

Simulations use the Rome street network, integrating low-emission zone regulations, micro-hub access, and delivery time windows.[34] Energy and fuel consumption are calibrated to measured operational data. Hydrogen refuelling is modelled as depot-based, supplied by renewable electrolysis consistent with EU green hydrogen targets.[35] The calculation of avoided CO_2 emissions and parking time savings is based on measured and simulated data from the project's operational trials, ensuring full consistency between the methodological framework and the results presented in the next section.

RESULTS

The comparative assessment covers the four service patterns described in the Methodology, focusing on CO_2 emissions avoided, energy or fuel consumption, and curbside time reduction. The baseline for comparison is the current diesel ICE LCV configuration (Pattern 1).

Environmental Performance and Interpretation

Replacing ICE LCVs with BEV LCVs (Pattern 2) eliminates tailpipe CO_2 emissions, avoiding 7.85 kg CO_2 per daily operation under the Rome service profile (≈ 35 km/day, ICE factor ≈ 0.224 kg/km).[36] Pattern 3 achieves the same direct CO_2 savings as Pattern 2, since the additional cargo e-bike operations have negligible emissions.[37]

For the extended-range configuration (Pattern 4), two cases are considered:

- Same daily distance as the Rome profile (≈ 35 km): avoided CO_2 remains 7.85 kg/day.

▪ 250 km/day scenario: the ICE baseline would emit ≈ 56.1 kg CO_2/day, fully avoided with FCEV operation when using green hydrogen.[38]

From a policy perspective, these results confirm that both BEV- and FCEV-based configurations can fully decarbonise tailpipe emissions in urban service operations. However, FCEVs extend this capability to inter-urban distances without requiring intermediate charging stops, which is critical for compliance with zero-emission delivery mandates in metropolitan and regional corridors. The choice between BEV and FCEV configurations should consider local availability of renewable electricity or green hydrogen to maintain well-to-wheel decarbonisation benefits.[39]

Operational Efficiency and Interpretation

Patterns 1 and 2 show average LCV curbside times of 432 minutes per day. Decoupling delivery from installation and service via micro-hubs and cargo e-bikes (Patterns 3 and 4) reduces this to 80 minutes per day, an 81% reduction.[40] The recovered time enables higher fleet productivity: +14% service points per shift in Pattern 3 versus Pattern 2, and +5% in Pattern 4, due to the removal of BEV range and charging constraints on long routes.

These operational gains have direct implications for fleet sizing and cost efficiency. A shorter curbside time allows either a reduction in the number of LCVs required for the same workload or the ability to serve more customers with the same fleet, which can reduce capital and maintenance costs. In congested urban areas, the reduced occupation of curb space also mitigates conflicts with other road users and improves compliance with delivery time windows.[41]

Energy and Fuel Use and Interpretation

In Pattern 2, BEV LCVs consume 11.90 kWh per day. Pattern 3 slightly increases this to 12.31 kWh per day (+0.41 kWh from e-bikes). In Pattern 4, for 250 km/day, hydrogen consumption is ≈ 2.25 kg/day, equivalent to ~75 kWh/day on an LHV basis.[42]

Energy demand profiles influence infrastructure planning. BEV adoption requires access to overnight or opportunity charging compatible with delivery schedules, while FCEV deployment depends on the presence of hydrogen refuelling infrastructure at depots or along inter-urban routes. For operators with mixed service patterns, combining BEV and FCEV fleets could optimise both operational flexibility and infrastructure investment, particularly where electricity grid capacity or hydrogen supply is limited.

The combined environmental and operational metrics for Patterns 2–4 are summarised in Table 1. The table reports, for each configuration, the CO_2 avoided relative to the ICE baseline, the daily energy or hydrogen demand (expressed in kWh equivalent where applicable), the average daily LCV curbside time, and the percentage reduction in curbside occupation compared to Pattern 1. The two variants of Pattern 4 (short-range and extended-range) highlight how the benefits in CO_2 savings scale with mission length, while operational gains in curbside use remain constant. Baseline tailpipe CO_2 per operation for ICE LCVs is 7.85 kg, BEV energy per operation is 11.90 kWh, and under the decoupled configuration BEV energy is 12.31 kWh, while total LCV dwell time decreases from 432 minutes per day to 80 minutes, as documented for the Rome case application.

For a 250 km inter-urban mission, the baseline ICE case yields 56.1 kg of tailpipe CO_2, computed as 0.224 kg per km obtained by dividing 7.85 kg per operation by approximately 35 km and multiplying by 250 km. For SP4, an energy-equivalent figure is reported to ease comparison: 2.25 kg of hydrogen multiplied by the hydrogen lower heating value of 33.33 kWh per kg gives approximately 75 kWh.

Service Pattern	Main Vehicle	Auxiliary Vehicles	CO_2 Avoided vs ICE (kg/day)	Energy (kWh/day or eq.)	LCV Curbside Time (min/day)	Curbside Time Reduction vs ICE
SP2	BEV LCV	—	7.85	11.90	432	—
SP3	BEV LCV	Cargo e-bike	7.85	12.31 (+0.41 e-bike)	80	–81%
SP4 (≈ 35 km)	FCEV LCV	Cargo e-bike	7.85	— (mission dependent)	80	–81%
SP4 (250 km)	FCEV LCV	Cargo e-bike	56.1	≈ 75 eq-kWh	80	–81%

Table 1. Key performance indicators (SP2–SP4).

CONCLUSION

This study evaluated four service patterns for urban and inter-urban freight operations, combining operational modelling, vehicle technology assessment, and curbside-use analysis. The analysis compared the current diesel ICE LCV baseline with BEV- and FCEV-based configurations, including both conventional and decoupled delivery–service trip structures.

The results demonstrate that:

1. **Decarbonisation potential** – Both BEV and FCEV configurations can eliminate tailpipe CO_2 emissions in urban operations. For extended-range missions (>200 km/day), FCEVs maintain zero tailpipe emissions without mid-shift downtime, provided green hydrogen is used.[43]
2. **Operational gains through decoupling** – Introducing cargo e-bikes and micro-hubs reduces LCV curbside occupation by 81%, enabling higher fleet productivity and improved curbside management in dense urban areas.
3. **Energy and infrastructure implications** – BEV adoption requires adequate charging availability aligned with operational schedules, while FCEVs depend on hydrogen supply infrastructure. Mixed BEV–FCEV fleets could balance infrastructure needs and service flexibility.

From an operational perspective, the most advantageous approach depends on the mission profile:

- For short- and medium-range urban services, BEV-based decoupling offers maximum environmental and curbside benefits with low infrastructure complexity.
- For long-range or inter-urban services, FCEV-based decoupling preserves these benefits while eliminating range and charging constraints.

Future research should focus on:

- Quantifying the full well-to-wheel environmental impact of each scenario under different energy supply mixes.
- Investigating the economic trade-offs between BEV and FCEV adoption, including total cost of ownership, infrastructure investment, and policy incentives.
- Extending the operational modelling to multi-hub networks and seasonal demand variations.

By integrating technological choices with operational reorganisation, the proposed service patterns offer a clear pathway towards zero-emission, high-efficiency freight operations in both urban and regional contexts.

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BRIDGING CIRCULAR ECONOMY AND HERITAGE CONSERVATION: CONCEPTUAL DEVELOPMENT AND PRACTICAL INSIGHTS

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INTRODUCTION

While circular economy (CE) and heritage conservation both engage with the reuse and extension of building lifespans, they are grounded in different epistemological foundations. CE typically emphasizes material efficiency and environmental performance through strategies such as minimal intervention, repair, reuse, and recycling.[1] These approaches are also present within heritage work, but only as one part of a broader practice rooted in social, cultural, and historical values. Heritage processes prioritize meanings embedded in place, memory, and community use; repair or retention is not a goal in itself, but is shaped by what is valued, by whom, and in what context[2]. **In practice, CE strategies often remain materially focused, with limited attention to the social and cultural dimensions that heritage work addresses.** This creates a disconnect: while both fields promote reuse, they may prioritize different outcomes and risk talking past one another in policy, planning, and design.

This study draws on concepts from CE, particularly system boundaries and value creation, to examine where circular and heritage frameworks converge or remain disconnected in practice. Focusing on the reuse of twentieth-century buildings in Sweden that lack formal protection but carry local significance, the analysis explores how different actors frame reuse, what forms of value are foregrounded or sidelined, and how these choices shape outcomes. The aim is to understand how socially grounded understandings of place and use can be more effectively integrated into circular strategies for the built environment.

THEORETICAL APPROACH

Heritage and Reuse as Processes

We start from the idea, widely discussed in critical heritage studies and adaptive reuse research, that heritage is not a fixed asset but a dynamic and socially embedded process.[3] Meanings attached to buildings and places shift over time as they are used, altered, or reinterpreted. Heritage emerges through these practices of use, memory, and negotiation rather than existing as a stable set of values waiting to be preserved.[4]

This processual view has also shaped recent thinking on adaptive reuse. Lanz and Pendlebury,[5] for example, describe reuse not as a single design intervention or final outcome, but as a transformation negotiated among actors with different interests, under changing cultural, political, and social

conditions. From this perspective, both heritage and reuse are fluid and contested, shaped by interactions between people, places, and materials rather than predetermined rules or endpoints.

Conservation System Boundaries

To make sense of how such negotiations take shape, we turn to the concept of **conservation system boundaries**, adapted from sustainability science and life cycle thinking.[6] In heritage contexts, the system boundary refers to the frames within which decisions are made: what is included or excluded, which values are prioritized, whose voices are heard, and over what temporal and spatial scales. These boundaries are shaped by laws, planning frameworks, professional norms, and institutional mandates, and they are never neutral.

Huuhka and Vestergaard[7] have shown how traditional conservation often centers on material authenticity and legibility, resulting in a reluctance to embrace partial preservation, hybrid reuse, or relocation. They point out that this can lead to "absurd situations where decay in situ is practically preferred over preservation through relocation". Similarly, they critique stylistic restorations of modernist buildings that reproduce visual appearance while disregarding both original material and use. Such practices may conflict with CE principles, which emphasize resource efficiency, minimal intervention, and extended life cycles. This tension reveals how the epistemologies of heritage conservation, rooted in specific values and aesthetics, can come into tension with circular economy principles, which emphasize resource efficiency, minimal intervention, and extended lifecycles. Thinking in terms of conservation system boundaries helps reveal how these tensions emerge and how they might be shifted over time.

Value Creation across Sectors

Questions of value run through all of this. In CE discourse, value creation is typically understood in terms of resource efficiency, lifecycle extension, and economic benefit.[8] In heritage contexts, value creation often involves social meaning, cultural identity, and place-based continuity.[9] We distinguish between multiple forms of value: e.g. economic, ecological, social, aesthetic and cultural. These do not always align. A strategy that maximizes material efficiency may undermine social continuity or local identity, while an aesthetically driven restoration may preserve visual coherence but erase embodied histories. Understanding how these values are articulated, negotiated, and prioritized, and by whom, is essential to bridging CE and heritage conservation. As Lanz and Pendlebury emphasize, reuse always involves some form of revaluation, where certain values are privileged and others sidelined. In this sense, both CE and heritage practice are value-driven processes, but often with different logics and priorities. Looking at where these value systems overlap, clash, or talk past one another can help illuminate why conservation and circularity sometimes pull in different directions.

METHOD: CASE STUDIES

This study is based on qualitative case study research, drawing on document analysis and semi-structured interviews with key actors involved in the transformation of three 20th-century built environments in Sweden.

- **Deje Power Station (Forshaga)** - A former hydroelectric plant that was saved from demolition through local mobilization and transformed into a cultural venue. However, a changed contract and renting terms threatens the long-term viability of this civic-led reuse.
- **Kv. Tuppfjätet (Gothenburg)** - A block of early 20th-century housing where reuse arguments were overruled by legal interpretations focused on lack of heritage value.
- **Hammarkullen (Gothenburg)** - A modernist area where design proposals combined circularity, conservation, and social sustainability, but faced political and economic obstacles.

The cases were selected for their relevance to the intersection of circular economy and heritage practice, and for their diversity in terms of actor constellations, outcomes, and governance contexts. Primary data includes planning documents, architectural proposals, and internal reports produced by municipalities, housing companies, and civic organizations. These were complemented by interviews with architects, planners, housing managers, and community representatives involved in the cases. The interviews focused on actors' interpretations of value, conservation priorities, reuse strategies, and the institutional dynamics that shaped decision-making. This empirical material was analyzed using the two interlinked analytical concepts developed earlier: conservation system boundaries and value creation. By tracing how actors articulated what was to be preserved, altered, or discarded, and which forms of value were foregrounded or marginalized, the analysis examines how CE and heritage discourses were mobilized, challenged, or reconfigured in practice.

RESULTS: CASE ANALYSIS

Deje Power Station

Deje Power Station in Forshaga, Värmland, is a former hydroelectric facility built in the early 20th century. After decades of operation, the site was decommissioned and stood empty, facing the prospect of demolition. However, through sustained local mobilization, the building was preserved and gradually transformed into a cultural venue hosting exhibitions, performances, and creative workshops. This transformation was not the result of a top-down heritage designation, but of grassroots engagement and civic initiative. The project illustrates how industrial heritage can be revalued through everyday use, while also exposing tensions around long-term sustainability and control.

Drawing and Redrawing the System Boundary

Initially, the conservation system boundary in Deje was narrow. The site was considered obsolete by technical standards, unprotected by formal heritage frameworks, and seen primarily as a cost by the private owner. Local mobilization enabled exterior restoration, supported by collaboration between the owner, regional authorities, and civic actors. However, once this initial work was completed, the building remained vacant suggesting that, within the prevailing system boundary, no further value or function had been recognized.

Over the following decade, however, the system boundary - understood here as an analytical frame that defines which actors, values, and meanings are included in a conservation process -began to shift. A local cultural association identified the site's latent potential not only as a physical structure but as a social and symbolic space embedded in the community's industrial memory. Through voluntary labour, small grants, and partnerships with local artists, the group reactivated the building as a cultural and civic resource.

Crucially, this broadening of the conservation system boundary enabled new forms of value to be both recognized and generated. Material values were retained through preservation of the building's industrial fabric; social values emerged from its role as a shared gathering place; and temporal values were articulated through adaptive reuse that reconnected past and future.

While no single actor intentionally redefined the system, this evolving constellation of practices and meanings reveals a transformation toward a broader conservation system boundary - one that includes both tangible and intangible dimensions and acknowledges informal, civic actors as legitimate agents of heritage-making.

Value Creation: Economic, Social, Cultural

The Deje case demonstrates how shifting system boundaries make value creation visible. Culturally, the site was re-signified from industrial ruin to civic landmark. Socially, it became a site of gathering, local identity, and pride, particularly significant in a region marked by post-industrial decline. Economically, although the site did not produce direct commercial profit, it supported small-scale events, attracted visitors, and helped support a creative micro-economy that contributed to local revitalization.

In this sense, value was not merely extracted from the material building, but actively constituted through the expanded system of actors, narratives, and uses. The case underscores a broader understanding of value in circular economy (CE) contexts. While CE frameworks often prioritize measurable outputs, such as material savings or carbon reduction, the Deje example highlights a processual and situated form of value creation, where reuse is embedded in local storytelling, community resilience, and long-term place-based investment.

Shifting Conditions and the Fragility of Circular Collaboration

However, the story is not one of unproblematic success. As the site became more visible and gained cultural capital, economic expectations shifted. The private owner, responding to increased interest, introduced new rental conditions that challenged the association's ability to remain in the building. At this point, the sustainability of the reuse effort became contingent on ongoing negotiations around access, ownership, and control.

This shift underscores the fragility of conservation practices that depend on informal arrangements and voluntary collaboration. While the broadening of the system boundary enabled new forms of value to emerge, it also exposed the reuse process to changing conditions beyond the civic actors' control. In the absence of institutional safeguards or supportive policy frameworks, even highly successful reuse initiatives can become unstable, dependent on precarious alignments of interest rather than guaranteed rights or long-term security.

The Tuppfjätet Block (Gothenburg)

The Tuppfjätet Block, located in the Kville area of Gothenburg, consists of a group of early 20th-century "landshövdingehus", which is a characteristic local building type with brick ground floors and wooden upper stories. The buildings were structurally altered over the decades but remained architecturally and socially significant to residents. Despite their potential for adaptive reuse, the property owner applied for, and was granted, permission to demolish the buildings and replace them with new housing designed in a similar style. This decision sparked protests from local activists and urban heritage advocates, who argued for the buildings' continued use based on circular and social sustainability principles.

A Narrow Conservation System Boundary

The buildings were initially evaluated primarily through a material-historical lens, with attention focused on questions of authenticity, architectural integrity, and technical condition. Because of previous renovations and lack of formal designation, they were judged to have limited heritage value resulting in a tightly drawn system boundary. This assessment mirrored what Huuhka and Vestergaard[10] critique as a rigid conservation logic that privileges unaltered materiality and risks excluding buildings with high everyday importance or social significance.

As a result, no formal mechanisms protected the buildings. Their material life cycle was cut short not because reuse was unfeasible, but because the institutional boundary around what counts as heritage, and what counts as worth saving, excluded both altered buildings and resident-based values. This case

clearly illustrates how a narrow system boundary can foreclose circular strategies, despite available technical, environmental, and social arguments for reuse.

Value Conflicts: Efficiency vs. Continuity

The demolition was justified by the owner and authorities in terms of economic efficiency, energy performance, and urban densification, favoring new construction with better insulation and higher rental yield. In contrast, residents and civic actors emphasized social continuity, material conservation, and affordable housing as critical components of sustainability and value creation. They argued that preserving the buildings would maintain both embodied carbon and social fabric.

This conflict exposes the competing logics of value creation. While CE in policy terms often centers on material and economic metrics, civic actors articulated alternative forms of social and cultural value: intergenerational memory, and the social cohesion of the neighborhood.

Style over Substance and the Role of CE in Argumentation

Notably, the new development mimicked the aesthetic of the original buildings, reproducing facades and stylistic cues. While the outcome gives an impression of heritage sensitivity, it simultaneously erases the original fabric and disconnects reuse from lived experience. The Tuppfjätet case suggests not, especially when demolition disrupts long-term social relationships and generates large quantities of waste, even if some materials are recycled.

Despite the decision to demolish, the case revealed an emerging use of circular economy rhetoric by heritage and architectural activists. Protesters and local organizations framed their resistance not only in cultural terms, but in terms of resource efficiency, climate impact, and social sustainability, i.e. the very vocabulary of CE policy. This strategic deployment of circularity suggests a shift in conservation discourse: from traditional appeals to historicity toward more transversal arguments about sustainability and cultural values.

The Redesign of Hammarkullen (Gothenburg)

Hammarkullen is a suburb in northeast Gothenburg, developed in the 1960s to address housing shortages. Like many such areas, it is today targeted for transformation to address aging infrastructure, socio-economic segregation, and safety concerns. A recent urban development initiative focused on *Hammarhuset*, a long five-story apartment block and the **entire redesign of the central square**: the symbolic and functional heart of the neighborhood. The project was initially framed as a flagship for circular, heritage-sensitive, and socially sustainable development. Through participatory workshops, municipal actors, architects, and residents co-developed proposals that combined adaptive reuse, public space improvements, and attention to social needs. The ambition was to create continuity rather than rupture, to enhance the existing environment rather than replacing it.

System Boundaries in Flux

Early on, the project embraced a broad conservation system boundary. The municipal housing company and architects recognized the value of not only the building's structure but of spatial practices, community uses, and neighborhood rhythms centered around the square. Adaptive reuse proposals preserved the building's basic framework while improving light, entrances, and balconies. However, as the process advanced, concerns about rising renovation costs, long-term affordability, and political turnover emerged. The system boundary began to narrow as design ambitions were scaled back, and parts of the reuse strategy were deprioritized.

Tensions in Value Creation

Hammarkullen illustrates how different forms of value - social, material, economic, aesthetic - interact and often clash in the design process. While the reuse strategy was aligned with CE goals (limiting demolition, extending building life), its realization threatened to raise rents and risk displacement. These dynamics echo "stylistic restoration" in modernist heritage: visually compelling upgrades can undermine the embodied, social logic of place. Even when buildings are retained, changes to their form and surrounding public space may disrupt how people interact with them, functionally narrowing the conservation system boundary, even if materially it appears intact.

Circularity as Relational and Conditional

The Hammarkullen case reveals that circularity in the built environment is not guaranteed by technical strategies alone. It requires institutional support, and political continuity. Although the project began with broad aims and participatory inclusion, it shows how such ambitions can be reconfigured by structural forces. The redesign of the square and the building simultaneously aimed for spatial improvement and symbolic renewal but also risked disembedding local relationships and uses. In this sense, Hammarkullen exemplifies the contingent nature of circular heritage practice. It shows that adaptive reuse must account for the interdependence between physical form, social function, and political governance, and that the system boundaries of conservation are always under negotiation.

DISCUSSION

Together, these cases provide **conceptual insights** into how conservation system boundaries and value creation shape circular heritage practices, while also offering **practical lessons** for policy, planning, and civic engagement. They show that the success, or failure, of circular strategies hinges not only on material conditions, but also on institutional definitions, actor constellations, and power dynamics.

These examples raise fundamental questions about what circularity means in practice. How can conservation system boundaries be broadened to integrate social and cultural values alongside material and economic considerations? And what forms of institutional support and governance are needed to ensure that participatory and civic-led reuse initiatives remain stable over time?

Deje Power Station highlights how civic actors can redraw conservation boundaries from below, creating layered value through informal reuse. It exemplifies a type of *circular heritage practice* in action, where adaptive transformation is sustained through participation and place attachment. But it also shows how such efforts remain vulnerable to shifting economic pressures and the absence of institutional recognition.

Kv. Tuppfjätet, by contrast, shows how narrow system boundaries and rigid heritage assessments can obstruct reuse, even when technical and social arguments support it. Despite civic attempts to frame the site within CE discourse, institutional frameworks prioritized material authenticity and energy efficiency metrics. The result was demolition followed by aesthetic mimicry that preserved form, but erased substance. This case underscores the need for broader value frameworks that incorporate social and cultural dimensions as integral to CE.

Hammarkullen represents a hybrid path: an initial effort to integrate circularity and social heritage that was later constrained by economic feasibility and political redirection. It reveals how even well-conceived reuse strategies can be undone without long-term commitment to inclusive value creation. Importantly, it demonstrates that conservation system boundaries are not fixed but negotiated, and susceptible to redefinition over time.

Across all cases, we see evidence of the gap identified by international literature: while CE policy increasingly emphasizes lifecycle extension and reuse,[11] some heritage frameworks often remain oriented around material authenticity and visual coherence.[12] At the same time, other types of heritage practice often embraces broader dimensions, such as social engagement, cultural continuity, and community meaning, while CE continues to be understood to center primarily on material flows. Our findings therefore support calls for an expanded CE and heritage model that recognizes social infrastructure, cultural continuity, and participatory governance as integral to sustainable transformation.[13]

The notion of *conservation system boundaries* offers a useful lens for understanding where and how CE and heritage may converge or diverge. In contexts where the boundary is broad, encompassing intangible values, informal actors, and iterative use, we see greater alignment between circularity and heritage practices as a means for socio-cultural sustainability. Where the boundary is narrowly drawn, opportunities for adaptive reuse and long-term value creation are foreclosed.

Ultimately, for CE to fulfill its transformative potential in the built environment, it must move beyond a logic of material flows and embrace a richer understanding of place, use, and meaning. This requires rethinking not just design or policy, but the underlying definitions of value that govern how we build, preserve, and reuse. Recognizing and institutionalizing these broader values is not merely a matter of conceptual alignment, it is essential for ensuring that circular transitions are socially and culturally grounded, and environmentally effective.

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HYBRIDITY OVER TROUBLD WATERS: COASTAL MILITARY BASES, CLIMATE CHANGE, AND WHAT IT MEANS TO BE URBAN

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INTRODUCTION

Sea level rise (SLR) constitutes 'a major risk for many coastal regions worldwide that see an increase in frequency and severity of flooding,' with the East Coast of the United States displaying unusual vulnerability.[1] With SLR dramatically increasing, coastal resilience is even more important today, and continues to bear on the ability of communities 'to "bounce back" after hazardous events such as hurricanes, coastal storms and flooding.'[2] Many US military bases exist on the US East Coast, including those on the Mid-Atlantic Seaboard, where states like Virginia host significant hardware and platforms at Naval Station Norfolk, Joint Base Little Creek-Fort Story, Naval Weapons Station Yorktown, Langley Air Force Base, and Naval Air Station Oceana, among others in the floodplain and in the path of SLR effects.[3] One study determined that significant flooding would occur at Naval Station Norfolk given hurricane conditions of a 50-year storm, a 100-year storm, or a weather system greater than the magnitude of Hurricane Isabel in 2003.[4] This clear threat affects not only the bases, but the cities which host them. In many ways, the fates of these two spheres are deeply intertwined, and deeply implicated in both climate and urbanity, even as they may seem at first to be very separate.

A Changing Landscape

Climate change appears to have catalyzed catastrophic events like the civil conflicts in Sudan and Syria.[5] A Congressional Research Service bulletin from 2019 explains that the US military 'manages more than 1700' installations globally in coastal regions vulnerable to SLR and climate change; this brief recounts $4.7 billion in damages to Tyndall Air Force Base from Hurricane Michael and another $3.6 billion in damages from Hurricane Florence across several North Carolina Marine Corps bases.[6] Worsening storms threaten the baseline operation of military bases as just they try to handle climatically strengthened threats, and they may also affect the large concentration of installations operating out of Hampton Roads in Virginia.[7] Attempts at regional collaboration and flooding adaptation have emerged out of scholars and institutions working in Southeastern Virginia, but an innovative pilot project was disbanded after only a few years of bringing together the many different municipalities and stakeholders of Hampton Roads.[8] Furthermore, resilient infrastructures, such as water and sewer networks, will need increased investments on a regional basis to protect them from damage generated by sea level rise.[9] Significant research has gone into SLR preparedness and flooding resilience in cities, but less data is available as regards climate readiness in adjacent bases.

Another example of this imbalance is Annapolis, MD, which has generated a coterie of public-facing hazard mitigation plans, waterfront redevelopment materials, and comprehensive plan strategies addressing flooding and SLR, but little to no available resources regarding flooding and SLR in the adjacent Naval Academy, an important component of federal naval infrastructure.[10] Just as the city and the water have been rendered separate and antagonistic by flooding effects, so too have the city and the base been rendered separate worlds, though they share spatial, economic, and social proximity. There is an artificial divide between city, nature, and base, but this separation begets a culture of control that is wholly out of touch with the widespread, blanket effects of SLR and the promised chaos of a changing global climate.

This process is becoming more recognized in the mainstream. According to a judge advocate general in the United States Air Force, 'the U.S. military has recognized climate change as a national security threat.'[11] Aging facilities, aging infrastructure, and facilities which have exceeded their lifespans create a climate where military hardware grows more vulnerable to weather events and global environmental change.[12] Outside of the United States, climate change creates complex political systems as old bases discharge waste and let their infrastructure fall into decay.[13] Thus, the conflux of a more threatening global environment with considerations of time, resources, and security create a novel opportunity for leveraging new and innovative strategies for integrated military installations and systems which are attuned to both nature and the encompassing urban sphere.

Urban Political Ecology (UPE) as Theory of a Military Urban Scene

The field of urban political ecology provides important theoretical framing for understanding the relationships between humans, nature, and the urban, as well as their applications regarding military contexts. This vein of literature also engages with issues of water, whether in the politics of flooding, ocean management, or drinking water resource controls.[14] Narratives of water are particularly important for naval military infrastructure as it is both an ally and an adversary in the climatic world of storms and SLR.

The frameworks of urban political ecology often crystallize around the concept of the hybrid.[15] The hybrid emerges from the work of Haraway (1991) as 'a cybernetic organism… A hybrid of machine and organism… A creature of social reality as well as a creature of fiction.'[16] This construct would implicate humans as a component of nature, and nature as a critical element of the dominant and pervasive human condition, rather than establishing them as separate spheres.[17] Swyngedouw later terms this phenomenon as 'fusing the social and natural together to produce distinct 'hybrid' or 'cyborg' urbanization.'[18] One author offers heat island effect as an example of this hybridity, whereby an urban fabric responds to atmospheric heat by heating the atmosphere in return: nature and urban space in a direct and reflexive dialectic.[19] Hybridity interweaves the natural with the urban in a framework which can analyze perceptions of the closeness or separation of the two, and it can serve to incorporate disparate and disjointed human creations into a more harmonious urbanity: the city made whole through acceptance of nature, and the urban military base deeply enjoined within it. On the base, it becomes clear that nature is necessary for survival and function, rather than serving as a threat or an obstacle.

The literature on natural systems living in built environments posits that 'urban nature, in particular, reveals the porosity of nature … [to] encompass the metabolic functioning of the human body, the ambient characteristics of space, or the engineered synthesis of nature as a material resource.'[20] The critical contributions of urban political ecology to the study of urban nature emerge through investigations into uneven power relations in the urban system; the inherent natural characteristics of the city; and the breakdown of the dualism existing between humans and nature as nature becomes urbanized.[21] The theoretical nexus of urban political ecology provides this study with the armature

necessary to configure the nature around and within military installations, while also binding those stations into an adjacent urbanity. Whether in an unmanicured creek marsh, or a park space maintained to a desired and accessible wilderness, nature can be an extension of the urban fabric and a natural outgrowth of coastal urbanization, rather than an environment living a separate and bounded existence. UPE escapes the common pitfall of the city standing as an antithesis to the countryside, and to some extent, the prevalent water bodies in coastal cities make the streets and the waterways less of a 'distinction between inside and outside… the core and the periphery as part of the same socio-environmental continuum.'[22]

This argument interprets Gandy's 'porosity of nature' as a means of investigating the fluidity and flexibility in molding natural environments to human settings whether in towns, cities, or the standalone naval station.[23] This tension of the inside against the outside – or the built against the unbuilt, or the controlled and the uncontrollable – generates fertile ground for finding common ground and chipping away at the division between humans and non-humans in a shared environment that is somewhat manmade, and somewhat organically generated. This dynamic is especially important for military installations like naval bases which must project a locus of control while inhabiting environments which are uncontrollable as regards flooding, storms, heat, and other environmental factors. Bases in general depend on their natural context – especially naval bases – yet this nature cannot be perfected. Changes are necessary to prevent the isolationist tendencies of military space from cutting off relationships which might be productive, and to stop systems from aggravating existing tensions in the environment by responding to threats with force. For instance, as regards flooding, military installations might move beyond working with flooding or even preparing for it, but move to a place of expecting it, and being ready to provide support in their immediate urban contexts under extreme conditions like hurricanes.

Green space and nature in urban settings can generate environments where community action emerges in order to criticize 'hegemonic urban development imperatives;' where 'environmental sustainability and environmental-justice goals' are raised; and where inclusivity grows to encompass 'employment… programming… information sharing… [and] partnering… to empower diverse populations to enhance their health and well-being through nature contact.'[24] Green features like urban parks can thus illuminate or even exacerbate social issues.[25] The 'systematic reshaping of the landscape… that occurs with city building and rebuilding' also generates 'how people use space… as well as their own social, political, and economic position.'[26] Aquatic environments benefit from the application of urban political ecology as well.[27] This can be interpreted as a hybrid of landscape and waterway, or the study of the interstitial space which stitches the waterway into the landscape, and vice versa. Representation from a plethora of different stakeholders, as well as ethical and considered green development principles, are necessary to support sustainability in coastal urban areas and inland cities alike.[28]

In the case of military bases, which may not be accessible to the general public, creating these hybrid landscapes within the boundary fence may have the green infrastructure benefits of water filtration and flood control, in addition to the psychological benefits of a more tranquil setting.[29] But the cities within cities which are military bases need more than bioswales and pocket parks to be made whole. The entire relationship with the naval station environment – from the reeds and grasses between each dock, to the waterbirds perched on old wires – can be seen as an integral part of the base and a supporter of the mission, rather than something unnecessary needing to be mitigated or eradicated. The city and the base do not need to be so separate, as with land, water, and other forms of nature. If the urban landscape of military architecture can blend and mix itself into the environment, rather than stand out from it, it may find itself more secure than it was before. Leveraging technologies and

constructed environments which are built to flood, rather than to resist flooding, and developing new such strategies would be a basic way to begin this process of blending, or even hybridization.

Global environmental change and the military base

Human systems face extreme difficulties in the face of SLR alone: saltwater intrusion can damage vital infrastructure; higher tides and warmer conditions can increase storm surge from hurricanes; populated areas stand in harm's way regarding coastal flooding.[30] Erosion driven by sea level rise and compounded by factors like land subsidence can cause profound land loss in coastal areas.[31] Perhaps most threatening, sea level rise may also poison aquifers and render underground freshwater supplies unfit for human consumption.[32] Industry and urbanization pose another threat to natural habitats, with the creation of synthetic chemicals which pollute the air and water among other issues.[33] Thus, just as urban spaces must access nature to better coexist with the non-human environment and ultimately synthesize the human sphere with the non-human sphere into a shared ecology, the world of the military base can be treated as the urban for the strengths and weaknesses that it shares with the city.

The concept of hybridity in UPE theory 'rejects any idea of the unnaturalness of the city.'[34] Some authors consider the city to be a transfigured form of nature, wrought by human labor, while later scholars would come to view nature as environment, thus entangling the city with nature instead of posing one as a twisted mirror of the other.[35] The concept of 'peri-urbanization' explores the border spaces between city and country, and positions the world of urban nature surrounding bases like Naval Station Norfolk as an absence of clear boundaries: a byproduct of urbanization, rather than a product of it.[36] This notion of urban nature as being separate from the urban – and, due to its proximal location to the city, separate from nature as well – truly places it in a liminal, marginal position within the structure of the constructed environment. The idea of the military base has a double life within this *mélange* of factors, as stations as large as the Norfolk base are large enough to be cities of their own, while often physically cut off from any surrounding urban fabric.

Compounding this political and often social isolation is the need to rigorously control nature for the purposes of facilitating the warfighter. The resultant, walled-off city-within-a-city raises questions of hybridity with both the surrounding city and the surrounding water. For those servicemen and -women who live off base, this hybrid-non-hybrid can be a challenge of traffic, security, access, flooding, and housing availability. While there may be no immediate answer to the question of social and political gulfs between base and host city, the relationship between a naval station and its neighboring waters is both intimate and adversarial. Water is necessary to conduct naval warfare and preparations, but in the case of SLR and its effects on hurricane flooding, 100-year storms have the potential to put naval bases under significant amounts of inundation – potentially up to 60% of the base footprint in the case of Naval Station Norfolk.[37] Attempts to harden shorelines may actually increase this flooding in the long run, by pushing water off onto other areas, which may themselves armor up in a vicious cycle of impermeability that only pressurizes the trapped bodies of water.[38] Still, there can be no naval station without a waterway to support it, and oftentimes this water cannot be open ocean for safety and mooring purposes. Thus, the marriage between base and host waterway cannot remain hostile and yet remain sustainable. More and better ways to allow nature into the military installations of Hampton Roads and the wider maritime world will go beyond the need to secure a location, but allow harmony, reflexivity, and attunement to the environment to become a new form of security. That security goes beyond simple flood resilience but extends to a holistic urban condition that can bridge spatial intimacy with cultural and potentially social intimacy between host cities and the isolated – but still urban – world of the American military base.

Finally, UPE posits the city as a hybrid of that which is human and not-human, but which is natural; in this way, *all* human constructs can be said to be hybrids, or even cyborgs, as they arise from nature

and take form through human influence.[39] Thus, nature abhors a disconnect between the fluid channels of the world. Bringing the bay or ocean all the way into the naval base might at first seem counterproductive. On the surface, this relationship between the base and the water would seem only extractive. The human side takes the protection and mobility that it needs from the natural side and rejects the rest. This is an untenable situation. UPE theories demonstrate the need to move past dualities between the urban and the natural, or the urban and the country, which would seem disconnected at the outset but perhaps easier to connect than the militarized sphere. The urban sphere and the military sphere share more than sharp borders. They are places to live and work and eat. Soldiers, airmen, and sailors may live and sleep on either side. Thus, the border between city and base, or between city and nature, appears all the more unpleasant because of its arbitrariness. This is not to say that a world exists where bases can have no fences and walls, though a world can indeed exist where a better exchange can exist between urban dweller and military dweller, between land and water and construct. Blending an increase of green areas and green infrastructure with cultural and social exchanges among urban dwellers across these barriers can make them into boundaries and markers instead of walls.

CONCLUSION

Knowledge, relational values, and care are 'salient ingredients' which generate results from stewardship behaviors.[40] Residents of cities hosting military bases will need to engage with the parts and processes of changing environmental conditions and urbanization in their communities to preserve immediate and fragile urban environments,[41] and the same can be said for officers and officials within the branches of the armed forces. Place attachment may create optimal outcomes if such feelings can be cultivated in regards to marginal, natural areas, possibly leading to protective behavior for urban spaces, which should be maximized when contributing ecosystem benefits.[42] The separation between a needy, impoverished nature; a thriving, insurgent nature in marginal urban areas; and the military, urbanized city fabric must be addressed in the literature to cultivate the widespread engagement and environmental awareness that will allow this urban nature to be stewarded, regardless of overarching beliefs in climate change, urbanization, and nature. Whether in the city or on the military base, urban political ecology holds trenchant tools and paths forward for mending the antagonisms between ecological systems and the human systems that depend on them. Cultures of control must be amended, and soon, to prepare the US military and those of other countries for the changes posed by sea level rise, hurricanes, and other climatic effects. Most importantly, the desire for perfect mastery must be relinquished, because this quality cannot exist in the total environment: the sum of human and non-human spaces. Creating an urbanity out of the military base is necessary to avail these occluded spaces the access to nature and natural benefits that is slowly being afforded the city itself.

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YOUTH AS URBAN CLIMATE INNOVATORS: EXPLORING THE ROLE OF YOUNG LEADERS IN KUWAIT AND EGYPT'S SUSTAINABLE URBAN DEVELOPMENT

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INTRODUCTION

Because urbanization concentrates people, ideas, and resources, it has long spurred innovation. Urban areas are now major contributors to climate change and essential test sites for sustainable solutions. The world's population living in cities is expected to be above 68% by 2050.[1] Young people (15–24 years old) are increasingly driving climate innovation in the towns due to their digital fluency, sustainability education, and substantial personal stake in the future.[2] In areas such as the Middle East and North Africa (MENA), which are undergoing rapid urbanization, this trend is particularly pronounced.

Egypt and Kuwait, despite their differences, both face significant climate-related risks. However, the resilience and determination of young leaders in these countries are inspiring. Egypt grapples with sea-level rise, water insecurity, and urban congestion, while Kuwait battles heat, pollution, and water scarcity.[3] However, youth-led projects, often with the support of foreign partners, are addressing these issues in both nations through innovative social, technological, and policy solutions.

This study examines how young entrepreneurs in Egypt and Kuwait are spearheading urban climate solutions, stressing their successes, challenges, and the transformative potential of their initiatives. These initiatives not only address immediate climate challenges but also pave the way for a more sustainable and resilient future for the region and beyond.

SPECIFIC YOUTH-LED INNOVATIONS IN KUWAIT

Kuwait Vision 2035: Youth Engagement in National Development

Kuwait Vision 2035, commonly referred to as "New Kuwait," is a comprehensive national development plan that aims to transform Kuwait into a commercial and financial hub by 2035. Youth have played essential roles in promoting sustainable urban development within this framework. Launched in 2018 as part of Vision 2035, the Youth Empowerment Symposium has provided young Kuwaitis with a platform to propose and implement green urban solutions.[4]

A prime example of youth participation in extensive sustainable infrastructure is the Shagaya Renewable Energy Park. The park has been developed in part by young Kuwaiti environmental scientists and engineers, many of whom received their training through government scholarship programs. By 2030, the facility, which integrates solar photovoltaic, solar thermal, and wind

technologies, hopes to meet 15% of Kuwait's energy needs with renewable sources.[5] Teams led by young people have focused on creating dust-resistant solar panels and heat-tolerant energy storage systems, as well as modifying renewable technologies to adapt to Kuwait's harsh climate.

The Kuwait Smart City Platform is another notable project that brings together young tech entrepreneurs to develop solutions for sustainable urban living.[6] These include water-saving technologies, clever waste management strategies, and intelligent traffic management systems that lower emissions and congestion. The efficiency of Kuwait's water infrastructure is a significant concern in one of the world's most water-stressed nations. Young Kuwaiti innovators have developed applications that enable citizens to optimize water consumption.[7]

UN Youth4Climate Action Initiative in Kuwait

The UN Youth4Climate Action Initiative, in collaboration with the US, UK, and Canadian Embassies, has catalyzed significant youth-led climate innovation in Kuwait since its launch in 2019. The program operates through a network of climate labs, workshops, and exhibition spaces that provide young innovators with resources, mentorship, and visibility for their projects.[8]

Eco-star, a non-profit group established by university students, including Fatma Elzalzala, who won the UNEP prize, Young Champion of the Earth. Eco-star recycled tons of plastic, paper, and metal waste from schools, homes, and restaurants. Eco-star waste management efforts partner with waste producers, demonstrating both waste reduction and awareness-raising.[9]

Another successful Youth4Climate project is the Urban Cooling Initiative, which addresses Kuwait’s extreme urban heat. Young environmental engineers have designed and implemented reflective pavement materials and green infrastructure in pilot neighborhoods, resulting in a reduction of ambient temperatures by up to 3°C during the summer months. The project combines traditional Middle Eastern architectural cooling principles with modern materials science, creating an approach suited to Kuwait’s specific climate challenges.[10]

Kuwait Universities Green Initiative

The Campus Carbon Reduction Project best illustrates the initiative's methodology. Teams conduct an audit of university buildings to identify areas for energy efficiency, then implement the solutions and monitor their effectiveness. Since 2019, their efforts have resulted in a 23% reduction in campus energy consumption, establishing models that other educational institutions and commercial buildings in Kuwait City have subsequently adopted.[11]

Innovations in water conservation have become especially prominent within the initiative. To maximize irrigation in farms, engineering students at the American University of Kuwait developed a project on the Smart Irrigation System. This system has addressed a significant resource shortage in Kuwait's urban environment by reducing water consumption by 40% while preserving the health of the vegetation.[12]

The Sustainable Transportation project serves as an example of how young people's innovations extend beyond technological fixes to incorporate efforts aimed at changing behavior. Student teams have installed solar-powered electric vehicle charging stations, developed a carpooling app, and built specialized infrastructure for micro-mobility options. In addition to reducing emissions associated with transportation, these interventions have led to the development of models that Kuwait City's commercial developers are exploring for the implementation in new urban areas.[13]

SPECIFIC YOUTH-LED INNOVATIONS IN EGYPT

Youth-led Urban Agriculture in Cairo

In Cairo, where issues of food security, lack of green spaces, and the effects of urban heat islands come together, urban agriculture is a significant area of interest for innovation. Young entrepreneurs and community organizers have developed multilayered approaches to urban farming that simultaneously address several sustainability challenges.

The integration of rooftop hydroponic systems in informal settlements was pioneered by Schaduf, which was established in 2011 by young Egyptian entrepreneurs. Using a social enterprise model, the program gives residents microloans to start rooftop farms and then helps them access markets and receive technical training. More than 500 rooftop gardens have been created throughout Cairo as a result of the project, enabling participants to generate income while establishing functional green areas in crowded cities.[14] Young agronomists working with Schaduf have created lightweight, water-efficient hydroponic systems that can be installed on existing buildings.

Another youth-led initiative tackling urban food systems is Cairo Vertical Farms. This initiative, started by graduates of agricultural engineering, utilizes indoor vertical farming techniques to produce vegetables with 95% less water consumption than traditional agriculture. The group has converted abandoned urban structures—such as old factories in Cairo's eastern industrial zones—into functional agricultural areas. Their system combines rainwater collection and solar energy, resulting in a comprehensive strategy for urban resource efficiency.[15]

A university researcher investigated the Green Urban Farming Initiative, which approaches urban agriculture from a community-based perspective. The research suggests native plant species and traditional Egyptian farming methods to transform empty lots in densely populated neighborhoods into community gardens. In addition to producing food, these areas serve as community cooling hubs during heatwaves, which are becoming increasingly problematic as Cairo's temperatures rise.[16]

Educational Programs and Academic Initiatives

With specialized programs opening doors for climate-focused research and entrepreneurship, Egyptian higher education institutions have transformed into hubs for youth-led urban sustainability innovations. The Center for Sustainable Development (CSD) at the American University in Cairo is a major center for youth-led urban climate innovation. Students are supported, funded, and mentored to address SDG 11: aligned urban challenges through the SDG Innovation Lab. The Smart Waste Mapping initiative is a notable project that utilizes a GIS-based app to optimize waste collection routes in informal settlements, thereby reducing fuel consumption and enhancing service delivery.[17]

The German University has been pioneering research in Cairo since 2016, focusing on the analysis of buildings to assist students in designing passive cooling systems that combine traditional elements with modern materials. Pilot projects across New Cairo city have shown temperature reductions of up to 5°C in public spaces.[18]

Engineering students at Future University are enhancing transportation. With more than 500,000 users, their Integrated Public Transport Application project streamlines Cairo's fragmented transit networks, reducing travel time and emissions. The project team presented, the project that was later selected for sponsorship by NTRA during the International Conference on Sustainable Construction and Project Management “Making Cities Green, Smart, and Resilient”.[19]

The first sustainability-focused curriculum in Egypt is provided by Heliopolis University for Sustainable Development, which addresses SDGs 2 and 12. Students test biodynamic farming, textile recycling, and natural building initiatives in its SEKEM Ecovillage, which serves as a living laboratory.[20]

Egypt's youth-led projects demonstrate how young creatives are maximizing scarce resources to address interconnected urban sustainability issues. Their work frequently combines social entrepreneurship and technological innovation to provide solutions that address socioeconomic needs and Cairo's unique environmental conditions. Youth-led solutions can now scale beyond specific neighborhoods to impact larger urban development patterns thanks to the increasing institutional support from universities and international programs.

INTERNATIONAL AND POLICY IMPACT

Impact of United Nations, European Union and United States Initiatives on Youth Projects

United Nations international organizations have played a crucial role in promoting youth-led climate innovation in Kuwait and Egypt by providing local projects with funding, technical assistance, and international recognition. Through its Youth Leadership Program, which has trained over 5,000 young Kuwaitis and Egyptians in climate entrepreneurship since 2015, the United Nations Development Programme (UNDP) has had a particularly significant impact.[21] Initiatives like Egypt's Green Lung Initiative and Kuwait's Eco Beam have significantly benefited from this program's seed money and technical support, which allowed them to progress from idea to reality.

For instance, the EU's Clima-MED program has established an innovation hub in Cairo, where young business owners can connect with European green tech companies, access testing facilities, and receive mentorship. Projects like Cairo Vertical Farms were able to implement Dutch hydroponic systems with this assistance, resulting in a 30% increase in water efficiency.[22] Meanwhile, US diplomatic initiatives emphasize knowledge sharing and education. The USAID funds university partnerships in Egypt that connect students with US experts in climate-resilient design, and the US Embassy's Exchange in Kuwait organizes study tours to US sustainable cities. These partnerships have influenced sustainability initiatives at several universities, as well as within US Climate Diplomacy.[23]

The impact and visibility of Kuwaiti and Egyptian youth innovations have increased thanks to international climate forums. Initiatives like Schaduf and Kuwait's Smart City Platform have achieved international recognition thanks to the UN Climate Change Conference of Youth (COY), which is held in conjunction with the annual Conference of the Parties (COP). South-South collaboration has been aided by this exposure, as innovations from Egypt and Kuwait have been modified for use in other urban settings in the Middle East and Africa.[24]

Sustainable Finance and Technological Integration

Scaling youth-led urban climate innovations requires access to sustainable finance. International financial institutions have developed targeted instruments to aid in this endeavor. Egyptian municipalities, many of which are run by young entrepreneurs, have benefited from technical assistance provided by the World Bank's City Climate Finance Gap Fund to develop climate projects.[25] Like other country cases in the UNEP report, young climate innovators in Kuwait have the possibility of accessing not only funds from the Kuwait Fund for Arab Economic and Social Development but also the Arab Fund and the Small and Medium Scale Enterprises Fund for Kuwaiti Startups.[26]

Additionally, green bonds are gaining popularity. In 2020, Egypt issued the first sovereign green bond in the Middle East, worth $750 million, to fund urban sustainability initiatives. Funding for nature-based flood solutions was given to one recipient, the Green Delta initiative, which was run by young engineers.[27] In Kuwait, youth-led startups can now participate in larger infrastructure projects thanks to green financing provisions in public-private partnerships.[28]

Technical capabilities have been further enhanced through international partnerships. Kuwait's dust-resistant solar panel project was linked to Chinese producers for commercial production through the UN Technology Facilitation Mechanism.[29] To enhance the accuracy and policy relevance of student-generated urban heat maps, the Center for Sustainable Development at the American University in Cairo has collaborated with European research institutions to incorporate cutting-edge remote sensing technology.[30]

Long-term Policy Implications of International Collaborations

International partnerships have impacted national and local policy frameworks in ways that formalize support for youth-led urban climate innovation. Preferential access to government contracts for youth-led green businesses is one of the specific provisions for young climate entrepreneurs included in Kuwait's National Youth Policy, which was updated in 2021.[31] As an example of how international engagement opens doors for policy influence, this policy change was directly the consequence of advocacy by Kuwaiti youth representatives to the UN Secretary-General's Youth Advisory Group on Climate Change.

A specific Youth Climate Action chapter in Egypt's National Climate Change Strategy 2050 emphasizes the need for youth participation in the formulation and implementation of climate policies.[32] The Egyptian Youth Climate Movement successfully advocated for formal recognition in national climate governance by utilizing its connections with international organizations, as evidenced by this inclusion. To establish a sustainable funding source for upcoming innovations, the strategy allocates explicitly 15% of climate adaptation funding to youth-led projects.

These international partnerships have long-term effects that extend beyond specific projects, including the strengthening of national institutions' capacity. With technical assistance from the UK Met Office, the Kuwait Institute for Scientific Research established a Youth Climate Innovation Unit, providing a long-term institutional framework for nurturing young innovators.[33] Similarly, with assistance from UNIDO, Egypt's Environmental Affairs Agency established a Climate Technology Center that offers certification services and testing facilities for climate solutions created by young people.[34]

CHALLENGES AND OPPORTUNITIES

A. Barriers for Scaling up

Funding Constraints and Financial Sustainability

Youth-led projects in both nations face financial obstacles despite international support systems. There are few opportunities for youth-led innovations to gain government support, as the Kuwait Authority for Partnership Projects has only allotted 7% of its 2022 budget to sustainability-focused projects.[35]

Egypt also faces some financial limitations. Green lending targets were set for commercial banks by the Central Bank of Egypt's Sustainable Finance Framework; however, young entrepreneurs report several obstacles to obtaining these funds and a preference for well-established companies.[36]

Knowledge and Technical Capacity Gaps

Young entrepreneurs in both nations recognize technical capacity gaps that limit their ability to create and scale climate solutions, despite having robust educational foundations. Graduates from Kuwaiti universities possess a solid theoretical background but often lack hands-on experience with climate technologies. Sixty-two percent of Kuwaiti climate entrepreneurs surveyed stated that specialized technical knowledge was a significant obstacle, particularly when it came to adapting global solutions to Gulf climate conditions.[37]

Young innovators in Egypt report that accessing testing facilities and specialized equipment is a significant challenge. Since many resources are only available in English or other non-Arabic languages, language barriers can occasionally hinder access to international technical knowledge.[38]

B. Opportunities for Growth and Impact

Smart City Technologies and Digital Innovation

For youth-led digital innovations tackling urban climate challenges, Kuwait and Egypt offer substantial prospects. With 98% internet penetration and significant government investment in smart city technologies, Kuwait's sophisticated digital infrastructure fosters an environment conducive to tech-based climate solutions.[39] Digital sustainability solutions are given top priority in the Kuwait Smart City strategy, which aligns policies to support innovation in areas such as water conservation, energy management, and transportation optimization.

Egypt's quickly growing technology sector presents different but equally important opportunities. Digital climate innovations can flourish in ecosystems created by government programs, such as the National Program for ICT Applications in Environment, and the emergence of technology parks like Cairo's Smart Village.[40] Young Egyptian developers have proven adept at creating user-friendly mobile apps that run on devices with limited capabilities, opening digital climate solutions to a broader range of socioeconomic groups.[41]

Institutional and Policy Leverage Points

There are new policy opportunities in both nations that could strengthen backing for youth-led urban climate innovation. Opportunities to formalize youth involvement in climate governance and allocate funds to youth-led projects are presented by Kuwait's National Development Plan revision process (2023–2024).[42] This process has been orchestrated by young policy advocates who have created specialized funding mechanisms, regulatory sandboxes for climate innovations, and specific recommendations for procurement reform.

Despite their slow pace, Egypt's urban decentralization initiatives present opportunities for testing small-scale climate solutions. Youth participation in participatory planning processes has been piloted by the Local Development Program in Upper Egypt.[43] Young innovators could be given official roles in urban climate governance by expanding these models. Furthermore, Egypt's hosting of COP27 has heightened political attention to climate issues and created policy opportunities for young activists to advocate for laws that foster climate entrepreneurship.

CONCLUSION

The data shows that young innovators' technological proficiency, interdisciplinary approaches, and willingness to question established development paradigms enable them to contribute uniquely to urban climate solutions. Young engineers and businesspeople in Kuwait have developed innovative city tools, pioneered green infrastructure financing, and adapted renewable technologies to harsh climates. Egyptian youth have created community-based urban cooling initiatives, developed mobility solutions for Cairo, and introduced urban agriculture in densely populated informal areas.

These are not merely technical solutions; they combine environmental, social, and economic objectives. Projects like Kuwait's Eco-Star and Egypt's Schaduf demonstrate how youth-led initiatives can provide multiple sustainability advantages simultaneously. International organizations, academic institutions, and embassy-led initiatives that increase the scale and capacity of innovation frequently contribute to their success.

Nevertheless, there are still difficulties. Institutional inertia, financial constraints, and regulatory obstacles hamper broader impact. Coordinated efforts in the areas of finance, policy, and capacity

building are needed to address these issues. The ultimate significance of youth-led urban climate innovation encompasses the alteration of development paradigms and governance structures, as well as the implementation of specific technological or policy interventions.

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TOOLS TO NEGOTIATE THE SUSTAINABILITY TRANSITION AT THE LOCAL LEVEL

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INTRODUCTION

The European Green Deal aims to achieve net-zero emissions of greenhouse gases by 2050, leaving no one and no place behind. At the same time, the EU Mission Adaptation to Climate Change calls for more European regions and communities to become climate-resilient by 2030 through the development of pathways for preparation and the implementation of innovative solutions. The EU has proposed several initiatives to support territories and people most affected by the transition to climate neutrality,[1] including the Just Transition Mechanism and the Social Climate Fund. The political guidelines of European Commission President Ursula von der Leyen for the years 2025-2029 reiterate the call for a Just Transition. This shows that at the core of the climate crisis is not only an environmental emergency but also a crisis of equity, justice, and fairness—marked by stark imbalances in responsibility, capacity, and vulnerability among nations, regions, and populations. Despite increasing recognition of climate justice as a necessary pillar for sustainable transitions,

critical obstacles remain in enabling effective, feasible, and fair decarbonization at the European, national, regional, and local levels.

This shows that the goals of achieving a sustainable Europe, at least its sub-goals of a low-carbon and climate-resilient Europe (SDG13), pose a number of profound challenges, as it is not only about how to effectively get the carbon emissions down to net zero, but also about how to distribute the related mitigation and adaptation measures feasibly and fairly. Feasibility relates to "the potential for a mitigation or adaptation option to be implemented".[2] Factors influencing feasibility are context-dependent[3] and may vary between different groups, actors and sectors[4]--pointing to equity and justice dimensions[5] underlying (the discussions around) the sustainability transition: Who bears the brunt and burden of the transition, and who enjoys its benefits. Such questions do not only relate to the distributional effects across European Member States and their regions, but also within regions, municipalities, and communities.

What is needed to get to a sustainable future?

To effectively implement sustainability and climate targets, people require spatially and temporally proximate information. They need to translate globally agreed targets,[6] such as the goals of the Paris Agreement, into regional and local targets. They need to decide upon effective measures, negotiate feasible instruments, and assign implementation responsibilities.[7] They also need to know what remaining risks there are for their territory after the implementation of climate measures, for whom, and by when, and how these risks could be effectively, feasibly, and fairly limited or reduced.

In particular, for smaller cities, generating all this information can be difficult because they are usually equipped with fewer resources (technologies, materials, staff expertise, and staff hours). In contrast to large cities, they do not have their own statistical units, which collect and process data to be useful for policy design. Smaller cities or regions often struggle to disaggregate statistical data to fit their jurisdiction,[8] have fewer staff, and still need to provide a range of similar municipal services, just like large cities.[9]

That's why not all mitigation and adaptation measures are similarly feasible or effective for every jurisdiction. Cities and regions differ in economic strength, socio-economic profile, location specifics, and governance conditions—relating to feasibility factors. Feasibility depends on various factors,[10] including geophysical, environmental-ecological, technological, economic, socio-cultural, and institutional factors, that enable or constrain the implementation of an option.[11]

Among these factors, local and regional governments play a major role in the sustainability transition, shaping a comprehensive approach that integrates climate adaptation, mitigation, public health, human well-being, and biodiversity goals.[12] However, local businesses—as the primary source of employment and economic activity—also play a crucial role in achieving regional decarbonization targets in their surrounding area and beyond.[13] Decarbonising industrial processes often faces numerous technical and economic challenges. Despite significant advancements in the adoption of renewable energies for residential consumption, many European industries remain heavily dependent on cheap fossil fuels imported from outside the EU for their operations. This includes, but is not limited to, hard-to-abate sectors such as cement, steel, and chemicals manufacturing, which are the backbone of the EU economy. Decarbonization, therefore, poses new risks and opportunities for local and regional industries, inspiring breakthroughs and innovations that can increase their resilience and enable EU regions to navigate their path to net-zero. But which options for businesses are available, and how can they learn from each other?

Additionally, not only are the local and regional municipalities and businesses needed at the table, but also citizens and their interest groups. People who are part of the transition or in any way affected by it also need to be part of the futuring process and its implementation. To achieve this, a particular

emphasis in the science and practitioner literature is placed on the co-creation[14] of mitigation and adaptation options[15] for the sustainability transition.[16] Co-creation approaches are praised for increasing the feasibility of adaptation and mitigation approaches,[17] supporting knowledge sharing and ownership of change processes. At the same time, caution is raised regarding how co-creation processes are implemented, specifically in terms of who can participate, who is heard, and what these processes can truly achieve, i.e., whether they lead to new knowledge or merely support the status quo.[18] In order to allow for smoother co-creation processes,[19] usually (more) trade-offs need to be negotiated[20] in an open and transparent way. To achieve this, better engagement processes need to be established, more data is required,[21] and additional tools are necessary. This is where the LOCALISED projects make a major contribution.

RESULTS

Demands speak for a localised approach: the LOCALISED project

LOCALISED is an EU HORIZON 2020 project (grant number 101036458), to do climate action planning for local authorities, citizens, and businesses. LOCALISED consists of 12 partners in 6 countries and across three larger cities and regions (Barcelona/ Spain, Vienna/ Austria, and Sopot-Gdansk-Gdynia/ Poland). The project was completed in September 2025, with a budget of approximately €5 million spent over a four-year period. In the LOCALISED project, the authors have translated the national decarbonization pathways into local option spaces for action. They did that for all EU regions/ cities at the NUTS3/LAU (100,000 units in Europe) level, using a science-based, data-driven, and co-creation approach.[22]

To do climate action planning for local authorities, citizens, and businesses, the LOCALISED project developed and co-created with its stakeholders and potential users a number of tools—allowing more informed, transparent, and data-driven deliberation processes. Fig. 1 below shows the various tools and sub-tools developed within the project. Four of the tools will be introduced in more detail hereafter: the Climate Action Strategiser (CAST), the Citizen Engager (CE), the Net-Zero Business Consultant (NZBC), and the LOCALISED Sustainable Business Model Canvas (LSBMC).

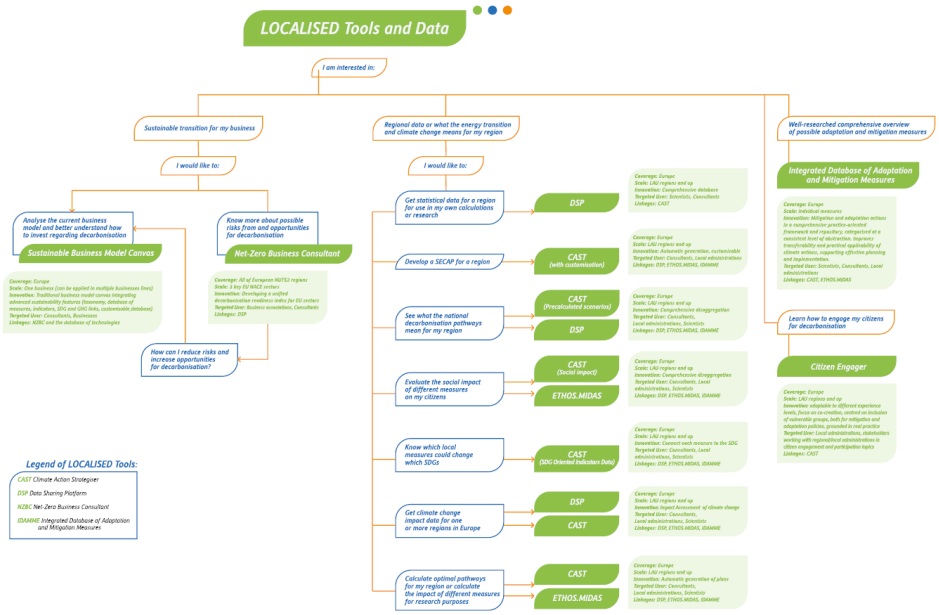


Figure 1. Suite of tools developed in the LOCALISED project—all needed to allow for better informed, transparent, data-driven deliberation processes for local sustainability transitions.

Supporting cities and regions in their sustainability transition with the Climate Action Strategiser (CAST)

The ***LOCALISED Climate Action Strategiser*** (CAST) is a science-based decision-support tool for regional and local municipalities that allows combining regional/local-level emission reduction pathways and adaptation options aligned with national and global long-term strategies. The tool is based on downscaled national decarbonization trajectories, consistent with Europe's net-zero target, and can help support the establishment of Sustainable Energy and Climate Action Plans (SECAPs) and the monitoring of related Sustainable Development Goals. The tool automatically generates SECAP (Sustainable Energy and Climate Action Plan) templates compliant with the Covenant of Mayors reporting requirements—thereby directly supporting formal climate planning workflows.

To achieve this, the platform provides users with access to region-specific data necessary for developing comprehensive, region-specific climate action plans through an interactive map interface (NUTS3 or LAU level). Beyond basic data visualisation, CAST offers sophisticated analytical capabilities, including the ability to explore multiple optimisation scenarios (balanced, cheapest, most climate-friendly, least risky, or most socially equitable plans), to customise regional data inputs, and to manually control the climate measure selection used for the optimisation runs. The CAST is powered by the LOCALISED MIDAS model, which calculates the optimisation choices in the background. CAST is coupled with a comprehensive database of adaptation and mitigation measures, which was also developed for the project. Additional information layers, including detailed measure descriptions and measure-specific lists of implementation instruments, additionally serve as valuable resources for decision-makers and practitioners. Besides the mentioned functionalities, the CAST also includes the evaluation of social impacts and equity of the chosen measures (see Fig. 2).



Figure 2. Dashboard view of the Climate Action Strategiser (CAST).

With all that, the tool focuses on motivating regional and local policy makers and experts in administrations on their journey to climate resilience, integrating elements for the co-creation of planning guidance to support stakeholder engagement throughout the climate planning process (see also Citizen Engager below).

Supporting cities and regions in their sustainability transition with the Citizen Engager (CE)

The Citizen Engager – Citizen Engagement Manual for Climate Action and a Just Transition is a practical, step-by-step guide for citizen participation in local climate policy. It aims to support local and regional decision-makers, such as politicians and civil servants, in co-creating climate action, policies, and strategies alongside their citizens. To fulfil this aim, it provides the reader with step-by-step guidance, hands-on methods, and lessons learned from five case studies.

At its core, the Citizen Engager is about meaningful participation. It moves beyond traditional approaches of informing or consulting citizens. Instead, it promotes **co-creation**: a participatory approach where citizens and decision-makers work collaboratively to shape solutions to the climate crisis. This collaborative approach fosters shared ownership of outcomes, increases acceptance of climate measures and necessary lifestyle changes, and strengthens the commitment to implementation—on the side of the municipality as well as the citizens.

Furthermore, the Citizen Engager places a strong emphasis on **inclusive participation**. Research shows that the impacts of climate change — and the policies aimed at mitigating or adapting to it — are not distributed equally across society.[23] Vulnerable and marginalised groups, including low-income households, people with migration backgrounds, women, and LGBTQI+ individuals, are often disproportionately affected.[24] Climate action that fails to consider these dynamics can reinforce existing inequalities.[25] The Citizen Engager provides guidance on involving groups that are often underrepresented or harder to reach. By doing so, it helps local governments to build trust and ensure that no one is left behind in the transition to a more sustainable future.

After providing a brief general introduction to citizen engagement — perfect for everyone new to the topic — the Citizen Engager guides the reader through the three central steps of **planning** an engagement process, **conducting** it, and **implementing** its results (see Fig. 3).

1. **Plan your process**: Define your topic, use Social Impact Assessment to identify your target groups, reach out through tailored approaches, and design your engagement process.
2. **Conduct your engagement process**: Provide accessible, science-based information, give time and space for participants' emotions, and create inclusive spaces for co-creation and joint decision-making.
3. **Implement and follow up**: Translate participation outcomes into action, communicate transparently, and stay engaged with your citizens — thus enabling them to become permanent agents of change.

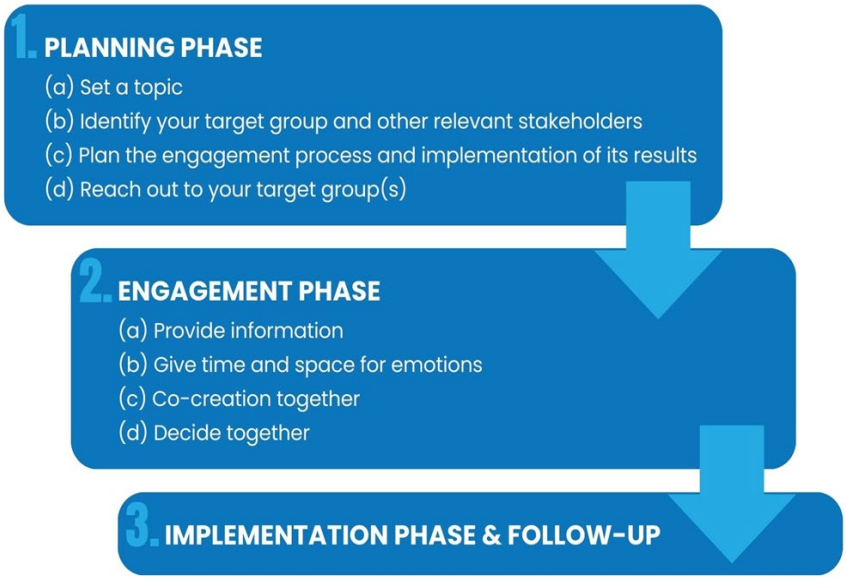


Figure 3. Steps of setting up a good citizen engagement process, as outlined in the Citizen Engager (CE): Important steps in planning an engagement process, conducting it, and implementing its results.

For each phase, detailed instructions, practical tools, and tested methods are provided. They can be tailored to different budgets, timeframes, and levels of experience. They are also adaptable to different contexts, ranging from the co-creation of overall climate strategies to the implementation of specific climate actions, and for citizen engagement at various stages of the policy cycle (see Fig. 4). However, the Citizen Engager does not prescribe a single "right way" to engage. Instead, it offers a range of adaptable options tailored to the user's context, capacity, and goals. The five case studies from Austria, Spain, and Poland vary on those dimensions and thus serve as real-life examples.

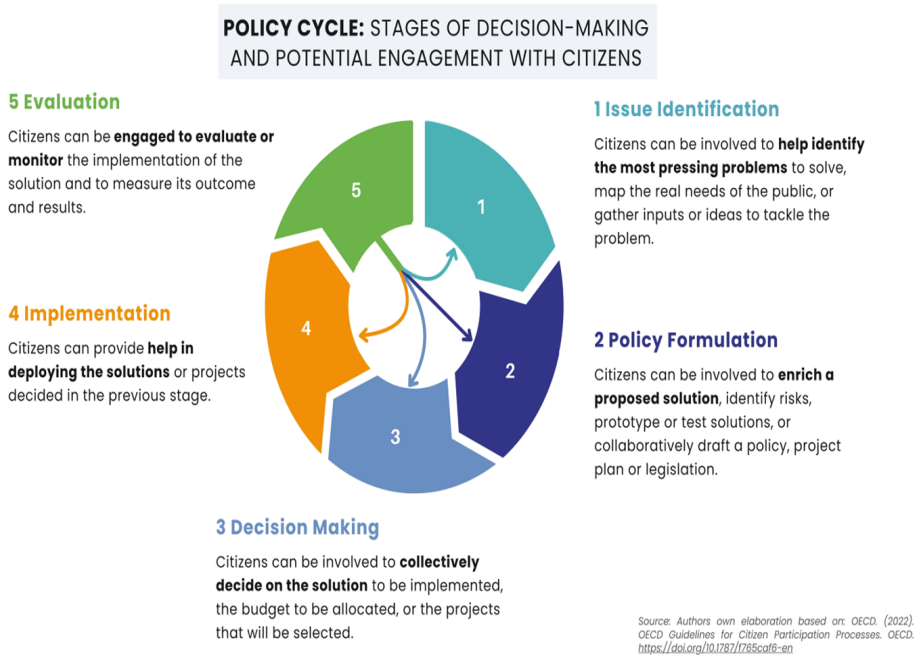


Figure 4. Stages of the policy cycle in decision-making and potential citizen engagement.

The Citizen Engager is also integrated into the Climate Action Strategiser (see above), enabling local decision-makers to directly link inclusive participatory processes to local climate data and planning tools.

Supporting cities and regions in their sustainability transition with the Net-Zero Business Consultant (NZBC) and the LOCALISED Sustainable Business Model Canvas (LSBMC)

LOCALISED project's NZBC tool is designed to provide a systemic assessment of decarbonization risks and opportunities to regional industries. The tool is built on the premise that regional heterogeneities in the distribution of decarbonization risks stem from differences in both regional environmental and economic architectures, as well as sectoral characteristics such as underlying technologies, supply chains, and workforce composition. As such, the tool views the decarbonization risk as a function of regional exposures to greenhouse gases (GHG) emissions and sectoral vulnerabilities along five key dimensions: energy, labour, finance, technology, and supply chain. Each of these key dimensions is composed of several indicators whose combination provides an overall vulnerability score along that dimension. For example, the energy dimension includes indicators such as the share of fossil fuels and the share of renewables in total energy consumption, as well as the energy intensity of industrial production. Data related to the indicators is extracted from the Eurostat publicly available database.

The tool displays the results of a business vulnerability assessment, utilising a predefined set of weights to combine vulnerability dimensions and indicators, as illustrated in Figure 5. The final decarbonization risk score is calculated from the combination of the composite vulnerability score and the exposure value, which indicates the average GHG emissions per enterprise in each region. The user can change the weights and test the sensitivity of the assessment to different weight distributions. An interactive heatmap provides a visual assessment of vulnerability, exposure, and risk distribution across the EU regions. Integrated into the tool is a survey that allows the user to calculate their personalised business risk index and compare their score with the values shown on the map.

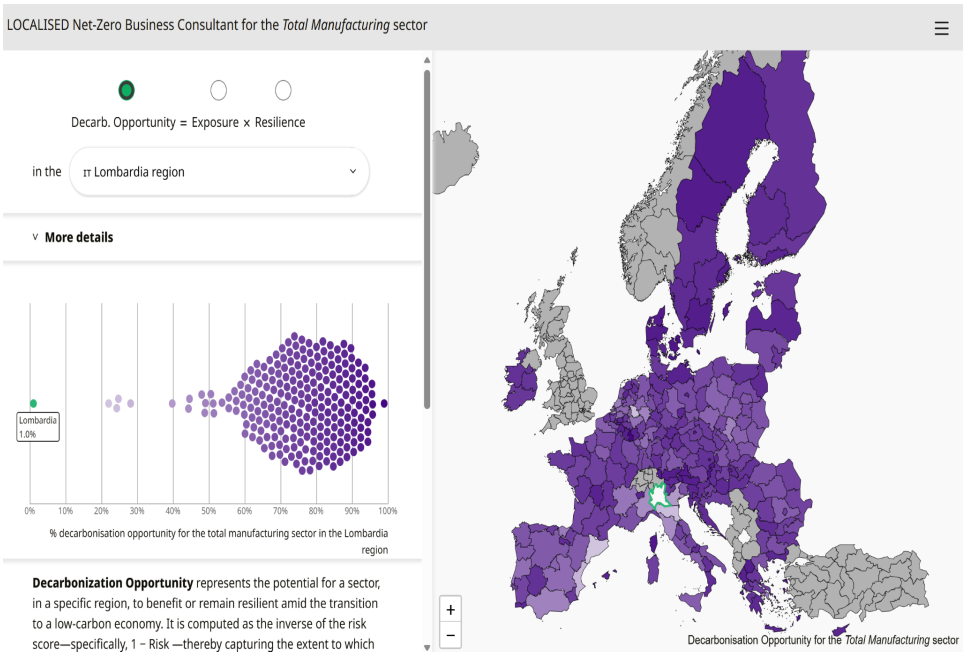


Figure 5. The NZBC interface allows users to explore the manufacturing decarbonization risk and opportunities across the EU regions.

Users can explore another tool developed under the LOCALISED project through a link in NZBC. The LOCALISED Sustainable Business Model Canvas (LSBMC) has been designed to assist organisations in identifying the nine essential elements of business models (supplies & outsourcing, production, functional value, materials, end of life, distribution, use phase, environmental impact, environmental benefits) explicitly to recognise the benefits and solutions for end-users and all involved parties.

Furthermore, there are two sets of examples that can help business users explore ways to increase their operational resilience and benefit from decarbonization opportunities. First, we provide a list of 20 cutting-edge technologies across 4 key economic sectors (agriculture, energy, construction, and manufacturing). Each technology is accompanied by an infographic demonstrating its adoption in an EU regional context. Second, we list 60 best practices in the agriculture, manufacturing, and transportation sectors where EU businesses have shown significant progress towards sustainability goals and decarbonization objectives by adopting new technologies to mitigate their carbon footprint or enhance their operations to adapt to climate change. These two sets of examples together constitute a valuable database of regional solutions and best practices that can be adopted by other businesses across the EU.

SBMC is primarily targeted at companies with established sustainability departments or consultancy firms specialised in sustainability and climate strategy. The tool is designed to help analyse and transform business models to align them with sustainable development. It could be particularly useful for guiding companies that lack the resources or expertise to conduct strategic reviews on their own, enabling an initial analysis of their current business model, the identification of barriers and areas for improvement, as well as the visualisation of potential measures and instruments to advance towards decarbonization.

CONCLUSION

Cities and regions play a crucial role in meeting global and national sustainability targets, such as those related to European decarbonization. As targets are formulated at the international level, cities and regions need to know how targets can be effectively, feasibly, and fairly distributed across cities and regions within a country. This means tools need to be available to decide which distribution of mitigation measures will allow reaching the decarbonization goals (effective), will be doable (feasible), and will be acceptable (fair).

To enable local authorities to develop effective, feasible, and fair climate action plans, such as the SECAPs under the framework of the Global Covenant of Mayors, we have observed in our work and argued in this paper that this requires harmonised local data sets that are intelligently downscaled to the local level. New and innovative tools are needed to optimise mitigation and adaptation efforts across regions and local authorities, thereby improving feasibility, i.e., the likelihood of implementing adaptation and mitigation measures in line with local capabilities and needs.

In this context, the LOCALISED project, in collaboration with front-runner cities and potential future users, co-created several decisive and innovative tools. We introduced the four main tools in detail: the Climate Action Strategiser (CAST), the Citizen Engager (CE), the Net-Zero Business Consultant (NZBC) and the LOCALISED Sustainable Business Model Canvas (LSBMC). The CAST proposes tailored measure sets optimised regarding emission reduction, affordability, social equity, or climate risk reduction—allowing for the automatic filling of Sustainable Energy and Climate Action plans (SECAPs) and alignment with the Sustainable Development Goals (SDGs). The measure sets are calculated by the underlying scientific optimisation model based on national decarbonisation trajectories that have been downscaled to local administrative units. The CE tool suggests concrete and tested co-creation methodologies with citizens. The NZBC supports a co-creation approach with

the business community, focusing on their climate mitigation potentials, while the LSBMC allows businesses to explore ways in which they can increase their operational resilience and benefit from decarbonization opportunities.

With that package, these tools enable local authorities to develop strategic climate action plans that engage decisive stakeholders, such as citizens, vulnerable groups, and the business community, making different local futures more negotiable and attainable.

Key takeaways from our work for local and regional municipalities include:

- Cities should strive to integrate mitigation demands and adaptation needs. → The integrated database IDAMME of the LOCALISED project is a useful start, already integrating several hundred adaptation and mitigation measures as well as associated instruments, along with a rule base on how the database can be meaningfully extended.
- Climate action needs to have a focus on social justice and include measures that support the most vulnerable. → This is best done by enabling co-creation within the region to empower all actors. The Citizen Engager (CE) outlines all necessary steps to make this a useful and successful process.
- For a successful sustainability transition, local businesses need support in checking risks and transforming their business models in order to become resilient. → The developed Net Zero Business Consultant and the Sustainable Business Model Canvas help businesses to do so.
- An important aspect that demands much more attention across regional and local authorities is the monitoring and evaluation of measures taken. This allows us to reevaluate, learn, and adjust plans and strategies along with the changing climate and potentially new, emerging risks in the future. → We see the need for a global or EU-wide Monitoring & Evaluation (M&E) framework with strong incentives to take M&E action—otherwise global and/ or European targets cannot be met.
- However, also during M&E activities and processes, focus needs to be placed on a broad participation process, bringing all stakeholders (local authorities, various businesses and economic sectors, and citizens of all social groups, particularly those in vulnerable conditions) together. The entire local and regional efforts towards a sustainability transition, including M&E, need to be a joint effort, tailoring local pathways that represent the best, i.e., an optimized, effective, feasible, and fair transition process to all.

ACKNOWLEDGEMENTS

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreements No 101036458 - LOCALISED - Localised decarbonisation pathways for citizens, local administrations and businesses to inform for mitigation and adaptation action.

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THE CITY AND THE SALMON: URBAN ACTIONS AND NON-HUMAN HABITABILITY IN SEATTLE'S WATERSHED

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INTRODUCTION

This paper examines the complex relationship between salmon and Seattle's urban infrastructure as discussed in J.B. Jackson's 1984 work *Discovering the Vernacular Landscape*. While salmon are central to Seattle's civic identity, the city's livability for salmonid species reveals a distinct tension between social aspiration and the realities of public infrastructure since the early 20th century. Pre-colonial water systems were the navigational paths of anadromous Pacific salmon (*Oncorhynchus* spp.) and these patterns were irrevocably altered through the construction of water-specific passages and road networks throughout the Seattle-metro area. With increasing changes wrought by anthropogenic climate change, the paths of adult salmon have altered yet further. By accepting salmon as active agents shaping landscape rather than mere passive resources, this work argues for understanding urban planning as a negotiation between human institutional designs and the pathways that salmon follow in embodied relationships with aquatic terrain.

In his work, Jackson distinguishes between paths created by local populations in ancient régime France prior to royal road construction, byways that followed more optimal topographical routes based on local knowledge, with institutional roads built by royal decree in straight lines that often contradicted terrain. Similarly, Pacific salmon historically navigated vernacular pathways: meandering rivers, complex estuarine channels, and seasonal tributaries that emerged from millions of years of salmon-terrain co-evolution. Colonial-era infrastructure imposed institutional pathways that force salmon through concrete culverts, straightened channels like the Duwamish River, artificial locks replacing outlets like the now-former Black River, and hatchery systems that truck adult salmon to spawning facilities rather than allowing natal waterway navigation. These institutional interventions prioritize human economic activities over the embodied knowledge that salmon carry in their navigation systems, altering the relationship between salmon agency and terrain.

WATERY BODIES FOLLOWING VERNACULAR PATHWAYS

While the earliest known fossil salmonid *Sivulliusalmo alaskensis* dates from approximately 70 million years ago, Pacific salmon (*Oncorhynchus* spp.) diverged from Atlantic salmon approximately 15-20 million years ago.[1] Speciation events leading to modern lineages occurred in the Miocene, with fossil evidence from Oregon and Idaho showing that chum, pink, and sockeye salmon lineages were established by the late Miocene/early Pliocene (~6 million years ago).[2] Repeated glaciation cycles created the modern genetic diversity observed in contemporary salmon runs.[3] By approximately 5,000

years before present in the Seattle-area, post-glacial isostatic rebound and sea level in Puget Sound had stabilized, with shorelines approximating modern conditions, establishing a foundation for human-salmon relationships that persisted until colonial-era extractive practices began.[4]

Pacific salmon are anadromous fish whose life cycle embodies salmon-terrain agency. Spawning adults create redds (gravel nests) in freshwater streams, which hatch in spring as alevins.[5] Once the alevin absorbs its yolk sac, it matures into a fry and undergoes transformation into a smolt in 6-8 weeks as it prepares for saltwater environments.[6] Adult salmon remain in the ocean from 18 months to 6 years before returning to natal streams to spawn, using magnetoreception to navigate to the general area of their natal stream and olfactory cues to find the specific natal stream.[7]

Much scholarship treats salmon as passive resource rather than active agents with intention, shaping and being shaped by their environment. Astrida Neimanis' insight that bodies are not merely composed of water but are material assemblages where boundaries between individual organism and aquatic environment dissolve challenges this perspective.[8] Bodies are terrain itself as constitutive elements of the material world rather than separate objects acting upon it.[9] When salmon navigate watersheds as fry, smolt, or adults, they are not separate agents moving through passive landscape but rather water-terrain exercising collective agency. For millions of years before human habitation, salmon exercised agency within proto-vernacular pathways: emergent routes from interaction between salmon-as-water and the "voluminous, processual, dynamic" terrain of the Pacific Northwest.[10]

Adult salmon perish once they spawn. Thomas Reimchen and colleagues demonstrated that salmon transport marine-derived nutrients far inland through spawning migrations, finding salmon derived nitrogen appearing in old-growth riparian forests throughout British Columbia.[11] One small stream with spawning and dying salmon provided enough nutrients from their remains to sustain "2 martens, 4 eagles, 12 ravens, 150 glaucous-winged gulls, and 250 crows," illustrating how salmon death creates life for multiple species in expanding networks of material relationships.[12] Hocking and Reynolds found that plants requiring high nutrition, such as salmonberry, depend on salmon-derived nutrients, while red alders survive in low-salmon environments, reveal salmon density's inverse proportional relationship to riparian plant diversity.[13]

For at least five millennia, salmon exercised agency within vernacular pathways of Western Washington rivers and streams. Terrain's "unruly materiality" is "ontologically primary in relation to human experiences of it as places and territories – and certainly much more powerful."[14] Salmon-terrain assemblages operated within material constraints that exceeded any single species' control. Terrain withdraws from full human control, and salmon's vernacular pathways embody this withdrawal, creating routes that responded to seasonal flows, geological processes, and ecological fluctuations beyond human management.

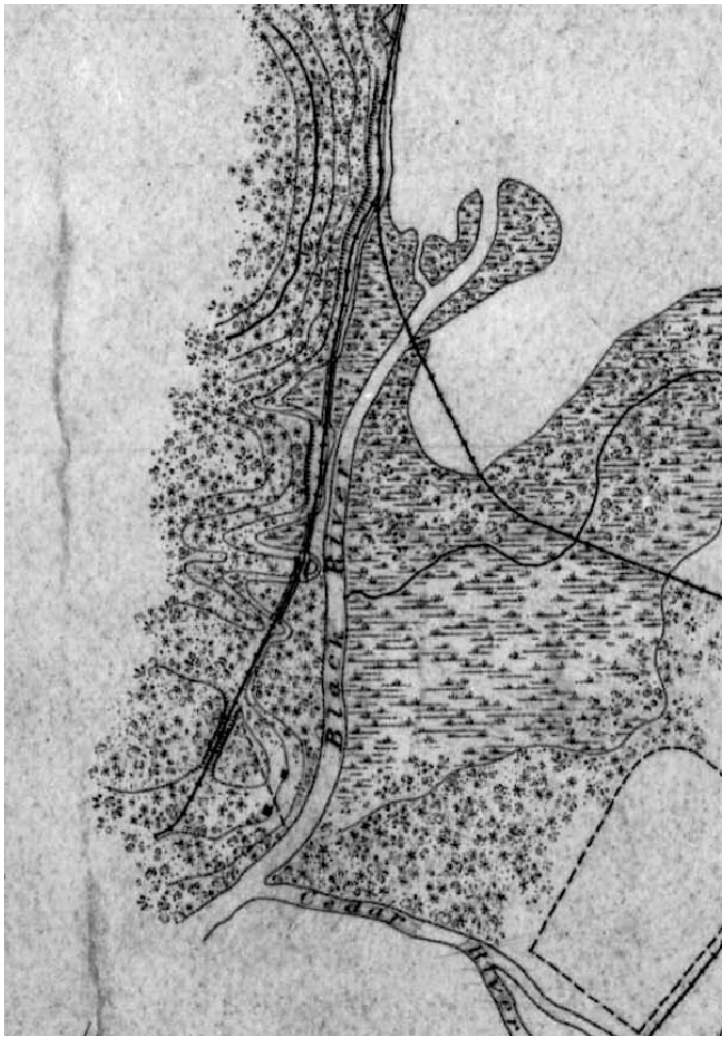


Figure 1. 1902 Topographic Survey Map Showing the Black River (Source: U.S. Coast & Geodetic Survey).

INSTITUTIONAL PATHWAYS

This paper examines the complex relationship between salmon and Seattle's urban infrastructure as discussed in Colonization in the area now known as Seattle brought extractive capitalist practices demanding controlling relationships to terrain. Where vernacular pathways emerged from embodied salmon-terrain relationships, institutional pathways imposed infrastructural planning onto the non-human. Urban and industrial development rewrote waterways into channels, blocked salmon access to rivers, and created culverts to divert streams under roads constructed for automobile transportation.

Taking the Rivers to Make the City

The construction of the Lake Washington Ship Canal between 1911 and 1917 was the most dramatic example of the imposition of institutional pathways over vernacular salmon-terrain relationships. This large-scale engineering project, culminating in the Hiram M. Chittenden Locks (known locally as the Ballard Locks), reorganized an entire watershed's hydrology in the service of industrial progress.[15] The canal lowered Lake Washington by nine feet, converting from a lake with seasonal fluctuations into a managed reservoir connected to Puget Sound through a human-built saltwater-freshwater interface controlled by lock operations.[16] This project entirely eliminated the Black River, which had served as Lake Washington's natural outlet and a major salmon pathway for thousands of years.[17]

The intellectual framework underlying this transformation appears in an essay by the head engineer for the U.S. Army Corps of Engineers on the Locks, Hiram M. Chittenden. In his 1910 essay "Sentiment Versus Utility," Chittenden articulated the institutional logic guiding the Ship Canal project, arguing for infrastructure development in the face of aesthetic beauty or emotional attachment to sites such as Seattle and Niagara Falls.[18] Chittenden's essay embodies the dueling notions of capitalist progress and post-Romantic wilderness appreciation that characterized colonial approaches to the Pacific Northwest, treating terrain as simultaneously beautiful and available for extraction and engineering manipulation. Notably absent from this vision are the considerations of salmon-terrain relationships or Indigenous peoples' relationships to the water, land, and non-human beings of the region. This institutional perspective could only conceive of terrain as aesthetic object or engineering problem, unable to recognize the active agency of salmon-terrain assemblages that the Ship Canal would alter forever.

Simultaneously, the straightening of the Duwamish River altered another major vernacular pathway system, transforming a meandering 25-mile river through tidal marshes and estuarine channels into a 12-mile industrial shipping corridor.[19] The original Duwamish embodied what Gordillo terms "voluminous, processual, dynamic" nature, hosting diverse habitat niches, complex flow patterns, and gradual salinity transitions that supported multiple salmon species and life stages. This straightening project imposed rigid geometry onto this terrain, creating uniform channel depths and velocities designed for cargo ships rather than salmon navigation.[20] This transformation destroyed over 99% of the river's estuarine habitat and forced salmon, especially in the early stages of life as smolt adjust to adult life and are vulnerable to predation, to navigate a monotonous industrial corridor where their evolved navigation system became maladaptive. Karen Barad's concept of "intra-action" illuminates how these institutional interventions reconfigure the material-discursive practices through which salmon and terrain constitute each other: the straightened Duwamish creates new boundary making practices that separate salmon agency from terrain responsiveness, disrupting the co-constitutive relationships that enabled salmon-terrain assemblages to emerge.[21]

This combined impact eliminated the two major vernacular pathways for salmon in what is now Seattle, replacing them with institutional infrastructure that constrains salmon agencies within artificial geometries. Following Jackson, these interventions represent the violent imposition of institutional logic onto vernacular salmon-terrain relationships that had emerged from millions of years of co-evolution.[22]



Figure 2. Salmon Going Through the Fish Ladder at the Ballard Locks. (Source: Smithsonian Magazine).

More Power, Less Salmon

The construction of the three major dams on the Skagit River (the Gorge Dam, the Diablo Dam, and the Ross Dam) represents one of the most comprehensive examples of institutional pathway systems eliminating vernacular salmon-terrain relationships at watershed scale. Seattle City Light constructed the three dams without fish passage facilities, relying upon an outdated 1920s survey of the Upper Skagit River that itself states it is only a cursory survey.[23] Salmon were then confined to the lower reaches of what had historically been one of Puget Sound's most populated salmon river. This decision reflected institutional logic that prioritized hydroelectric generation over salmon-terrain assemblages, converting flowing river terrain into still-water reservoirs that lacked velocity and substrate characteristics essential for salmon life cycles.[24]

Seattle City Light's justification for the lack of fish ladders on the Skagit River dams relied upon the aforementioned 1921 cursory survey, since the presence of salmon on the Skagit River above the dams would have required construction of fish passages by a Washington State law passed in 1893.[25] The utility argued that the construction of fish ladders was technically infeasible and economically unjustifiable, despite evidence from other dam projects demonstrating both the possibility and necessity of fish passage facilities.[26] This institutional reasoning ignored decades of scientific understanding about salmon biology and research conducted by scientists hired by the Upper Skagit Tribe documenting the presence of salmon in unexpected places in the watershed, along with centuries of Indigenous knowledge about salmon habitat.[27] Centrally, Seattle City Light's approach exemplified the blindness that Jackson identifies in the construction of institutional pathways in the deliberate ignoring of local terrain and knowledge, along with the assumption that terrain exists primarily for human economic progress. The utility's refusal to install fish passages represented a deliberate choice to eliminate salmon agency from the upper reaches of the watershed, removing salmon from a place they had inhabited for millennia.

The eventual legal challenge by the Sauk-Suiattle and Upper Skagit Indian Tribes exposed both the scientific inadequacy and legal vulnerability of Seattle City Light's position, forcing the utility to acknowledge their mistakes. After years of tribal litigation demanding adequate fish passage, Seattle City Light agreed in late 2023, enforced by a judicial position in early 2024, to implement the proposals for fish passage installation.[28] The upper watershed remains converted to support hydroelectric infrastructure, limiting salmon-terrain relationships to the confines of fish passages that will be retrofitted onto dams designed without consideration for such construction. While these measures will at least give passage for salmonid species to the Upper Skagit watershed, these measures will not restore the vernacular pathways the dams eliminated. Finally, climate change is now revealing the fundamental instability of this institutional planning, as altered winter precipitation patterns are disrupting reservoir management, an exemplar for what Gordillo identifies as a terrain's capacity to "withdraw from full human control."[29]



Figure 3. Hydropower Sources for Seattle City Light – 20% of its power is drawn from the Skagit River Dams. (Source: Author).

Roadways and Culverts

No infrastructure better exemplifies the transformation from vernacular to institutional pathways than the thousands of culverts that channel streams beneath the Seattle-metro road network, forcing salmon to navigate geometric constraints designed for automobile transportation rather than the anadromous life cycle. Washington State contains over 20,000 culverts that impede salmon passage, with studies identifying these as "the most pervasive obstacle to salmon migration in the Pacific Northwest."[30] These institutional pathways imposed on terrain prioritizes the logic of civil engineering over salmon's embodied relationship with terrain, compelling salmon-as-terrain to navigate concrete pipes designed for storm drainage rather than the variegated aquatic habitat salmon navigation systems evolved to utilize.[31] Culvert gradients often exceed the swimming capabilities of salmon, creating velocity barriers that prevent upstream migration.[32] Concrete surfaces provide no resting areas and eliminate subtle changes in water chemistry, temperature, and flow that signal pathway direction.[33] Culverts interrupt the continuous material exchange between salmon bodies and aquatic terrain, forcing salmon to navigate waters with different velocity, temperature, and chemical information than the streams and rivers they evolved within.

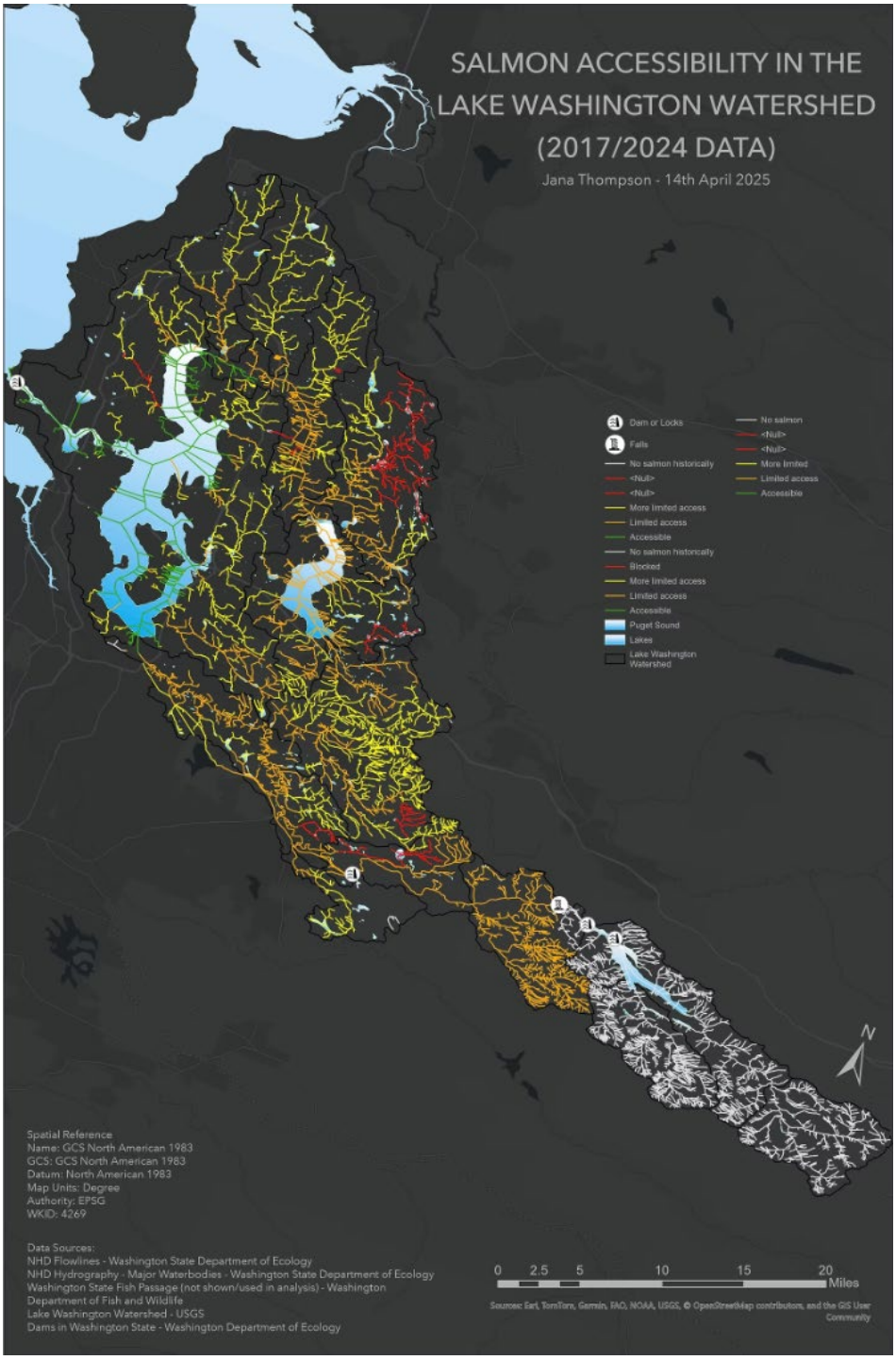


Figure 4. Accessibility for Salmon in Waterways of the Lake Washington Watershed. (Source: Author).

CLIMATE DISRUPTIONS

The development of salmon hatcheries in the Seattle region represents the most comprehensive attempt to subordinate salmon-terrain agency to institutional management, transforming salmon reproduction from a vernacular process embedded in waterway dynamics into an industrial operation (add note on Muckleshoot understanding).[34] As Taylor and Cummings document, the expansion of hatchery systems following overfishing and the destruction of salmon habitat from the late 19th-century onwards created what officials imagined would be technological solutions to ecological

problems created by extractive economic practices and institutional infrastructure.[35] Rather than addressing the fundamental issues of extractive practices and infrastructure that destroyed the lifecycle of salmon driven through their own agency, hatchery systems attempted to replace this agency with institutional management, creating artificial spawning environments and destroying the populations of natal populations with imported eggs from other watersheds.

More recently, due to high temperatures in the Lake Washington Watershed, salmon are now at times trucked from the fish ladder at the Ballard Locks to hatcheries. This represents the logical endpoint of institutional pathways and the complete replacement of salmon reproductive and navigational agency with human scientific and infrastructural practices.[36] Beginning as a pilot program in 2021 and expanding to over 1,600 fish in 2023, fisheries managers now truck sockeye salmon approximately 40 miles around Lake Washington to avoid warm, low-oxygen conditions in the Ship Canal that are lethal to salmon.[37] This trucking program is the final outcome of almost 200 years of colonial institutional planning that has reached functional limits: rather than acknowledging the failures of economic, institutional, and planning practices, planners create additional interventions to transport salmon around problems. This trucking process transforms salmon from active agents navigating terrain into passive objects managed entirely through institutional logistics.

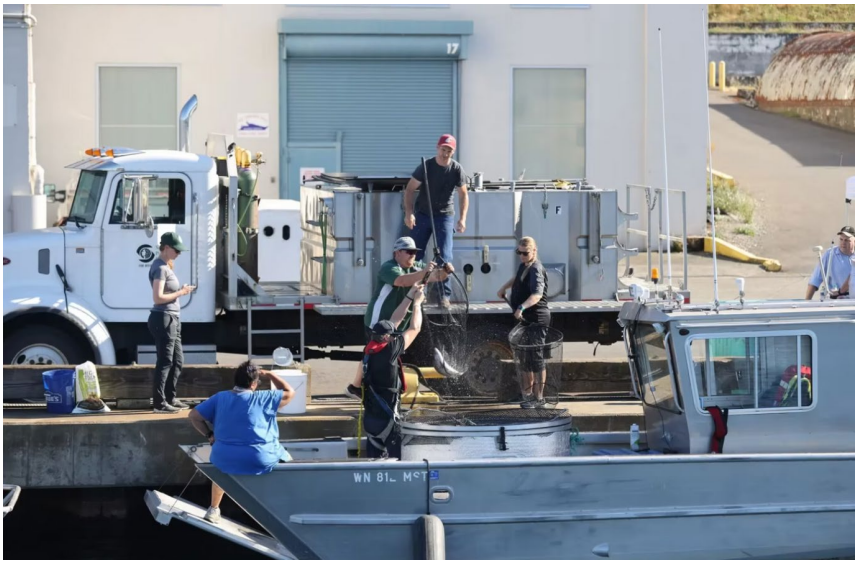


Figure 5. Fisheries workers transporting adult salmon to a hatchery. (Source: The Seattle Times).

Even hatchery facilities, designed as controlled environments for salmon reproduction, now struggle with climate impacts including power failures, inadequate cooling systems, and water temperature fluctuations that threaten fish survival.[38] The expansion of the salmon trucking system from a few hundred to thousands of fish represents an institutional admissions that the entire system of dams, locks, channelized rivers, and hatcheries cannot maintain viable salmon populations within the constraints that institutional infrastructure has created. The normalization of this system in the 2020s replays the original issues of the hatchery system as described by Taylor: as more habitat degradation and climate issues cause greater issues, governments and institutions respond by creating additional layers of technological intervention rather than questioning fundamental assumptions.

CONCLUSION

Understanding salmon as active agents exercising terrain agency rather than passive resources requiring human management reframes urban planning and restoration approaches in the Seattle region. The framework of the vernacular pathway with Gordillo's definition of terrain reveals how salmon-terrain assemblages operate at scales and timeframes that exceed institutional control. The specific examples of Seattle's institutional infrastructure, such as the straightening of the Duwamish River, numerous culverts, the Ballard Locks, Skagit River dams, hatcheries, and salmon trucking programs, illustrate how institutional pathways attempt to subordinate salmon-terrain agency to human economic priorities while failing to recognize that terrain's unruly materiality inevitably exceeds technological management. The progression from vernacular salmon pathways to fish ladders and trucking to hatcheries represents a logical trajectory of institutional thinking that cannot conceive of solutions outside of technological control, even as climate change renders these approaches increasingly inadequate.

As climate change pushes terrain to withdraw further and further from human control, the failure of planning systems exposes the necessity of approaches that work with rather than against the material agency of salmon-terrain assemblages. Supporting salmon recovery requires creating conditions for salmon-terrain assemblages to exercise agency within urban environments that acknowledge their material complexity, accepting that both vernacular and institutional pathways have been and will continue to be altered by climate change, and that what is to emerge must be something unprecedented: post-institutional pathways that come from negotiation between salmon agency, terrain materiality, and human habitation rather than technological management of putative natural resources.

NOTES

[1] While I use the term *salmon* generally, I am referring in this paper specifically to Pacific salmon (*Oncorhynchus* spp.). There are six distinct species of anadromous Pacific salmon in Washington State: Chinook or King salmon (*Oncorhynchus tshawytscha*), coho salmon (*Oncorhynchus kisutch*), sockeye or blueback salmon (*Oncorhynchus nerka*), chum or dog salmon (*Oncorhynchus keta*), pink or humpback salmon (*Oncorhynchus gorbuscha*), and steelhead salmon/rainbow trout (*Oncorhynchus mykiss*). Mark V.H. Wilson and Guo-Qing Li, "Osteology and Systematic Position of the Eocene Salmonid Eosalmo driftwoodensis from North America," *Zoological Journal of the Linnean Society* 125, no.3 (1999): 279-311; R.F. Stearley, "Historical Ecology of Salmonidae, with Special Reference to Oncorhynchus," *Systematics, Historical Ecology and North American Freshwater Fishes* (1992): 622-658; Robert H. Devlin, "Sequence of Sockeye Salmon Type 1 and 2 Growth Hormone Genes and The Relationship of the Rainbow Trout with Atlantic and Pacific Salmon," *Canadian Journal of Fisheries and Aquatic Species* 50, no.8 (1993): 1738-1748.

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RESILIENT TURFGRASS MANAGEMENT: INSIGHTS FROM HIGH-USE LANDSCAPES IN WASHINGTON STATE

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INTRODUCTION

Lawn landscapes, e.g., for public parks, golf courses, school grounds, and university grounds, are a part of urban life, adding aesthetic, recreational, and functional value. Yet, turf in such locations is often subjected to excessive use, making it difficult to maintain turf health and appearance. Compaction, wear, and erosion are typical problems that degrade turf quality and longevity. Successful turfgrass management of trafficked areas is an integrated process that involves the use of suitable grass species, cultural practice regimes, and the implementation of sustainable maintenance strategies. Using wear-tolerant turf species such as tall fescue or perennial ryegrass would improve wear tolerance. Frequent mowing, aeration, overseeding, and fertilization will keep the turf in good condition and stress mitigation. Further, methods such as conservation irrigation and integrated pest management (IPM) increase resource conservation and environmental stewardship.[1] Even with the existence of best management practices (BMPs), most turfgrass managers are not able to put the practices into action due to availability of constraints like budgets, limited resources, and low awareness. For this reason, this study seeks to evaluate turfgrass management practices within Washington State and determine constraints to applying environmentally friendly approaches. Having known these constraints, the study seeks to come up with user-friendly materials that will be able to guide maintenance crews to apply efficient and environmentally friendly turfgrass management practices.[2]

Background

Turfgrass systems are essential elements in urban and suburban areas that not only bestow recreational and aesthetic benefits but also have functions in erosion control, heat reduction, and stormwater management. Care and management of these systems, particularly in heavily used public parks, are a sophisticated environmental and operations concern.

Turfgrass and Environmental Stewardship

Beard and Green had established the general environmental roles of turfgrass systems such as runoff reduction, pollution filtration, and soil stabilization.[3] As these advantages are realized, however, conventional turfgrass maintenance depends on heavy use of such inputs as water, chemical fertilizers, and regular mowing, which may be incompatible with sustainable objectives. Milesi and colleagues elaborated on this work with U.S. turfgrass cover modeling and quantification of its substantial water and energy requirement, observing its ubiquity and possibly costly environmental

impact.[4] In response to this, scientists have made a growing call for using drought-resistant species like tall fescue and fine fescue mixtures, which cut water consumption while still lasting long.[5] Sustainable management also includes enhanced mowing, lowered fertilizing schedules, and organic soil amendments—practices that balance functional turfgrass performance with ecological stewardship.

Traffic Stress and Turfgrass Toughness

Heavy foot traffic is one of the most common forms of abiotic stress on turfgrass, particularly on multi-purpose fields and universities. Soil compaction, reduced root growth, and turf thinning are common consequences of extensive use, usually where there is little time for restoration or rotation.[6] Such activities can degrade not only the aesthetic look but even the environmental quality of grass landscapes. Rest periods, overseeding, and aeration have been found to be effective practices in compaction avoidance and recovery improvement of turf.[7] Public facilities do not have sufficient scheduling flexibility or financial capability to use these practices routinely. As Carrow and Petrovic noted, stress resulting from traffic requires forward-thinking and adaptive measures ideally designed with reference to site-specific usage patterns and climatic conditions.[8]

Bringing Design Intention and Maintenance Reality Together

The disconnect between landscape design and long-term maintenance practice is a common occurrence. Nassauer noted that ecological performance needs to be sustained by "orderly frames" in the visual landscape if it is going to be acceptable to the public and persistent stewardship.[9] In much of urban green space, however, landscape architects' ideal of multifunctional use is not necessarily carried through in maintenance planning or capability. Gobster and colleagues also called to mind the balance between public use and natural well-being, and they highlighted how design principles must serve both community demand and landscape sustainability.[10] This imbalance is most pronounced in school boards and local governments, where facilities groups are under-budgeted and are charged large turf spaces with numerous activities. Systematic best management practices (BMPs) are therefore not adhered to or become informally modified to fit practical limitations.[11]

The Demand for Practitioner-Based, Applied Research

Though peer-reviewed literature has reported many BMPs of sustainable turfgrass management, some of these best practices are not accessible or not being fully utilized by the practitioners who deal with public landscapes on a day-to-day basis. Beard and other researchers in turf science have pointed out the requirement of distilling experimental evidence to practical applications aligned to institutional needs, labor constraints, and local climate conditions.[12] There is an increasing requirement for studies that not only quantify ecological performance but also access on-the-ground experiences of school, park, and university turfgrass managers. This research project attempts to contribute to this effort by surveying Washington State turf maintenance professionals, eliciting their views regarding traffic stress, maintenance issues, and best management practices. Through the collection of these practitioner views, the research seeks to fill the existing gap between published BMPs and on-the-ground implementation, ending up with usable tools for more sustainable institutional landscape turf management.

METHODS, DATA, AND ANALYSIS

The research used a qualitative survey approach to investigate the turfgrass managers' practices, issues, and dispositions towards managing Washington State's high-use grass landscapes. The research placed particular focus on high or frequent foot traffic landscapes in public parks, sports fields, school playgrounds, university campuses, and golf courses. These are most prone to wear, compaction, and climatic stress but yet have to provide aesthetic and functional values year-round.

Participant Recruitment

Purposive sampling was used for identification and recruitment of turfgrass and landscape management professionals. Research assistants prepared a list of target contacts in various institutional and professional categories, such as municipal and regional park departments, golf course superintendents and grounds crew, K-12 school district maintenance departments, university facilities and grounds staff, and private-sector lawn care and landscaping services.[13] Participants were selected from various geographic points in Washington State to represent varied climatic regions, institutional settings, and resource environments.

Sector	Type	Rationale
Municipal & Regional Parks	Public sector	High-traffic public recreational areas
Golf Courses	Private/Public sector	Intensive turf management with aesthetic standards
K-12 Schools	Educational sector	Sports fields and recreational areas with heavy use
Universities	Higher education	Campus grounds and athletic facilities
Private Landscaping	Commercial sector	Professional lawn care and landscaping services

Table 1. Sector Types and Their Turfgrass Use Characteristics

Survey Instrument

The survey instrument was designed by the research team to measure existing turf management practice and high-traffic area problems. Closed and open-ended questions were asked in the survey to gather qualitative information and enable thematic analysis. The survey was administered via email and internet websites, aided by reminder emails to encourage response rates.

The survey was divided into four aspects of inquiry:

Current Practices and Perception of Effectiveness. The respondents were then questioned about how they actually treat turfgrass in heavy-use zones, such as questions regarding specific practices like mowing frequency, watering, overseeding, aeration, fertilizing, and using hardy turfgrass species. They were also questioned on how satisfied they were with these practices and to present evidence of what they found most and least helpful.

Training, Resources, and Operational Capacity. Staff members were inquired whether they were properly trained and equipped to care for turf in conditions of traffic stress. There were questions on the topic of staff experience, availability of continuing education or technical assistance, ownership of maintenance equipment, and barriers to best practice implementation perceived by them.

Efficiency, Safety, and Procedural Review. Questions in this area asked them if they had any questions regarding the efficiency of their maintenance work, for example, labor-intensive, time-consuming, and whether safety issues have ever been an issue for turf maintenance work. They also asked them if they ever look over or modify their procedures seasonally or site conditions.

Areas Needing Improvement and Specific Challenges. The last segment identified turf management areas where changes were most needed, according to respondents. Special emphasis was given to

protocol in addressing high-traffic zones, low-drain or flood-prone zones, and other common site-specific problems. Respondents were asked to suggest changes, innovations, or resources that would improve turf life or alleviate maintenance burden.

Data Analysis

Responses were gathered and subjected to qualitative content analysis. Emergent themes from open-ended questions were coded and categorized by management domain (e.g., golf courses, parks, schools). This facilitated comparison of responses by institutional setting and surfacing of common strategy, constraints, and requirements.[14] Through this survey-based approach, the study intends to provide evidence-based information regarding current turfgrass management conditions and to inform the development of effective, ecologically sound, and user-friendly management tools for high-use terrain.

RESULTS AND DISCUSSION

The results of the survey identified a broad array of practices, issues, and effective approaches adopted by turfgrass managers in Washington State. Although some practices differ by type of institution and resources at hand, the following distinct trends were evident in managing heavy-use grass landscapes.

Sector	Current Management Practices	Key Issues Faced	Successful Approaches
Lawn Care Services	Regular mowing, fertilization, weed control	Unhealthy grass leads to more weeds, creating larger issues	Adequate watering, fertilization, constant maintenance
Parks & Recreation	Overseed and topdressing, change mowing orientations to reconfigure wear patterns	Long season (March-October), water/irrigation constraints, manual fertilization	Consistent watering, divide areas into sections, fertilizer and herbicide planning
	Switched to drought/traffic-resistant fescue blend, change foot traffic patterns	Water zone timing, water regulations, limited sod grass mixture options	Compost supplementation for fertilizer, changing worn areas to hardscape
	Overseed, aerate, fertilize frequently, schedule on/off seasons for playfields	Shade areas difficult, insufficient fields for proper scheduling	Programming, fertilizers, relay sod in off seasons, treat normal areas like playfields
School Districts	Normal turf management, shockwave aeration, pathways installation	Proper watering in hot weather, overseeding timing, football fields challenges	Consistent best practices tailored to specific property purposes
	Watering, natural landscaping, keeping kids off grass, limited fertilizer	High water and maintenance needs, resource constraints	Minimal watering when stressed, 1-2x yearly fertilization, reduced summer use
	Short cutting, avoid overwatering, closed aeration for 1.5 months	Limited maintenance time due to continuous high volume use	Rotating use patterns, short grass cutting, controlled watering, regular aeration and fertilization
Universities	Decompaction focus, aeration/verticut 4x yearly, sand topdressing 2x yearly	Direct footpath traffic patterns	Aeration priority, avoid wet conditions, advanced grass seed varieties (perennial rye over bluegrass)
	Natural prairie stages, native plants, prioritize native grasses	Minimal issues, some volunteer pathways	Proper fertilization, water management, species selection, on-site composting
	Adjust sprinkler timing, use cones and tape for traffic control	Old irrigation systems, coverage issues, limited resources, hotter/drier summers	Normal aeration, fertilization, watering, limit space use when possible
	Minimal management, annual aeration, limited fertilization	Soil compaction	Remove other stresses, maintain adequate watering
	Machine decompaction, verification for high-traffic areas, event-based watering	Summer events create stress, water scheduling constraints	Weather-based planning, proper irrigation timing and speed

Table 2. Summary of Turfgrass Management Survey Results

Current Practices

Industry-wide, turf managers place great importance on aeration, fertilization, and watering as the core elements of standard turf maintenance. Public works and school district respondents often mentioned the use of overseeding, topdressing, and intentional mowing as one method of trying to redistribute wear patterns. Golf course and sports field managers placed high importance on decompaction processes like verticutting and shockwave aeration as a means of reducing soil stress. Others—particularly universities—stated planting native grasses or low-maintenance ground covers as a way of conserving against high maintenance requirements.

Common Problems

Most mentioned most frequently was water management, especially under duress from seasonal drought and regulatory restriction. Public school and university respondents also spoke in terms of time constraints for maintenance due to the virtual year-round use of grounds. Soil compaction, invasion of weeds, and minimum recovery time in between intensive usage events were also mentioned quite often. Some of the facilities also reported infrastructural issues such as old irrigation, inadequate funds, or bad staff. Climate change factors such as warmer and drier summers are increasingly affecting turf condition.

Successful Strategies

Effective management practices had a tendency to combine cultural management with careful planning. Frequent aeration, fertilizer regimes specific to the site, and changed mowing practices were frequently mentioned as effective. Grass choice was also mentioned as a factor, with many referring to the need to transition over to traffic- and drought-hardy types such as fescue or perennial ryegrass. Those taking user pattern control measures had decreased stress in areas of interest. Some city and university park managers observed periodic times of repose, rotation among fields, and even reorganization of highly stressed areas to hardscape or natural landscaping to promote sustainability.

Surprisingly, some institutions used organic maintenance methods, such as composting and natural fertilizer techniques. Institutions with a longer time perspective also observed keeping track of weather forecasts and scheduling irrigation in connection to prevent wastage of water.

Generally, the study indicates effective turfgrass maintenance in heavy usage as a factor of equilibrium between routine cultural care, adaptive planning, and judicious resource deployment. Regardless of the various scales of operations and objectives, all experts concur that user behavior management, soil health, and proactive planning are the key to maintaining grass landscapes under stressful conditions. Continual innovation in grass type, irrigation technology, and user education will be the answer to long-term turf survivability.

CONCLUSION

The research interviewed the Washington State turfgrass experts with high-traffic grasslands and their management, problems, and requirements. Lawn care professionals and golf course superintendents to municipal parks employees and grounds staff of educational institutions were all surveyed across the board, and the research found out what is being done and what ongoing issues there remain to achieve substantial, functional turf even in high usages.

Principal outcomes are that although central management procedures like regular mowing, fertilizing, aeration, overseeding, and watering are still at the heart of turf health, there are broad challenges. They consist of soil compaction, water resource limitations, challenges to balancing permanent use and recovery time, and limitations on apparatus, training, and access to resources. Also, changed

climatic conditions like warmer, drier summers increase stress upon turfgrass and add burdens to sustainable maintenance.

Effective approaches highlighted by the participants denote adaptive management techniques, such as drought- and traffic-enduring grass species utilization, rotational closings scheduled to permit turf recovery, selective aeration and topdressing, and integrated fertilization and irrigation plans adapted to site needs. Observe that heightened knowledge transfer, available training, and user-friendly materials allowing landscape professionals to apply ecologically sustainable and resilient turfgrass management approaches are considerably needed.

This study enriches turfgrass management scholarship by placing front-line practitioners' voices at the center and emphasizing practical constraints and innovations of actual field situations. The findings emphasize the need to form customized, sustainable management strategies to suit the varied functions and environmental demands of grass landscapes in the Pacific Northwest region and beyond. Future activities need to address bridging the gap between turfgrass science and applied management through creating participatory, user-friendly tools and educational platforms driven by practitioner experience. Resolution of resource limitations and focus on concerted strategies among managers, researchers, and designers will be essential to advancing sustainable turfgrass stewardship that fulfills aesthetic, recreational, and ecological goals.

RECOMMENDATIONS AND IMPLICATIONS

From observations made in this study, there are some important recommendations to optimize the sustainable management of high foot traffic stress in turfgrass landscapes.

Recommendations

Adopt Adaptive Management Practices. Adaptive methods such as sowing drought- and traffic-tolerant species of grasses, frequent aeration, overseeding, and site-specifically ruling and watering schedules should be given preference to the managers of turfgrass. Programmed closure of rotation or from time to time resting periods for the high-traffic zones can optimize recovery and turf life.

Improve Training and Knowledge Transfer. Ongoing investment in training and readily available educational materials are needed for maintenance staff. Extension courses, workshops, and websites targeting the unique issues of frequently used turfgrass maintenance are likely to improve expertise and application of best management practices.

Make User-Friendly, Accessible Resources. An interactive online resource center integrating practitioner and up-to-date scientific knowledge would prove to be beneficial for landscape professionals and local stakeholders. The site could include practical tips, troubleshooting guides, and information on emerging sustainable technology and methods.

Close Resource and Equipment Gaps. Financing and support systems must be found so that managers can provide specialized equipment and materials, including aerators or drought-resistant seed types. In addition, optimizing irrigation systems to prevent water loss and increase coverage is crucial, particularly in water-scarce areas.

Encourage Cooperative Approaches. More cooperation between turfgrass scientists, landscape architects, facility managers, and maintenance staff will ensure comprehensive, site-specific management practices integrating design, environmental values, and user requirements.

Implications

Successful management of intensively used turfgrass environments has far-reaching implications for the sustainability of urban greenspace, public health, and community quality of life. Intensely maintained turfgrass supports recreation, mitigates urban heat impacts, and assists in aesthetic and

ecological coherence in the institutional and public environment. With growing population urbanization and climate change, turfgrass managers evermore have to reconcile these demands with resource stewardship and environmental sustainability.

This study emphasizes the importance of gap bridging between research in academia and real practice such that turfgrass management development is supported by what practitioners actually experience. By adopting the strategies that are suggested, communities are able to render landscapes of grass more resilient, functional, and sustainable, in the long run leading to healthier environments that meet diverse public demands.

NOTES

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ENVIRONMENTAL CHALLENGES, URBAN INFRASTRUCTURES, AND URBAN ACTORS: A TRIVALENT STUDY OF SUSTAINABLE POLICYMAKING IN CITIES

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INTRODUCTION

The vision of a sustainable city is never neutral. Urban narratives of sustainability differ depending on a diversity of interests and knowledges from different actors; among them, academic institutions, urban planners, civil society organizations, local governments, and real estate developers. Their views scaffold citizens' expectations, support belonging to cities and legitimise power structures by making certain ideals ordinary and extensively accepted. The paper focuses on the analysis of sustainable discourses that articulate new urban visions, accommodate urban values and challenge problematic urban transformations.

The paper offers a critical analysis of the smart city paradigm. Nowadays, the widespread integration of artificial intelligence into the daily lives and work environments in cities creates environmental dilemmas. This point is exemplified here with urban dynamics in Mexico City, Singapore, and Rio de Janeiro, where infrastructural challenges such as water scarcity, the fragility of food distribution, and housing displacement are not only technological, budget-related problems, but are deeply intertwined with historical and contemporary spatial inequalities.

Examining ecological crises allows for a more comprehensive understanding of how cities are shaped and organized around environmental policies, moving toward a more complex, participatory, and nuanced approach to building low-carbon, sustainable, and just cities.

URBAN POLICYMAKING IN THE AGE OF ABUNDANT INFORMATION

In the context of a widespread integration of artificial intelligence into the daily lives and work environments in cities, the study of urban habitats requires a re-evaluation of the role of technology in shaping sustainability narratives. Since the 1970s, the majority cities and villages of the world have experienced a persistent environmental deficit, which occurs when the ecological footprint of a population exceeds the biocapacity of the area available to that population. In 2024, the global biocapacity was estimated at 1.5 global hectares per person, while humanity's ecological footprint was 2.6 global hectares per person.[1] We have a global ecological deficit of 1.1 global hectares per person. This environmental debt indicates that humanity nowadays consumes resources and generates waste faster than the Earth can regenerate them, leading to ecological damage and spatial inequalities.

Amerigo Marras[2] considers two limited approaches that dominate the construction of sustainability narratives in cities. On one end of the spectrum, dogmatic ecological attitudes or anti-technological development have limited usefulness, especially considering another kind of totalitarianism, under the banner of a "clean" environment, which forged a political straightjacket, mass control, and economic stratification of social classes. On the other end, the uncritical reception of any digital applications in the city, camouflaged as indispensable and inevitable. The challenge is to move beyond these two extremes to find a more complex, participatory, and nuanced approach to building low-carbon, sustainable, and just cities.

In this background, a growing body of research has explored the complex relationships between infrastructure networks, environmental sustainability, and spatial justice in cities.[3] A common approach of these works is the critique of the societal reliance on fossil fuel-dependent energy systems, a major driver of global warming. These works engage in "thinking futures" with attention to the social values and norms that deal with the growth and decay of cities, along with the study of hierarchical political structures that shape the visions of what a sustainable city should be.

The main critique of this paper is particularly concerned with urban imaginaries of the "smart" city that emerge from the ideal that sensors, smart grids, autonomous transport systems, and massive energy generators will palliate the economic and environmental challenges of urban living. This perspective often camouflages technology as an indispensable and inevitable solution to all urban problems. Not surprisingly, over the last decades the smart city design vision has gained popularity in urban studies and policymaking in the Global South, mainly due to its association with the ideal of "green infrastructure". This concept promises to tackle urban challenges of energy consumption, housing typologies, water and food provision, heavy traffic and mobility, or waste management through technological innovations. In a world of expanding cities, this proposal muddles the ability to construct comprehensive ecological narratives, to nurture sustainable futures. As Gillian Rose comments:

The smart city, then, seems to have a problematic relationship with notions of the imaginary and its close cousin, imagination. On the one hand, there's something about smart that seems to render imagination redundant. Smart technologies make things invisible and impossible to imagine; their code is arcane, the terms and conditions of apps are too long, their data hidden, their algorithms secret, their data shadows too distant, their cables and servers hidden underground, their Wi-Fi transmissions invisible. All this secrecy disables the imagination, but also demands it; it's all so invisible that the imagination has nothing to work with, but we must imagine it or suffer the consequences. On the other, smart is deemed too visible, too spectacular, too imaginary.[4]

The smart city discourse is part of a vision that sees urban entities as living organisms, metabolic entities of circulatory flows such as data, food, and waste, which are organised across infrastructures. Through the notions of flow and circulation, the idea of urban metabolism links ecological processes with the governance of cities. In other words, 'political and jurisdictional power can be exercised through biology'.[5] The conceptualisation of urban metabolism has fostered new interpretations of how material flows (e.g. fossil fuels, water) and immaterial flows (e.g. information, imaginaries) mediate their production and reproduction, both as a biophysical and socioeconomic entity.

INFRASTRUCTURAL CHALLENGES AND SUSTAINABILITY DISCOURSES IN CITIES

How can we frame urban discourses that shape the sustainable narrative of cities? Edward Soja[6] comments that the spatiality of human life is seen primarily in its material manifestations -buildings, streets, parks, infrastructures, as a mappable 'real' context that can be explained either through associations of its surface patterns, or through deeper social and historical forces that shape these forms. Alternatively, Soja explains, spatiality is understood as an "imagined" geography, visions

embedded in mental processes, or in the symbolic, ideological, and epistemological representations of urban environments. The first view objectively emphasizes "things in space", the second more subjective "thoughts about space". The fabrication of cities could be represented simultaneously and interactively by social, historical, and spatial points of view.

Between the biophysical and the imagined city, the analysis of infrastructural discourses requires a re-examination of technologies and their affects upon cities to search for a more complex participation of communities and specialists in a context of informational wealth. In the book End of Millennium, Manuel Castells (1998) acknowledged the paradigmatic challenges of the 'network society' at the end of the 20th century. One of his speculations in 1998 was that highly polarized cities were evolving, where "premium" infrastructure networks such as high speed telecommunications, "smart" cities and global airline networks selectively connect the most favored users and places, both between and within settlements:

The global economy will expand in the twenty-first century, using substantial increases in the power of telecommunications and information processing. It will penetrate all countries, all territories, all cultures, all communication flows, and all financial networks, relentlessly scanning the planet for new opportunities of profit-making. But it will do so selectively, linking valuable segments and discarding used up, or irrelevant, locales and people. The territorial unevenness of production will result in an extraordinary geography of differential value making that will sharply contrast countries, regions, and metropolitan areas. Valuable locales and people will be found everywhere, even in Sub-Saharan Africa. But switched-off territories and people will also be found everywhere, albeit in different proportions. The planet is being segmented into clearly distinct spaces, defined by different time regimes. [7]

On the other hand, scholars such as Nestor Garcia-Canclini [8] suggest that it is also necessary to determine the scope of the opposite position which affirms that all societies, in all times, have been knowledge societies, that is, that every human group has owned a knowledge set appropriate to its contexts and its historic challenges. The logic is that far from having brought society to a new stage of its development – the Artificial Intelligence Age, computers and digital connections have simply intensified and accelerated the flow of knowledge, a flow which, like any other catalyst that accelerate a process, still needs matter and energy (raw materials, electricity, water, pipes, roads, gasoline, buildings, infrastructure) to be effective. A critical task in urban studies, thus, is to identify who governs tangible and intangible flows in cities. This is relevant because the analysis of infrastructural challenges in urban centres helps us to locate the places in the Earth where the distribution of resources occurs, and in relation to the forms of social organisation that arise from those sites.

MEXICO CITY, SINGAPORE, RIO DE JANEIRO: THREE EXPLORATIONS OF ECOLOGICAL CRISES AND THE CHALLENGE OF INFRASTRUCTURAL GOVERNANCE

The exploration of ecological challenges and infrastructure governance requires empirical evidence from cities. Mexico, Singapore and Brazil are three national states that face environmental challenges of water, food, and housing supply. These difficulties are often associated with infrastructure policymaking and ecological narratives that are proposed by real estate developers, civil society organizations, urban planners, and local governments, among others. Their representations and discourses of urban development scaffold inhabitants' expectations, support belonging to cities and legitimise power systems by making certain ideals ordinary and widely accepted. The practical aim of this research is to study evidence of the scale and network of environmental challenges, urban infrastructures, and urban actors. Three variables that help to define and reproduce urban dynamics and their environmental impacts on cities.

Water governance in Mexico City

Mexico City faces a multi-faceted water crisis stemming from its unique geography and complex infrastructural governance. The original city of Tenochtitlán was built on a former lakebed of 1,200 km2 by the Mexica Civilization (1325-1521 AD). Over the last fifty years Mexico City has over-extracted its underground aquifer to meet the demands of millions of residents. This has led to dramatic land reduction, causing the city to sink and damaging its aging infrastructure, which in turn results in significant water losses—up to 40%—from leaky pipes.[9]

The water that is supplied from both the overexploited aquifer and a massive, expensive inter-basin transfer system, the Cutzamala system, which draws water from distant basins and is vulnerable to drought and maintenance-related shutdowns. This unsustainable model is exacerbated by climate change, which makes rainfall patterns increasingly erratic and unpredictable.

The social and political dimensions of water governance in Mexico City are just as challenging. Access to water is highly inequitable, with low-income, peripheral neighborhoods often receiving intermittent or no water service. This forces residents to rely on expensive and unregulated water trucks, or pipas, which creates a parallel, informal water market and further deepens social inequality. The institutional landscape is fragmented, lacking a single, coordinated authority to manage water resources across the entire the Metropolitan Zone of the Valley of Mexico. This inefficiency and a lack of transparency lead to public distrust and political conflicts, as residents and civil society organizations protest the unequal distribution of a fundamental resource.

The vision of returning Mexico City into a pre-Hispanic, wetland-like state, allowing rivers to flow freely along the city is a powerful tool for inspiring change. However, big plans of complex technological systems for recovering the original lakes in the central core of the city means that any large-scale change would require massive relocation of citizens and land-use reform. One could argue that this approach is politically and socially unfeasible in a city that hosts more than 21 million people.

Food distribution in Singapore

For decades, Singapore has faced significant challenges in food distribution primarily due to its heavy reliance on imports. As a small, land-scarce city-state, it produces less than 10% of its own food. This makes its food supply chain extremely vulnerable to external shocks such as geopolitical tensions, global warming-related events, and global supply chain disruptions. For example, a trade ban or export restriction from a major food source country could immediately impact the availability and price of essential food items in Singapore. The high cost of land and resources also makes local food production expensive, hindering efforts to increase self-sufficiency and create a buffer against these risks.

As part of the “30 by 30” vision, the Singaporean government (in 2019) set the target of producing 30% of the country’s nutritional needs locally by 2030.[10] The complexity of managing a diverse network of food suppliers from over 170 countries, (among them Brazil, Australia, and Spain) poses its own set of challenges. Ensuring food safety and quality standards across such a vast and varied supply chain requires rigorous inspection and accreditation processes.

Singapore has developed strategies like diversifying import sources and investing in high-tech urban farming. However, maintaining a resilient and stable food supply remains a constant and evolving challenge. A vision of complete food self-sufficiency for Singapore is not a realistic future. The country's inherent geographical constraints are too great. However, its "30 by 30" vision is a tangible and achievable reality that is already transforming its food landscape.

Housing crisis in Rio de Janeiro

Rio de Janeiro's housing crisis is a direct result of rapid urbanization and a long history of deep socio-spatial inequality. The geography of Rio de Janeiro, with its mix of steep hillsides and expensive coastline, has led to a sharp segregation between segments of the society. For decades, low-income residents, often rural migrants, have been forced to build their own homes in informal settlements known as favelas, typically on precarious land susceptible to landslides and floods. While these communities are often vibrant and self-sufficient, they lack adequate public unfrastructures to suffice sanitation, clean water, and formal waste collection. This persistent lack of basic services, combined with a lack of legal property ownership, leaves residents in a state of constant vulnerability and prevents them from accessing formal credit or government assistance.

Real estate speculation and the city's focus on large-scale, market-driven development projects have consistently overshadowed social housing projects. Events like the 2014 World Cup and the 2016 Olympics led to a multimillion-boom in property prices, driving up rents and displacing low-income residents from centrally located areas. Urban planning in Rio has historically prioritized demolition and relocation over integration and upgrading, often moving favela residents to distant, poorly serviced housing projects on the city's periphery. These actions have not only exacerbated the housing deficit but have also destroyed established communities and severed residents' ties to their jobs and social networks.

A utopian vision for the low-income housing is a complete reversal of their informal status in Rio de Janeiro and fully integrated into the formal city. The legal land tenure, and the access to basic public services (sanitation, water, electricity) is a starting point of departure to a more sustainable city. The unique, vibrant culture and strong community bonds should be preserved and celebrated, not erased by gentrification. A vision of sustainability requires policies where the favelas are not just "fixed" but are recognized as vital, dynamic parts of Rio de Janeiro, contributing to its culture and economy on an equal footing with the rest of the city.

CONCLUSION

The vision of a sustainable city is never neutral, particularly in an age of abundant information and artificial intelligence. The urban sustainability discourse is embedded in political, economic, and cultural systems with contrasting interests and knowledge. Thus, an integrated approach to sustainable urban policymaking must move beyond a simple reliance on technology to address environmental deficits.

The idea that big solutions and their app-based monitoring can solve complex urban problems is close to the vision of the "smart" city. This imaginary sees urban centres as mere metabolic entities that are filled with data and natural resources. A more comprehensive vision requires a nuanced understanding that connects physical infrastructure and technological flows with the social, historical, and imagined aspects of cities. The cases of Mexico, Singapore, and Brazil are an attempt to explore a trivalent study of sustainable policymaking in cities.

If we study the relationships between environmental crises, urban infrastructures, and decision makers, we can better understand how different actors and their discourses shape our collective vision of a sustainable future. This research aims to encourage architects, urban designers, and citizens to explore the size, scale, and networks of infrastructures in the quest for sustainable cities. It promotes a particular lens to analyse ecological problems where policymakers can infuse the argument of environmental justice in their urban projects.

NOTES

[1] "Open Data Platform", Global Footprint Network, accessed September 5, 2025, https://data.footprintnetwork.org/?_ga=2.204826064.1762421636.1757080596-515437318.1752140496&_gac=1.187444954.1757080601.CjwKCAjwlOrFBhBaEiwAw4bYDTdGgyYK4xRssLLDQKqGxEcIewPgPJ0HRNMQZrWsv-L7IJcnyykuuRoCbUcQAvD_BwE#/

[2] Amerigo Marras, "Hybrids, Fusions, and Architecture of the in--Between" in *Eco--Tec: Architecture of the in Between*, ed. Amerigo Marras (Princeton Architectural Press 1999)

[3] Benjamin Sovacool et al. 'New frontiers and conceptual frameworks for energy justice', *Energy Policy* 105 (2017): 677–91.

[4] Gillian Rose "Smart urban: Imaginary, interiority, intelligence" in *The Routledge Companion to Urban Imaginaries*, ed. Christoph Lindner and Miriam Meissner (Routledge 2019),104-112.

[5] Manuel De Landa, "The Nonlinear Development of Cities", in *Eco--Tec: Architecture of the in Between*, ed. Amerigo Marras (Princeton Architectural Press 1999), 23-31

[6] Edward Soja, *Seeking Spatial Justice*, (University of Minnesota Press, 2010).

[7] Manuel Castells, *End of Millennium*, Blackwell Publishers, 1998), 390.

[8] Nestor Garcia Canclini, "Totalizations / Detotalizations," Theory, Culture & Society, 24 no. 7–8 (2007). 298.

[9] M. Carmen Valdez et al. "The Water-Energy-Carbon Nexus: Optimising Rainwater Harvesting in Mexico City", Environmental Processes, volume 3, (2016) 307–323.

[10]"Agriculture", Singapore Country Commercial Guide, accessed September 5, 2025, https://www.trade.gov/country-commercial-guides/singapore-agriculture

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HEAT RESILIENT STREETS: PRIORITISING PEDESTRIAN HEALTH IN HIGH-DENSITY URBAN ENVIRONMENTS

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INTRODUCTION

In Southern European cities along the Mediterranean Sea, extreme heat events are becoming more frequent and more intense.[1] Athens faces increasingly severe environmental challenges, including those associated with climate change, urban heat, and socioeconomic disparities. The city's high-density urban fabric, ageing infrastructure, and limited access to green spaces heighten vulnerability to extreme heat.[2]

The interaction between global climatic shifts and local urban morphology exacerbates the Urban Heat Island (UHI) effect, resulting in sustained temperature differences between urban cores and surrounding rural areas.[3] This is particularly critical in Athens, where impervious surfaces dominate the public realm and where green infrastructure is sparse.[4] Streets represent a major underused public asset that can be leveraged for climate adaptation. Reconfiguring streets as multifunctional spaces, rather than single-use traffic corridors, creates an opportunity to integrate climate resilience into everyday urban life.[5]

This paper develops an integrated spatial diagnosis and design methodology to transform Athens' streets into multifunctional climate-adaptation infrastructure, prioritising pedestrian health. This paper presents a method for diagnosing urban heat exposure, identifying priority sites for intervention, and implementing design strategies. Unlike existing studies on urban heat mitigation, this research develops an operational framework that translates theory into tangible strategies for testing and iteration by linking spatial data analysis, environmental modelling, and street-level design.

Physical Drivers of Urban Heat in Athens

The intensification of urban heat in Athens is closely linked to its rapid post-war expansion. Driven by urgent housing demands and economic restructuring, urban development prioritised concrete construction and vehicular access over ecological preservation. This process led to the covering of natural watercourses, insufficient allocation of green spaces and tree canopy cover, and streets designed primarily for vehicular movement. Consequently, Athens' urban form amplifies the urban heat island (UHI) effect, whereby urban areas experience significantly higher temperatures than surrounding rural zones due to human activity and heat-retaining built surfaces.[6] Athens' physical environment is characterised by narrow, densely built streets, with impervious surfaces predominating. These materials absorb large amounts of solar radiation during the day and re-emit it

as longwave radiation at night, prolonging heat exposure and creating a thermal "trap" that intensifies the UHI effect. The compact, high-density urban fabric further limits airflow and heat dissipation. High-rise *polykatoikia* residential blocks exacerbate this condition by absorbing and reflecting solar radiation, which is reradiated into the urban atmosphere, raising ambient temperatures. The narrow street widths, coupled with limited open space for trees or vegetation, impede natural cooling mechanisms such as air circulation and evapotranspiration, a process essential for moderating urban heat.[7]

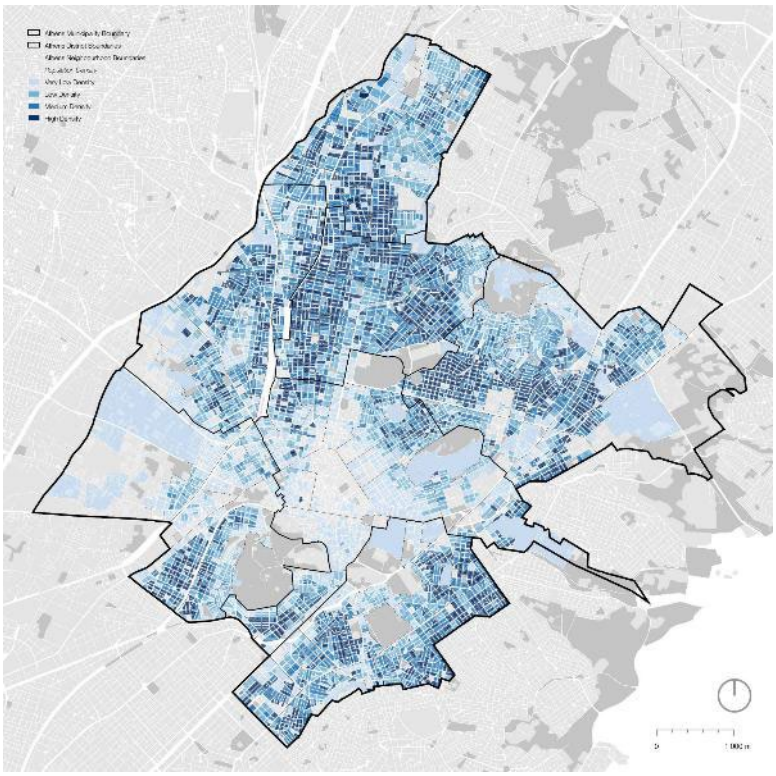


Figure 1. Population Density of the Municipality of Athens, Census 2011.

Green space reduction diminishes evapotranspiration, the process by which plants release water vapour into the air, producing natural cooling effects.[8] The city's dependence on impermeable surfaces, including roads, parking lots, and buildings, increases surface runoff and heat retention, exacerbating thermal stress.[9]

Densely populated neighbourhoods experience the highest surface temperatures. Due to their spatial composition, these areas intensify residents' exposure to extreme heat during heatwaves.[10] The lack of accessible cooling areas places disproportionate strain on public health, especially among vulnerable populations such as the elderly, children, and those with pre-existing health conditions.[11] In contrast, neighbourhoods with greater access to green spaces exhibit lower surface temperatures due to the cooling effects of vegetation. However, green spaces are unevenly distributed throughout the city, leaving many densely populated districts underserved and more vulnerable to heat-related risks.[12]

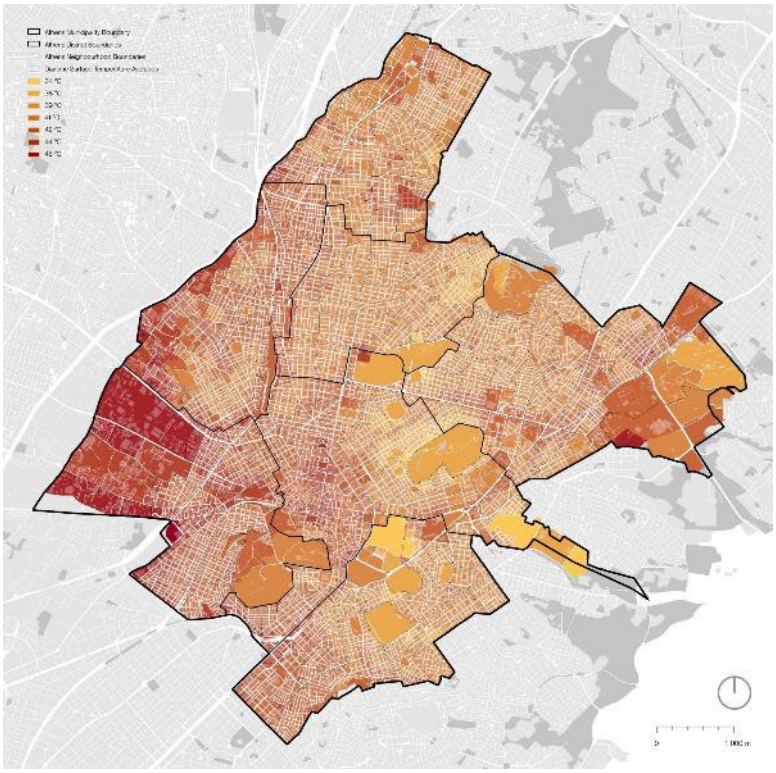


Figure 2. Mean Daytime Surface Temperature 2016 - 2020, City of Athens Geoportal.

Across the municipality, Athens' street tree density is fewer than two trees per 100 linear meters; this condition is critically low, especially in comparison with other capital cities like Paris with 4.9 trees, Buenos Aires with 9.9 trees, or Washington D.C. with 7.3 trees per 100 meters.[13] This scarcity undermines shading and evaporative cooling, particularly in areas most affected by heat.[14] The uneven spatial distribution of street trees and limited overall green space contribute to thermal disparities across the city. Expanding green infrastructure, such as street trees, green roofs, and urban parks, offers significant potential to reduce surface temperatures.[15] Trees shade surfaces, reduce heat absorption, and cool the air through evapotranspiration, directly lowering ambient temperatures.[16] Moreover, green spaces contribute to water management by absorbing rainwater and promoting soil moisture retention, facilitating additional cooling through evaporation.[17]

Spatial analysis of satellite imagery from 2016 to 2020 reveals that surface temperatures peak in western Greater Athens, where heat-retaining materials, such as concrete and asphalt, predominate. Conversely, large green spaces exhibit substantially lower surface temperatures, underscoring the critical role of vegetation in cooling.[18] Further analysis highlights inequities in green space availability: only 0.96 square meters of green space are allocated per resident of the Municipality of Athens, a figure well below the World Health Organization's recommended range of 9 to 50 square meters per person.[19]

Climate Goals of the Current City Administration

The Municipality of Athens adopted a Climate Neutrality Action Plan to achieve net-zero emissions by 2030. While the Climate Neutrality Action Plan sets ambitious targets, our spatial analysis indicates that achieving them in high-density districts would require a substantial reallocation of parking spaces.

Key strategic actions include the large-scale planting of 35,000 new trees across the city to expand canopy cover, enhance carbon sequestration, and improve microclimatic conditions.[20] In tandem, the

municipality aims to reduce vehicular traffic volumes by 50 per cent, thereby decreasing emissions, reducing heat generated by traffic, and reclaiming public space for non-motorised users. Complementing these measures is the creation of a network of cooling corridors: linear green and blue infrastructure corridors designed to facilitate airflow, reduce surface temperatures, and improve pedestrian thermal comfort.[21]

These objectives are supported by frameworks such as the Athens Resilience Strategy, which provide policy coherence, financing mechanisms, and cross-sectoral coordination.[22] Effectively leveraging streets as multifunctional spaces requires a paradigm shift in urban planning away from prioritising vehicle movement and towards pedestrian health.[23]

Urban Heat and Public Health in Athens

Urban heat poses a substantial public health threat in Mediterranean cities such as Athens, where summers are prolonged and hot. Average daily maximum temperatures in July and August frequently exceed 33 °C, with peaks exceeding 40 °C.[24] The frequency and duration of heatwaves have increased in recent decades and are projected to continue rising under climate change scenarios. Built surfaces store heat during daylight hours and release it gradually at night, elevating nocturnal temperatures by up to 4 °C above surrounding rural baselines.[25] In Athens, high building density, limited vegetation, and extensive impervious surfaces contribute to elevated surface temperatures. Minimal night-time cooling prolongs heat stress, disrupts sleep, and heightens risks, especially during multi-day heat events.[26]

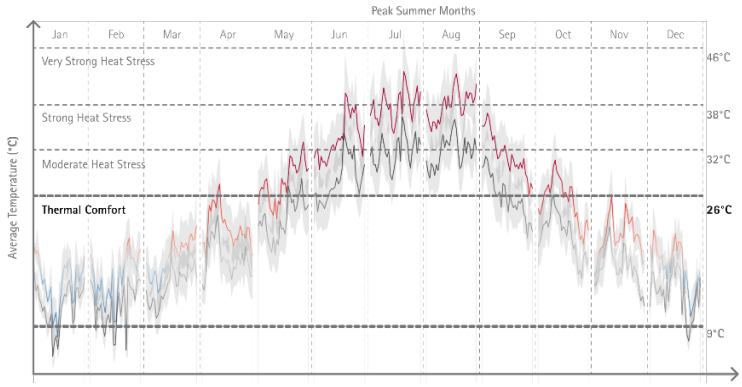


Figure 3. Annual Average Temperature in the Municipality of Athens, 2020 and 2100, IPCC.

Health impacts are most severe for vulnerable populations, including older adults, young children, and individuals with pre-existing medical conditions. These groups typically exhibit reduced physiological heat tolerance, restricted mobility, and limited access to adaptive resources such as air conditioning or shaded outdoor environments.[27] In Athens, residents aged 65 and over represent 21% of the population, with many living in older housing stock characterised by poor thermal performance.[28] Heat-related illnesses span a spectrum, ranging from mild to life-threatening conditions, including heatstroke and cardiovascular events. Epidemiological studies in Athens have linked extreme heat episodes to increased hospital admissions and excess mortality.[29] During the 2007 European heatwave, Greece experienced a 16% increase in mortality, with the highest incidence in densely populated urban areas.[30]

Climate projections for Athens indicate that by 2050, the city could experience more than 30 days annually with maximum temperatures above 35 °C, compared with a current average of approximately 17 days. [31] Without adaptation, these changes will exacerbate health risks and deepen existing social inequities.[32]

Streets as Climate Adaptation Infrastructure

Reconfiguring Athens' public streets to prioritise pedestrian use and environmental sustainability offers a direct, scalable approach to mitigate urban heat stress and enhance climate resilience. Streets, traditionally designed as corridors for vehicular traffic, can be transformed to provide shade, manage stormwater, improve air quality, and support thermal comfort.[33]

Vegetative shading, achieved through the strategic planting of street trees, the installation of green walls, and the use of climbers on building façades, can substantially lower surface temperatures by blocking direct solar radiation and facilitating evapotranspiration.[34] Empirical studies show that shaded urban areas can experience temperature reductions of up to 8°C compared to unshaded asphalt surfaces, significantly improving pedestrian comfort and reducing heat-related health risks.[35]

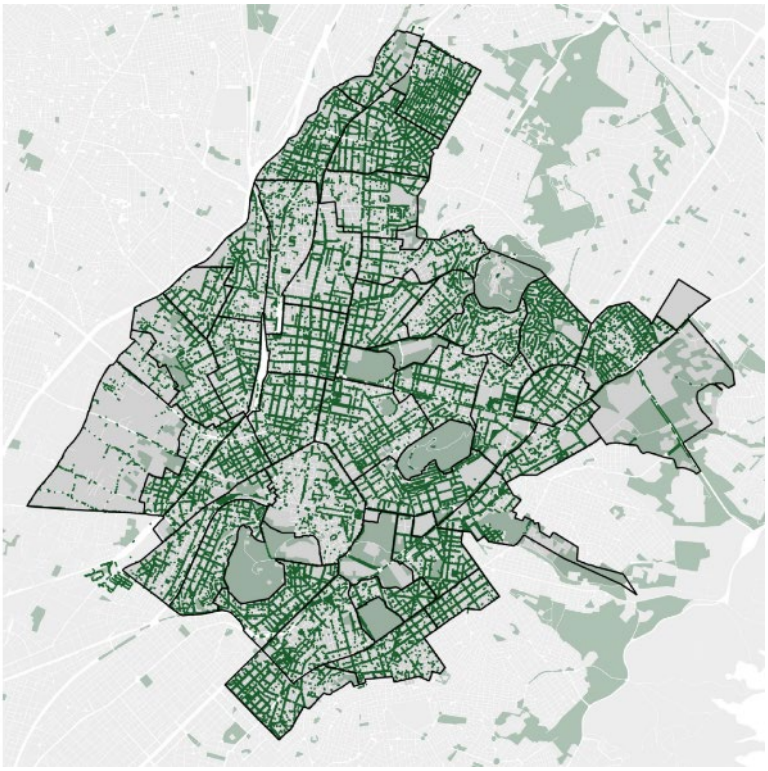


Figure 4. Current Street Tree Planting (91,117) in the Municipality, 2021, City of Athens Geoportal.

In addition to shading, the incorporation of permeable surfaces enables stormwater infiltration and retention, thereby mitigating surface runoff and contributing to localised cooling through evaporation. Retained stormwater can sustain vegetation during dry periods, supporting long-term canopy health and climate-adaptation benefits.[36] The use of reflective and high-albedo materials on pavements and street furniture reduces radiant heat loads by reflecting a greater proportion of solar energy.[37] When combined with shaded walkways, these materials enhance pedestrian thermal comfort, thereby encouraging active mobility and reducing reliance on private vehicles. This shift supports broader environmental and public health goals, including reductions in air pollution and greenhouse gas emissions, as well as the promotion of more active lifestyles.[38]

Streets become cooler, more inviting public spaces that promote health equity and urban resilience. The integration of climate adaptation into street design aligns with the Municipality's broader vision for a climate-neutral Athens, positioning the public realm as a frontline defence against rising temperatures and heat-related vulnerabilities.[39]

METHODOLOGY AND SPATIAL DIAGNOSIS

This study develops an integrated spatial diagnosis and design methodology to transform Athens' streets into multifunctional climate-adaptation infrastructure, prioritising pedestrian experience. The methodology is operationalised through four interconnected components: a spatial analysis framework for extracting street-level climate and pedestrian-experience insights from open data sources; methods for prioritising streets for targeted interventions; site-specific solutions simulated in the case-study neighbourhood of Kypseli; and scalable street-design strategies for heat resilience.

Spatial Analysis Framework

This study employs an integrated spatial and analytical methodology to directly support Athens' Climate Neutrality Action Plan and related resilience strategies. The approach combines geospatial analysis with environmental scenario modelling to identify, evaluate, and prioritise street-level climate adaptation interventions.

The process begins with the creation of a comprehensive Urban Analysis Database. Data sources include GIS-based data from the Municipality GIS department, satellite imagery, and the OASA transportation database. Key indicators compiled in the database include land surface temperature, vegetation cover, impervious surface ratio, land use classification, mobility flow patterns, and access to public amenities. These indicators are georeferenced and mapped onto Athens' street network to generate a spatially explicit diagnosis of urban environmental conditions.

Analytical and modelling tools such as Python, QGIS, and the Ladybug environmental plugin are used to simulate microclimatic effects and visualise projected performance outcomes. These simulations quantify potential reductions in peak surface temperature and improvements in pedestrian comfort scores under various design scenarios.[40] Due to delays in the release of updated demographic data, the analysis relies on representative case-study neighbourhoods, including Kypseli, that reflect a range of densities, street morphologies, and social profiles. While this ensures that the current findings are contextually relevant and scalable, incorporating updated demographic data, specifically on the most recent income distribution, age structure, and household size, will strengthen future vulnerability assessments.

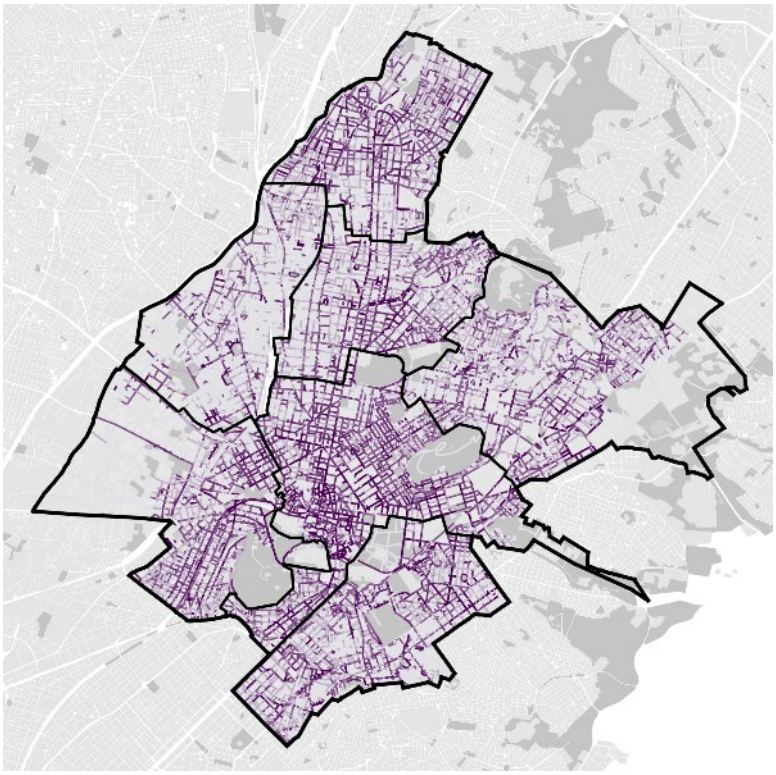


Figure 5. Sidewalk Quality Analysis in the Municipality of Athens, NFI 2024 Cohort.

Street Prioritisation Framework

Following the development of the spatial analysis framework, a weighted centrality framework is applied to identify corridors of high pedestrian significance, with priority given to those in proximity to targeted land uses, such as schools, healthcare facilities, transit stops, and public parks. Network centrality refers to the potential of pedestrian trips based on the underlying street network structure and connections.[41] In this case study, the centrality model for street analysis is weighted to emphasise routes that connect to socially crucial destinations, ensuring that corridors link sensitive land uses and are prioritised in the intervention pipeline.

These corridors undergo further assessment using the Universal Thermal Climate Index (UTCI), calculated through the UMEP (Urban Multi-scale Environmental Predictor) package in QGIS. This assessment enables a theoretical simulation of baseline microclimatic conditions and pedestrian comfort, particularly during peak summer periods. The analysis is complemented by the Cityseer package, which links spatial network metrics with environmental and socio-economic data to enhance street prioritisation. Together, these tools highlight areas with the highest heat exposure.

Intervention prioritisation is conducted using a multicriteria decision framework that ranks candidate sites based on vulnerability, impact, and feasibility. While quantitative metrics from the Spatial Analysis Framework form the foundation, this prioritisation framework is explicitly designed as a collaborative decision-support tool rather than a deterministic model. This ensures that the final priority outputs reflect objective environmental performance deficits and locally identified needs.



Figure 6. Street Prioritisation for Walking Routes in the Municipality of Athens, NFI 2024 Cohort.

Kypseli Neighbourhood Case Study

The methodology for developing the spatial analysis framework and prioritising streets is tested to explore site-specific solutions for the Kypseli neighbourhood case study. By applying these principles to real-world scenarios.

Kypseli is one of the most densely populated neighbourhoods in Athens, with approximately 32,000 residents per square kilometre. This residential population density is nearly double the citywide average of 17,000 residents/km². The area consists primarily of narrow residential streets framed by post-war *polykatoikia* apartment buildings, typically six to seven stories in height, with minimal setbacks and negligible private garden space. This continuous building frontage limits opportunities for vegetation at the parcel scale and contributes to elevated local heat retention.

Typical street widths range from 6 to 8 meters, configured for one lane of vehicular traffic and two lanes of on-street parking. This spatial arrangement leaves only narrow sidewalks, severely restricting the potential for tree planting. Current street tree density in Kypseli averages two trees per 100 linear meters, which is significantly below the minimum recommended for Mediterranean climates to achieve meaningful cooling benefits.

Spatial reallocation of even a modest proportion of this space to green infrastructure could yield substantial environmental and social gains. Modelling scenarios show that a 5% reduction in on-street parking would enable the planting of approximately 1,815 additional street trees. A more ambitious 25% reduction would accommodate over 9,000 trees, effectively more than doubling canopy coverage and substantially increasing neighbourhoods' cooling potential.

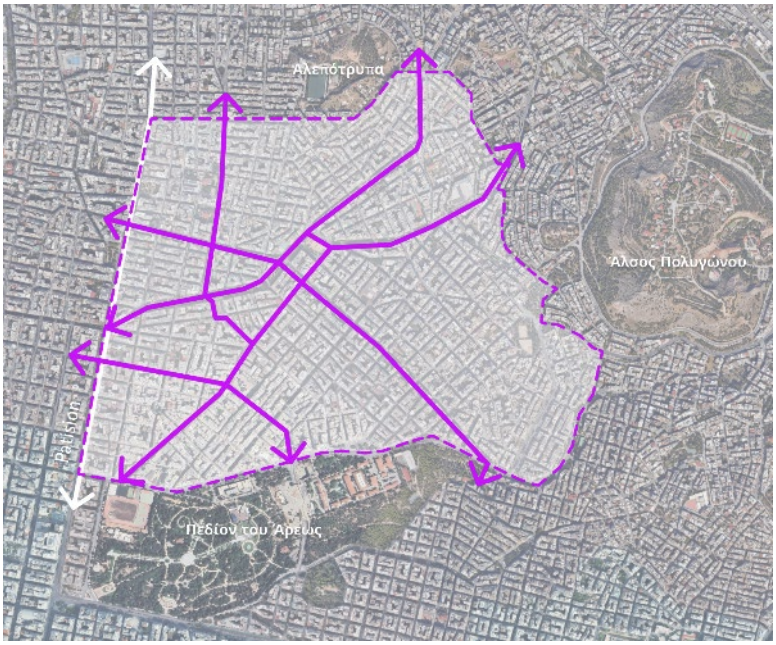


Figure 7. Prioritising Streets for Tree Planting in the Kypseli neighbourhoods, NFI 2024 Cohort.

Intersection analysis indicates that 42% of Kypseli's four-way intersections have sufficient unbuilt space to incorporate green infrastructure without materially affecting traffic operations. Additionally, the neighbourhood's irregular street grid produces 17 triangular intersections. These sites are frequently underutilised and could be repurposed for small-scale cooling interventions such as shaded seating nodes, stormwater planters, or rain gardens, without disrupting existing traffic patterns.

The Universal Thermal Climate Index (UTCI) assessment confirms that Kypseli experiences high levels of heat stress during the summer, with the most severe conditions occurring in July and August. Notably, the zones with the highest pedestrian activity often coincide with the lowest levels of tree cover, thereby compounding the exposure risk for residents and visitors.

Kypseli's combination of extreme density and high pedestrian use makes it a priority location for climate adaptation and an area where interventions can deliver significant impact. Targeted reallocation of public space from vehicular storage to vegetation and pedestrian use offers measurable improvements in thermal comfort, reductions in heat-related health risks, and overall enhancement of neighbourhood liveability.[42]

Design Strategies for Heat-Resilient Streets

This section builds on the integrated spatial diagnosis and methodology by presenting the final stage: scalable street design strategies for heat resilience. These strategies will translate insights from spatial analysis, prioritisation, and the Kypseli neighbourhood case study into tangible interventions that reframe Athens' streets as multifunctional climate-adaptation infrastructure and enhance pedestrian well-being.

To mitigate the impacts of extreme heat and improve public health outcomes, Athens must transform its street network through a coordinated approach that incorporates spatial, environmental, and social strategies. In Kypseli, streets account for more than 31% of the total land area, making them the largest category of public space. Reframing streets as both ecological and social infrastructure, rather than solely as vehicle corridors, is central to the district's climate adaptation.

Street configuration strongly influences the local microclimate and pedestrian experience. Kypseli's network is dominated by narrow, single-lane streets, primarily of two types:

Type A: parking on both sides.
Type B: parking on one side.



Figure 8. Common Types of Streets in the Kypseli Neighbourhood, NFI 2024 Cohort.

Both configurations present clear opportunities for intervention. Reducing parking is among the most effective means of expanding green infrastructure and reducing vehicular dominance. The neighbourhood currently contains an estimated 12,114 on-street parking spaces. A 5% reduction provides sufficient space to plant approximately 1,815 trees; a 25% reduction allows for more than 9,000 trees, effectively doubling the existing tree count and significantly improving thermal comfort.

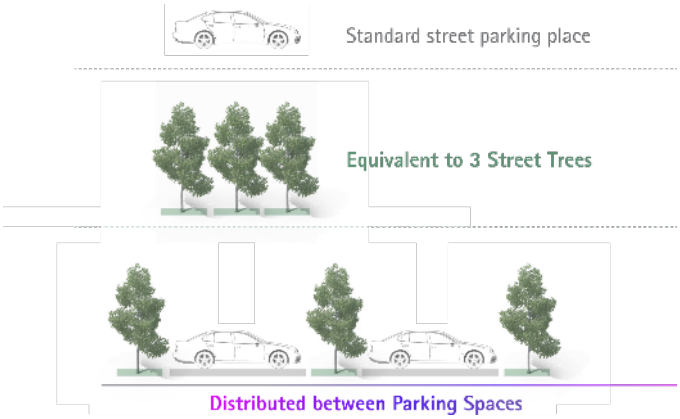


Figure 9. Standardising the Removal of Street Parking for Tree Planting, NFI 2024 Cohort.

Streets also contain critical nodes of opportunity. Kypseli has 593 four-way intersections, many of which are compromised by substandard pedestrian infrastructure and illegal parking. Approximately 42% are suitable for transformation. Introducing trees, shade structures, accessible pathways, and water-sensitive design elements at these intersections could yield nearly 2,000 additional trees. When designed with safety and resilience in mind, these locations can serve as comfortable, socially active spaces.

A distinct spatial typology within Athens is the triangular intersection, formed by the city's irregular street grid. Kypseli contains 17 such sites, generally paved and surrounded by parked cars with

minimal public function. Reclaiming these residual spaces could accommodate approximately 204 new trees. Their compact footprint, unique geometry, and low impact on traffic flow make them ideal candidates for early-stage pilot interventions, with strong potential for inclusive public use.

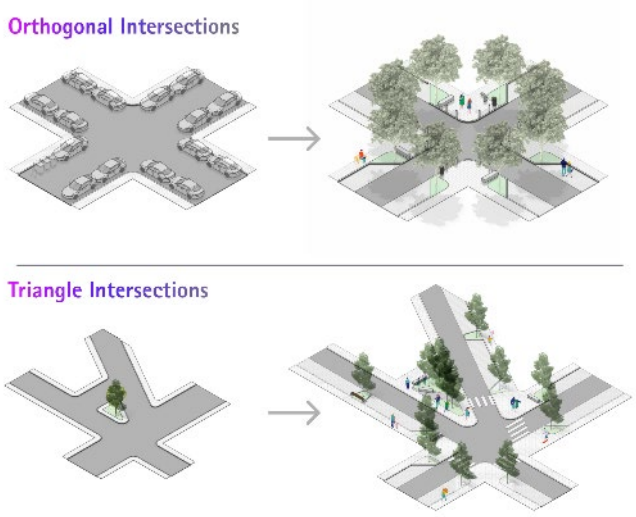


Figure 10. Common Orthogonal & Triangular Intersections, Kypseli Neighbourhood, NFI 2024 Cohort.

Organising interventions according to the physical typology of streets, intersections, and triangular nodes enables the development of targeted and replicable strategies. Kypseli can function as a scalable pilot for heat-resilient street transformation, aligning with municipal climate objectives while improving environmental performance and social equity. In the context of rising temperatures and ageing infrastructure, treating streets as climate infrastructure is essential to protecting public health and strengthening urban resilience.[43]

CONCLUSION

This paper presents an integrated spatial diagnosis and design methodology to transform Athens' streets into multifunctional climate-adaptation infrastructure, prioritising pedestrian health. The approach combines three key steps: diagnosing urban heat exposure, identifying priority sites for intervention, and implementing design strategies. This research advances an operational framework to link spatial data analysis, environmental modelling, and street-level design strategies, translating theory into tangible, testable actions for the Municipality of Athens.

Athens faces a critical and escalating challenge from heat exacerbated by its uneven distribution of green spaces. Addressing heat is crucial for safeguarding public health, particularly among vulnerable populations disproportionately affected by heat stress. This study highlights the pivotal role of streets, which constitute the city's most extensive and accessible public space in high-density environments, as key sites for climate adaptation interventions. By reframing streets as multifunctional climate infrastructure, Athens can effectively leverage strategies to mitigate urban heat.

The integrated methodology facilitates context-sensitive interventions tailored to the specific urban morphology. The case study of the Kypseli neighbourhood demonstrates that strategic reallocation of parking spaces for tree planting, targeted replacement of heat-absorbing surface materials, and the incorporation of water-sensitive urban design can yield measurable reductions in temperatures, thereby improving pedestrian comfort and liveability.

Aligning these interventions with the Municipality of Athens' Climate Neutrality Action Plan ensures coherence with policy objectives, maximises resource efficiency, and supports the city's broader goals

of reducing emissions, increasing green infrastructure, and enhancing social equity. More broadly, these street-level transformations offer scalable and replicable models for other Mediterranean cities confronting similar climatic and urban challenges, demonstrating the potential for urban design to serve as a frontline defence against rising temperatures.[44]

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BLUE URBANISM: REINVENTING THE ROLE OF URBAN PONDS IN ENHANCING SOCIAL CONNECTIONS

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INTRODUCTION

Urban landscapes are increasingly recognizing the value of natural elements. The importance of urban ponds in this respect is multifaceted as they are distinct features that can add value to urban spaces in various dimensions. These water bodies do not only have environment value, but also hold the promise of contributing to community relations and social interaction. This paper analyses the complex social relations that urban ponds are inherently tied to, aiming at understanding how these water features may be creatively incorporated within the overall design of the urban fabric to improve social life of the community. Urban ponds offer benefits such, as mitigating heat in cities and providing habitats. However social opportunities that they can provide are often. Underutilized by communities.

This study aims to investigate how various factors influence interactions, around ponds to bridge the existing knowledge gap effectively and comprehensively delve into the essential design principles and programming techniques that facilitate the creation of vibrant urban pond spaces, with strong social connections by analyzing a wide range of literature sources and real world examples of urban pond initiatives as well as conducting empirical research. By grasping the relationship, between the layout of cities and how people interact within them alongside environmental influences this study aims to create a set of urban planning tactics that empower city planners, designers and community leaders to utilize the power of urban ponds, as drivers of social bonding and community welfare.

Need for the study

The increasing urbanization and globalization have led to a decline in social cohesion, a sense of belonging, and community engagement. Well-designed urban ponds can create spaces for community gatherings, fostering a sense of belonging and shared identity. Urban ponds, in the context of Kerala, can be repurposed or newly created to provide much-needed green spaces for urban dwellers. By restoring and revitalizing these water bodies, we can preserve our heritage and ecological balance. This research can identify best practices for integrating urban ponds into the urban fabric, with improved social connections. Indian Smart City guidelines recognize the necessity of mitigating the increasing social detachment and intolerance by promoting social interactions and creating open spaces, a key feature of holistic urban development. Urban ponds can be integrated into smart city plans to enhance urban resilience, biodiversity, and social well-being. This study also aligns strongly

with several Sustainable Development Goals (SDGs), particularly those focused on economic growth, inequality reduction, sustainable cities, life on land, life below water and peace, justice, and strong institutions.

Aim

To develop a comprehensive framework of urban design strategies for the effective integration of urban ponds into urban spaces to enhance social connections.

Objectives

1. Identify parameters that foster social cohesion in an urban public space.
2. Analyze how the parameters identified influence usage of urban ponds and related public spaces.
3. Develop a design framework to enhance social cohesion in such waterfront public space.

Limitation

1. Inherently subjective, social cohesion is very difficult construct in many ways to measure.
2. There are several types of public open spaces on the waterfront, most happen to be different in scale, location, and surrounding metropolitan environment. Hence design concepts may be exhibiting contextual variability.
3. Economic, cultural, and policy variables also influence social cohesion variables. These external factors are uncontrollable.
4. Measuring the influence and effects of design strategies over the problem of social cohesion at the interface necessarily takes time and is also difficult to gauge in the long run.

Research Methodology

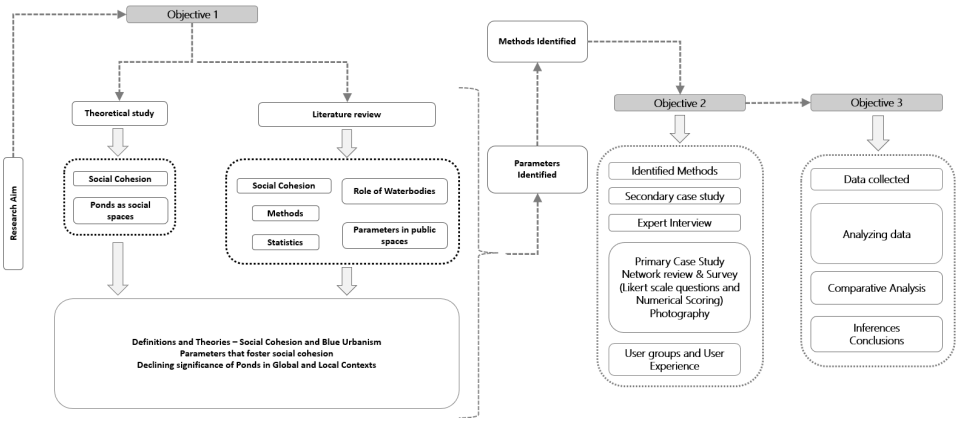


Figure 1. Research Methodology

THEORETICAL PREMISES

Social cohesion refers to the unity and solidarity within a group or society. It involves the characteristics and dynamics that keep a group functioning effectively as a unit to meet common goals. It is in the bonds that unite members of a society or group, fostering a sense of belonging, trust, and shared values. It is often described as the “glue” that holds communities together, promoting stability and resilience against social fragmentation.

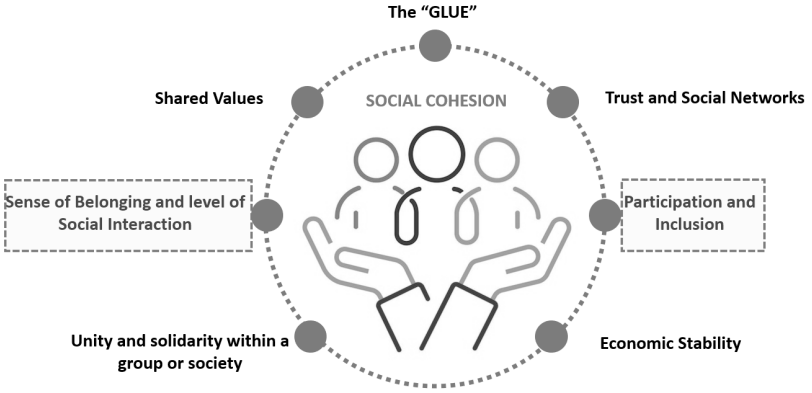


Figure 2. Social Cohesion

Émile Durkheim, a French sociologist. Durkheim established the academic discipline of sociology, introduced the concept of social cohesion in his work 'Suicide' (1897).[1] Judith Maxwell is the founding president of the Canadian Policy Research Networks. Maxwell's definition: social cohesion focuses on the growth of shared values and communities that interpret collective experiences. She highlights the importance of reducing disparities to foster a sense of community engagement and shared challenges.

According to Nicola Dempsey (Director of Research and Senior Lecturer at Department of Landscape Architecture, University of Sheffield), increasing the physical quality of streets and public spaces as well as how users perceive them should be the main goals of neighborhood regeneration, urban planning and design policy.

Concept of blue urbanism was introduced by Timothy Beatley in 2005, with a focus on the integration of urban development with marine environments.[2] Blue urbanism approach is such that 'we are all connected on the blue planet' and is also closely linked to E. O. Wilson's concept of biophilia.

PONDS: A MICROCOSM FOR SOCIAL EQUITY

Ponds, as bodies of water within urban and rural landscapes, offer a unique opportunity to study the interplay between physical environment, social interaction, and community well-being. They are the communal hearts of neighborhoods, drawing people together in celebration, connection, and shared experiences.

Large water bodies like oceans, rivers and lakes offer grand vistas, promote tourism and provide recreational opportunities, but are only accessible to people living in close proximity to such special water bodies. However, ponds located within neighborhoods or communities can help create sense of ownership. They are more accessible to a wider range of people, especially those with limited mobility or resources. Smaller scale of ponds would promote more intimate interactions and stronger sense of community, engaging communities in pond restoration. Man-made ponds are also created for aquaculture, flood control, water conservation etc. with better control and management and safety, making them versatile additions to backyard gardens and large public parks alike.

Reflecting Kerala's past: social significance of ponds

Ponds were not just water bodies but integral parts of Kerala's social fabric. They were places of worship, recreation, and community building, reflecting the deep connection between people and water. They were vital social gathering spaces, fostering community bonds and cultural exchange. Ponds, often associated with temples and religious practices, therefore testify to community devotion and socio-religious hierarchy. Hence Padmatheertham, connected with the Sree Padmanabhaswamy

temple, was not only a source of water but a sacred place embodying the socio-cultural identity of Thiruvananthapuram. The gathering places around ponds facilitated communal gatherings for rituals and festivals, consolidating and nurturing social bonds. The upkeep of the various water bodies usually involved the combined efforts of the community members, constructing a sense of unity amongst the people and thus assuring collective responsibility. The community aspect was very vital in maintaining social order and cultural continuity.

Ponds also supported local economies. Ponds were not just water bodies but integral parts of Kerala's social fabric. They were places of worship, recreation, and community building, reflecting the deep connection between people and water. They brought communities together. The periodic maintenance of these ponds was often tied to local festivals, such as the Murajapam festival, reinforcing their role as centers of communal activity. These events facilitated social bonding and collective participation in cultural heritage. Ponds in Kerala have been prominently featured in various literary, artistic, and cinematic works, reflecting their cultural significance and aesthetic appeal.

IDENTIFIED PRAMETERS

The study began with the review of a literature that consisted of academic papers, books, and articles. This provided the theoretical part of this thesis regarding the topics of social cohesion and blue urbanism, which included what they meant, their history, and how they are practiced today. This study examined in-depth the determinants of social cohesion, what public space can provide for social interaction, and how blue spaces may be used to increase well-being within a community.

The parameters for analysis, which are produced by synthesizing many concepts and literature, enable a comprehensive understanding of the various points of view within the research. In this respect, empirical data collection has been done through qualitative and quantitative techniques from a mixed-method approach. Design and management insights into urban ponds have come from in-depth interviews with town planners and engineers of the irrigation department of Kerala. A comparative analysis was conducted to outline similarities and differences among the case studies, allowing for an understanding of the elements of success and failure in each project related to ponds in urban areas and elaborating on a series of design principles applicable for future projects.

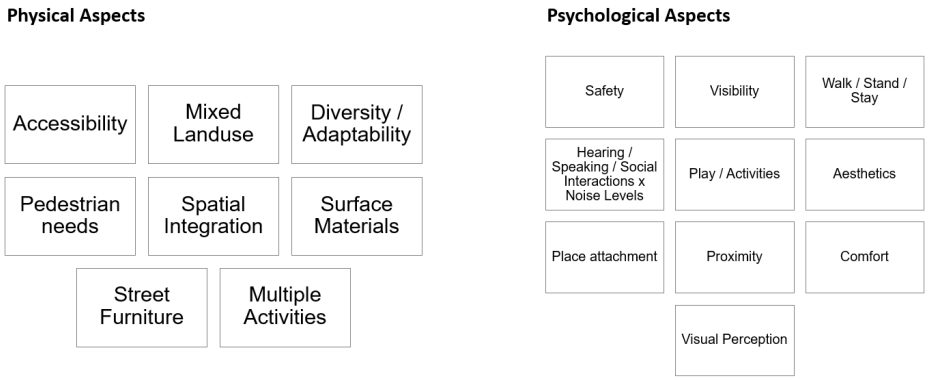


Figure 3. Identified Parameters

COMPARITIVE ANALYSIS
Secondary case study

Parameter	Moravian Square Park	Rajokri Lake Rejuvenation Project	Inference
Accessibility	Multiple access points Soft edges and pedestrian-friendly	Two access points Walkable	Soft edges and more access points from different edges preferable
Mixed Landuse	A combination of residential, commercial, and recreational spaces paving way for a mixed-use development. The park itself serves as a vibrant community hub, offering green spaces, playgrounds, and walking paths. Surrounding the park are various residential buildings, shops, restaurants, and cultural venues.	Doesn't strictly adhere to a mixed-use development model. The project's integration of ecological, recreational, and community functions demonstrates a holistic approach to urban development	Integration of different land uses creates a lively and dynamic environment, promoting social interaction and economic activity
Diversity / Adaptability	High degree of diversity and adaptability with community spaces, play areas and other flexible spaces.	The project supports Wetlands, Lakes/ponds, Rain Gardens, Pocket parks in itself.	Space should be a diverse and adaptable hub
Spatial Integration	Seamless Integration which respects the historical character of the square, preserving existing elements 		Space should be seamlessly integrated
Pedestrian Needs	Prioritizing pedestrian access and connectivity between different land uses encourages social interaction and fosters a sense of community.	Walking paths, seating areas, and an amphitheater are strategically placed around the lake, inviting people to engage with the natural environment.	Prioritize pedestrian comfort and safety

Surface Materials	The pathways are paved with natural stone, providing a timeless and durable surface that blends well with the surrounding environment. Grassy areas offer a soft and inviting surface for relaxation and play, contributing to the park's green character. Concrete and steel is used for other structural elements.	Natural styles of landscape design Preservation of historic traditions.	Utilize a variety of surface materials Textured surfaces can improve traction
Street furniture	The park features a variety of seating elements, such as individual chairs, benches, and picnic tables, providing flexibility for different needs and group sizes. The large, curved bench surrounding the central arena creates a sense of enclosure.	Proper lighting fixtures were installed to illuminate the pathways, the lake, and key features of the park. Clear and informative signage was used to guide visitors, provide information about the project, and promote responsible behavior	Weather-resistant, and easy to maintain elements in design preferable. Promote wayfinding and proper signages. Ample lighting to ensure safety at night.
Multiple Activities		Supports multiple recreational activities as well as cultural and social activities. Venue for festivals	A vibrant and inclusive environment, encouraging social interaction

Table 1. Comparative Analysis of Secondary Case Study

Primary case study

Parameter	Vanchikulam, Thrissur	Pallikulam, Thrissur	Inference
Accessibility	Prominent access points Supports walkability	Poor access points	Prominent, Visible and safe access points required
Mixed Landuse	Prominent, Visible and safe access points required	Context: Residential areas, Retail / Commercial areas and complexes	Mixed-use surrounding can significantly enhance the quality and vitality
Diversity / Adaptability	Design composed of a variety of seating options, OAT, meeting space, birdwatching tower	–	Variety of uses, inclusive environment, encouraging physical activity
Spatial Integration	Potential to improve visibility Navigation / Wayfinding issues	Poor visibility and integration	Visible sightlines enhance safety, social interaction
Pedestrian Needs	Supports walkability. Can be made more inclusive	Not pedestrian friendly	Well-maintained sidewalks, ample shade, and clear wayfinding signages needed.
Surface Materials	Wood and permeable pavement Concrete, Wall art	-	Consider factors such as climate, foot traffic. Permeable paving.
Street furniture	Variety of seating options are available.	No street furniture or pedestrian infrastructure	Should be designed to be accessible to people of all abilities
Multiple Activities	Limited. (Potential to provide integrated activities)	- (Underutilized and dilapidated premises)	Integrated or related activities in close proximity can be highly beneficial

Table 2. Comparative Analysis of Primary Case Study

ANALYSIS AND INFERENCE

From these inferences, the vision of a dynamic, inclusive, flexible blue urban area unfolds. Intrinsically, this concept fosters social contact and togetherness. Evidence shows that attention is paid to smooth edges, mixed uses of land, and comfort for pedestrians. Including a variety of land uses allows for the encouragement of diverse relationships between individuals from different origins. This diversity can close social gaps and give more of a sense of community. The request to make navigation easy and intuitive underlines the importance of wayfinding and signage, especially for people with disabilities. Adequate lighting and clear lines of vision support a safe and secure environment, and active use at night. Inclusive design enables all users, regardless of ability, to access

the space, minimizing social isolation and fostering inclusivity. This would ensure that all people feel included and are able to participate fully in community life. The design shall focus on multiple access points and clear sightlines with the aim of encouraging exploration, social interaction, and a sense of security.

Urban design strategies

Accessibility

If the pond space is located within a large open area, multiple access points leading to the pond is preferable. In case of a pond that is isolated, bounded by streets or within a private land parcel; consider pedestrianization, opening it up to the public by creating pedestrian-only zones. Access to pond to promote active as well as passive participation with the landscape is encouraged.

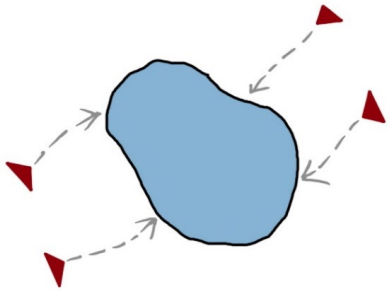


Figure 4. Accessibility

Mixed Landuse

The public space proposed around a pond should ideally be located within a context of mixed land use, to promote diverse user groups and activation.

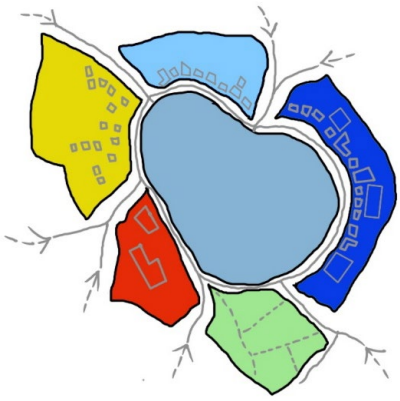


Figure 5. Mixed Landuse

Diversity / Adaptability

Consider designing flexible spaces instead of a fixed design for a designated use. This will help the pond and its premises to be utilized, even with the changing needs of people as time passes.

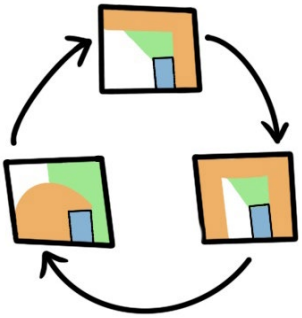


Figure 6. Diversity / Adaptability

Pedestrian needs and Safety

Safe and walkable urban pond spaces will attract a wide range of users

Multiple activities

Diverse activities that can coexist utilizing the pond may be considered, especially those which foster intergenerational and intercultural interactions.
Symbiotic activities foster an interaction between people, the environment, and the built.

Spatial Integration

Consider both integration of the design elements as well as the integration of activities. Ideally, the activities and spaces designed should be symbiotic, instead of several stand-alone design interventions that cater to small isolated user groups.
Designing the space to connect with adjacent neighborhoods can promote support local businesses, pedestrian traffic and with the urban fabric in general, with value added connections.

Surface materials

Natural landscape elements and permeable paving combined with disability- friendly pathways

Street furniture

The placement of elements should not only cater to diverse needs but also preferably be oriented towards the active zones, promoting active or passive engagement. Shared facilities like public restrooms, bike racks, and charging stations can be introduced.

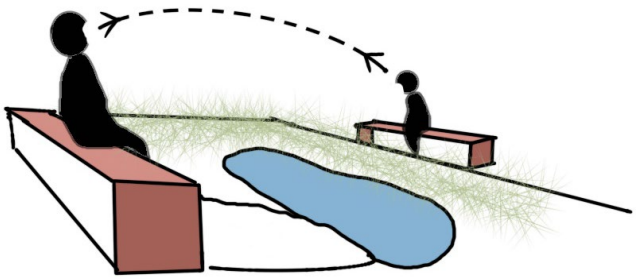


Figure 7. Diversity / Adaptability

Edges
Soft edges that invite people to spaces, ideally public zones, abutting it.

Visibility
Avoid visual barriers and encourage visible sightlines, with seamless integration and transitions.

Walk / Stand / Stay
Encourage diverse options

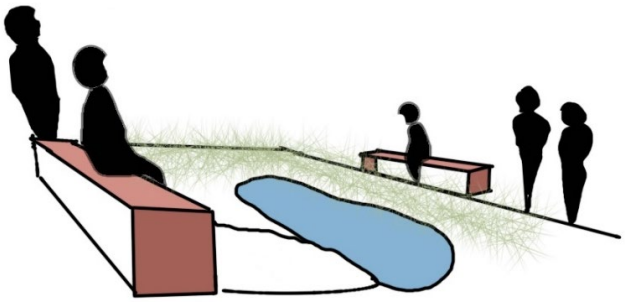


Figure 8. Options to choose

Noise levels
Ideally, controlled noise levels preferred to encourage social interactions. Natural buffers and other calming measures may be utilized in design.

Play / Activities
Child-friendly design interventions that evoke a sense of curiosity and play helps keep the space vibrant and active for a longer period.

Aesthetics, Comfort and Visual Perception
The element of water should be effectively utilized. Experimenting with aesthetic quality like mirror effect, mist etc. The water body will also help enhance the comfort levels, if ample shade is also provided. Visually appealing urban pond spaces will attract a wide range of users.

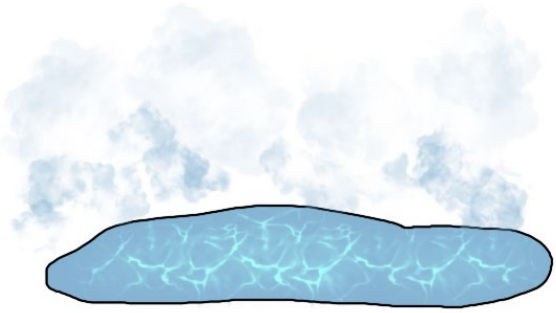


Figure 9. Aesthetics

Place Attachment

Consider the aspirations of local residents living in the vicinity. The intimate relationship they have with the pond considered can provide interesting insights regarding planning and design proposals.
Community participation in design and maintenance, along with design elements catering to community needs like stormwater recharge, fresh water supply or even community gardens can be considered.

Proximity

Encourage walkability and consider proximity accordingly.

CONCLUSION

The urban ponds, if thoughtfully designed and integrated within the urban fabric, can serve as powerful catalysts toward social cohesion and community engagement. The present research undertakes a qualitative examination of the most vital design principles that make for energetic and inclusive public spaces with water bodies. Design shapes possibilities for social interaction, crucial for building a community. Considering accessibility, diversity of use, and aesthetic appeal, designers conceive the best spaces for people to come together and hang out with each other. Water bodies naturally draw people and provide a serene environment. Even more so, smartly designed urban ponds can become hotspots of social activity, serving opportunities for relaxation, amusement, and social bonding. Spending time in nature has been argued to have numerous positive effects on people's mental and physical health. Urban ponds can offer respite from the hustle and bustle of the city, reducing stress and promoting well-being. As cities continue to grow in size and density, urban ponds form an increasingly important component of sustainable and liveable urban environments. By focusing attention on innovative design approaches sensitive to social and environmental needs, we are able to retain these valuable assets for the health, well-being, and social cohesion of our communities.

NOTES

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[2] Timothy Beatley. *Blue urbanism: exploring connections between cities and oceans*. Washington, DC: Island Press, 2014.

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VERTICAL COMMUNITIES: HIGH-DENSITY URBAN LIVING IN HONG KONG

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INTRODUCTION

Urban density has long been regarded as an inherent blight, an inevitable consequence of political, industrial and economic necessity. Until the Industrial Revolution, the compact, walkable city had been the default urban form since antiquity. Its three-dimensional scale corresponded with the capabilities of the human body to build, maintain, move through, and defend it, producing a variety of organizational forms in different climatic and cultural contexts. Their compactness developed incrementally and was driven by the need for protection and the limitations of city walls, and access to markets via available forms of mobility.

The Industrial Revolution brought unprecedented technological advances and levels of economic production to cities, and it triggered a significant population increase as people migrated from rural areas to urban centers in search of better opportunities. The rapid growth of factory towns led to overcrowding and disease outbreaks. The negative impacts of this rapid urbanization were further exacerbated by exploitative working and living conditions. These factors contributed to the formation of negative connotations associated with urban density, such as unhealthiness, crime, and social instability. These were further cemented by the trend of wealthier populations evading these conditions, enabled by technological progress in the form of trains and, later, cars. While urban cores experienced extreme overcrowding and concentrations of pollution, poverty, and disease, the middle and upper classes settled in green urban peripheries.

Modern Urban Visions: Countering Congestion

The effects of industrialization on cities led to the development of modern urban planning. Although the proposed solutions among the most prominent visions for the future of cities were diverse, they all shared the common goal of alleviating congestion, pollution, and disease in urban centers. Ebenezer Howard's *Garden City*, Le Corbusier's *Radiant City*, and Frank Lloyd Wright's *Broadacre City* were ambitious projects that employed state-of-the-art technology to address the problems of industrial cities and to propose new ways of organizing society and industry.

Ebenezer Howard's vision of a network of "slumless and smokeless cities," was a schematic outline of an organizational structure that did not suggest a concrete built form, but rather prescribed an optimal population density: a population of 58,000 for the Central City on 12,000 acres (48.56 km2) including green areas, and 32,000 inhabitants on 6,000 acres for each of the satellite Garden Cities whereby 1,000 acres would be designated urban area, and 5,000 acres agricultural land.[1] Rail-based connectivity was a key aspect of his proposition.

Le Corbusier's visions, on the other hand, were very explicit in relation to architectural typology, verticality, and the layering of infrastructure. The vertical zoning was pure, and so was the zoning in plan. His *Ville Radieuse* separates clusters of governing, business, transport, living, tourism, and industry by placing vast spaces between them.[2]

In contrast, Frank Lloyd Wright's vision for Broadacre City was firmly rooted in the concept of individual self-determination, centering on the single-family home on an acre of land as the fundamental unit of the future city.[3] He proposed a sprawling network of prefabricated single-family homes, interspersed with amenities such as markets and gas stations, all of which would be accessed by private cars. His sketches reveal that he even anticipated a version of future drone delivery. He envisioned a new spatial organization and occupation of the land, in which individuals would thrive through independence and self-sufficiency.

While Howard's and Le Corbusier's propositions were committed to the idea of the city, Wright's Broadacre City—despite its denomination—was fundamentally anti-urban. With what he called *Ruralism* he intended to critique and counter the *Urbanisme* promoted by Le Corbusier.[4] A couple of decades later, the single-family home as a prefabricated, mass-produced, affordable form of living became a reality, and heavily promoted as the new desirable housing for returning WWII veterans in the United States, laying the foundations for vast areas of suburbs to develop as sprawling residential monocultures—the antithesis to a compact, walkable, community-based, and potentially vertical city.

HONG KONG, THE VERTICAL CITY

In its relatively young urban history, Hong Kong has faced similar challenges to many other cities. However, due to its unique circumstances and constraints, the city has grown through consistent increases in density. As in other places, Hong Kong initially embraced high-density living as a necessity. By committing to, and evolving this approach, urban density became both a choice and a proficiency.

Hong Kong has developed relatively quickly from a sparsely populated area to a high-density metropolis. The first settlement was established in 1842 on a narrow strip of land on the northern shore of Hong Kong Island. Early on, the British colonial government adopted a policy of controlled land release, cultivating a state of land scarcity for economic gain. To this day, the Hong Kong government owns all land and leases a limited number of plots to the highest bidders each year. This creates intense competition among private developers and drives up housing prices in the private market. Due to the limited expansion of the urban footprint, only 25.6% of Hong Kong's territory is developed land; the rest is natural landscape, over half of which is designated as country parks.

Hong Kong experienced several waves of migration from mainland China during the 20th century. The enormous influx of people put pressure on housing and infrastructure, leading to the growth of squatter settlements. These shanty towns suffered from overcrowding, poor infrastructure, hygiene issues, and frequent fires. In 1953, a fire in a Shek Kip Mei squatter area left 53,000 people homeless. The government responded immediately with a resettlement program. Over the following decades, the Hong Kong government began developing its public housing program. The first housing estate with "comprehensive planning," meaning it included supporting programs such as shops, a wet market, and schools, was completed in 1967. It set a new standard for subsequent public housing projects. Over time, the Public Housing Authority developed different generations of housing units with high efficiency and in compliance with building ordinances and technological advancements. In the 1980s, prefabrication began to be incorporated into the construction process.[5]

Private residential developments, initially in the form of tenement housing and, from the 1960s onwards, housing estates, evolved alongside public housing. These two types of housing development

produced generations of housing designs in response to evolving building technologies and building regulations, resulting in increasingly dense and vertical living arrangements over time.

Two Vertical Communities: The Cases of Chai Wan and Lohas Park

The following two cases, Chai Wan and Lohas Park, illustrate how high-density, vertical communities have developed in different neighborhoods at different times in different parts of Hong Kong.

Chai Wan

Chai Wan is located at the northeastern end of Hong Kong Island and the final stop of the Mass Transit Railway (MTR) Island Line. Its population is 95,973.[6] Administratively, it is part of the Eastern District, which has 529,603 inhabitants on 21.84 km². Chai Wan in many ways reflects the overall history of urban and housing development in Hong Kong, while at the same time evolving its own unique characteristics. Today it presents an instructive example of a typical local neighborhood in Hong Kong.

Historically, Chai Wan was a rural area with fishing villages, and in the mid-20th century it was home to squatter areas as well. In 1952 the government designated Chai Wan as one of the resettlement areas and, in 1957, began to construct resettlement estates and factory estates in the area. During the 1960s the neighborhood developed primarily as a mix of industrial buildings and public housing estates, and with the beginning of the 1970s private residential estates were being constructed as well. The oldest of these projects still existing today, are e.g. *Man Wah Building* (1971), *Moon Wah Building* (1971), and *Kin Yip Court* (1971).

In 1982, the construction of the MTR station started, and it opened as part of the *Island Line* in 1985, establishing a fast and reliable connection with the rest of the territory, and triggering an increase in housing development. The MTR built a mixed-use development right on top of the railway station. Completed in 1988, *New Jade Gardens* consists of six towers with 1,480 flats, a rooftop garden and a swimming pool for its residents, and *New Jade Shopping Mall* with a GFA of 11,100 sq.m.[7] in the podium levels. Today, the MTR Island line, several bus lines, and mini-bus routes, offer convenient access to many parts of Hong Kong, despite Chai Wan's relative marginal location at the Eastern end of Hong Kong island.

In the year 2000 the government held a design competition for a Center for Youth Development, with a project by Meta4 Architects emerging as the winner, which was realized in 2006. The building concept works with Hong Kong's DNA in most innovative ways. The underground portion is comprised of a car park and a theatre; above the ground, several programs stacked on top of each other: an open plaza, a theatre, a food court, art studios and galleries, multipurpose rooms, and at the very top, a three-story hostel, shaped and experienced like a low-rise courtyard building.

The entire building, which is named *Youth Square*, is wrapped in a five-meter-wide corridor space all along the façade that is vertically connected across levels, and that is explicitly not programmed to allow for informal activities. The building connects to the MTR station and to the neighboring public housing estates with a sloping plaza and a series of footbridges. Its volume extends into a vertical slab that houses additional hostel rooms and that bridges over the extension of the MTR tracks. *Youth Square* creates a three-dimensional hub for pedestrian circulation, community, and culture. A variety of programs bring diverse populations to and through the building. Local residents of all ages take classes in the multifunctional rooms. Schoolchildren do their homework in the bright, open, unprogrammed spaces rather than in their confined homes. Visitors come to the galleries and theater, and international travelers stay at the hostel.

In the early 2000, the repurposing of industrial buildings into art spaces started to gain momentum in Hong Kong, in the form of entire building conversions, as well as through adaptations of individual

units in industrial buildings into galleries, ateliers, or lofts. This has been the case for the industrial buildings in Chai Wan as well, attracting artists and architects to move their ateliers to the neighborhood.
Chai Wan is directly connected to the hiking trail system on Hong Kong Island. A 75-minute hike or a 40-minute bus ride connects the neighborhood to Big Wave Bay, the closest of several beaches in the area. This is an example of the consequences of the city's land use distribution, which is 25% urban and 75% natural areas.
While Chai Wan remains mainly a residential area with a strong presence of public housing, its planned and organic development over time has created a unique mix of programs and a rich set of amenities supporting the everyday life of its close to 100,000 inhabitants. Approximately 35,000 people live within the 400-meter radius of the MTR station. The pedestrian network is a patchwork created by the MTR, the Highways Department, and the Public Housing Authority, seamlessly linking residences, wet markets, retail, community services, and recreation areas. In conjunction, these places and connections form a coherent and comprehensive neighborhood community network within a five-minute walking radius of the station, which includes a footbridge extending from the station building to Chai Wan Park. These connections continue at multiple levels into even the oldest housing estates in Chai Wan, the wet markets and supermarkets that are part of these estates, and to their communal pathways and outdoor spaces. Like virtually all neighborhoods in Hong Kong Chai Wan has a municipal services building with wet market and cooked food center, and a public library. The communal and cultural center also comprises a cinema and countless restaurants and small eateries.

Lohas Park

Lohas Park is part of Tseung Kwan O New Town in the southeastern New Territories. As per 2021 census data it had 46,755 inhabitants. Administratively, it is part of Sai Kung District, which has a total of 489,037[8] inhabitants in an area of around 130 km2 size, the largest part of which is designated as country park. The majority of Sai Kung population live in Tseung Kwan O and Lohas Park, with the remaining population residing in Sai Kung Town and rural areas.[9]
Lohas Park is an entirely new, vertical residential development planned by the MTR Corporation and built from scratch next to a recently discontinued landfill, and on top of an existing MTR train depot. The development happened in two major stages, the construction of the first stage is completed, and the second stage is close to completion. The MTR is the proprietor and developer of the overall project, while the towers are being constructed in clusters and in corresponding temporal phases by various other developers.
A comprehensive walkway system across several levels within and on top of the podium connects all the towers, podium level park, parking garage, Mass Transit Railway (MTR) station and transport terminal. The central portion of the walkway system leads through a centrally located shopping mall. Developers are given very detailed requirements for each of the development packages to provide a public passage that must provide public access 24 hours seven days a week.
At completion, the entire development is projected to comprise between 25,500 residential units with an estimated population of 68,349 people, 50,000 square meters of retail (GFA), five schools, four kindergartens, various care and services centers for elderly, handicapped persons, youth, and children, and approximately ten hectares of open space.[10] The planned layout for the park includes a variety of landscape features, jogging track and sports fields, which in large parts are still under construction. A public playground in the central area is already in operation. The shopping mall, as the sole local supplier, houses a variety of shops and restaurants, supermarkets and bakeries, as well as a game center, a cinema, and an ice rink. The mall forms the heart of the pedestrian path system, it has direct entrances from the MTR, the bus terminal, and from the public park on the podium roof. As a part of

Tseung Kwan O New Town, Lohas Park does not have its own wet market. It will be served by the new municipal services building in Tseung Kwan O that is projected to be completed by 2029 and that will comprise district administrative offices, social & welfare facilities, learning centers and a three-level market with 143 stalls.[11] It will be accessible from Lohas Park in a three-minute ride on the MTR, though there is no convenient pedestrian connection.

Lohas Park is a very recent development and parts of it are still under construction. It is sought after for its safety, convenience, cleanliness, comprehensive amenities, connectivity and walkability, and views of the mountains and the sea. In turn, it does not offer the same programmatic, typological, cultural, and social richness that Chai Wan was able to develop more organically and over a longer period of time.

The Quality of High Urban Density

Jane Jacobs, in her writings about the American city, highlighted the importance of a clear distinction between density and overcrowding.[12] According to her, density was a vital ingredient for the livelihood of cities, alongside other criteria. While the large-scale developments for public or private housing, and for retail, may not fit within the ideal conditions she describes due to their top-down nature, Hong Kong's vertical communities correspond to and intensify in many ways the combination of factors she envisioned to be conducive to what she called "city diversity," in particular in terms of "concentration" and the—in Hong Kong's case vertical—"mixture of uses." Like in Ebenezer Howard's Garden City, Hong Kong's neighborhoods are to a substantial degree self-sufficient. While they lack agricultural capabilities, they provide opportunities for work, as well as all provisions for daily life and community care. The municipal services buildings that exist in almost all neighborhoods form the communal nucleus around provisions of food for the body (wet market and cooked food center) and the mind (public library). Chai Wan's footprint approximately corresponds to the size that Howard envisioned for his satellite garden cities, though its population exceeds these by more than three-fold. With Lohas Park, these two neighborhoods also share aspects with Le Corbusier's Radiant City. Corbusier's vision comprised repetitions of housing complexes, or unités, each of which would constitute a vertical village of 2,700 residents—which approximately corresponds to the average number of residents per housing development in Lohas Park—with provisions of laundry and dining facilities on the ground, and recreational areas including pools on the roof. Where Hong Kong's neighbourhoods starkly diverge from this proposition, is in their complex integration in the transition from the vertical to the horizontal and into the city of residential functions and communal facilities that cater to all stages of life with other uses, most notably work and retail. Key to the success of these structures in forming urban communities is their reliance on pedestrianism as the primary mode of movement and connection in combination with a highly effective multi-modal public transport system that integrates each neighbourhood with the larger urban system.

CONCLUSION

While urban density carries a negative bias since industrialization, it reemerges in the context of 21st century sustainability discourse with more positive connotations. As local governments have become more apt in managing their cities over the past century, the degree of livability in high-density environments depends greatly on the fine balance of space allocation and coordination between different urban systems that make up the urban living environment.

While responding to unique conditions and consistently facing their own challenges, Hong Kong's vertical communities present an instructive example of how we, as a human species, can live well in community and with the smallest possible spatial and environmental footprint, and what we may gain in return from an increase in urban density.

NOTES

[1] Ebenezer Howard, *Garden Cities of To-Morrow (Being the Third Edition of "To-Morrow: A Peaceful Path to Real Reform")* (London: Swan Sonnenschein & Co., Ltd., 1902), 22-24.
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ALTERNATIVE HOUSING STRATEGIES TO FOSTER SUSTAINABLE LIVELIHOODS IN NEW YORK CITY

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PRATT INSTITUTE GRADUATE CENTER OF PLANNING AND THE ENVIRONMENT, UNITED STATES

INTRODUCTION

Cities across the globe are grappling with a housing affordability crisis. While New York City is unique it often serves as a harbinger of housing and related urban problems that other urban areas, despite their differences, eventually confront. Income disparities and the widening economic divide may vary in intensity from city to city, but they remain common forces driving shared challenges that must be addressed.

The following data illustrates this reality in the United States: Since 2011, the number of homes renting for less than $800 per month has declined by more than four million units.[1] In 2024, over 771,480 people were homeless in a single night.[2] For half of low-income renters, housing costs account for more than 50 percent of all household expenses.[3]

New York City is the pinnacle of this crisis. No other city in the United States has more millionaires and billionaires.[4] The influx of international wealth has raised the cost of living and housing while driving some of the highest levels of income inequality by both income and race.

The City of New York is well aware of the affordable housing shortage, and its primary strategy to address it has been to incentivize the private sector to build more housing.[5] While increasing supply is part of the solution, recent research indicates that the trickle-down benefits of new housing does not lower rents for the poorest New Yorkers."[6] New York City does not only face an affordable housing crisis. It must also contend with the climate crisis, long-term migration, the need for more well-paying jobs, and the equitable distribution of services and amenities.

The Pratt Institute's Graduate Center for Planning and the Environment has been addressing these issues since 1964. GCPE educates the next generation of planners to promote social justice by balancing the needs of communities with the realities of politics and the economy. The following research, written by three recent graduates of the program, discusses current policies and planning around affordable housing in New York City as well as possible solutions.

EXPLORING THE HISTORY AND IMPACT OF MANDATORY INCLUSIONARY HOUSING IN NEW YORK CITY: AFFORDABILITY, INCOME INTEGRATION, AND RACIAL INTEGRATION

Tal Litwin

Introduction

New York City faces a persistent housing crisis that is reaching new extremes. As of early 2024, homelessness has risen to its highest rate since the Great Depression, nearly a third of renters spend more than half of their income on rent, and the housing vacancy rate is at 1.4 percent—the lowest since 1968 and far below what urban planners consider healthy.[7]

To address this escalating crisis, in 2016, after decades of advocacy, the City of New York passed Mandatory Inclusionary Housing (MIH). MIH mandates that in neighborhoods rezoned to permit additional housing, any new development must be 25 to 30 percent affordable. MIH not only seeks to create affordable units but also to spur income-integration; the policy report that first introduced MIH articulated the benefits of economic integration and its absence in New York City.

Methods

This thesis employed a mixed methods approach to evaluate the dual goals of MIH. An analysis of expert interviews, policy documents, MIH hearing testimonies, news stories, and community comments informed a thorough history of the policy. A quantitative analysis of the policies relied on a review of the underwriting agreements for each MIH developments and geospatial analysis. The Department of City Planning did not establish clear quantitative targets for MIH, making it difficult to assess its success or failure. To address this issue, this thesis examines the production, location, and type of MIH units.[8] This condensed version focuses on the outcomes from mixed-income MIH developments—projects with 70–75 percent market-rate and 25–30 percent affordable units—as they are the clearest measure of MIH's effectiveness in leveraging the private sector to build affordable housing.

Analysis

From March 2016 to June 2024, 169 MIH developments have produced 8,537 affordable units. This accounts for 10 percent of all affordable housing units built since March 2016.

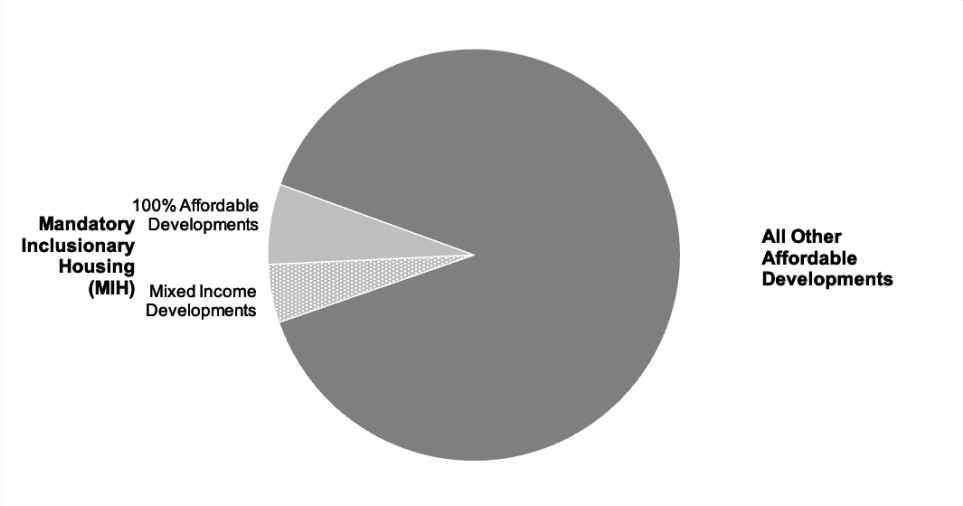


Figure 1. Affordable Housing Units Constructed: MIH vs. Other Programs in New York City (2016 - 2024)

The effectiveness of MIH is contingent on rezoning being passed, which is dependent on market and political forces. For a rezoning to pass it must be supported by the local council member. Moreover, Mayoral administrations have varying ambitions: Bloomberg passed 120 neighborhood rezonings, de Blasio eight, and Adams five with a larger focus on a citywide text amendment.
And beyond the political forces, once a rezoning passes it has not always created new units. There have been 130 developer initiated rezonings that have not started construction.[9] The expiration of the 421-a tax incentive and rising interest rates are likely a part of this. These many undeveloped MIH areas reflect a downside in the reliance on the private sector to create a social good; it is susceptible market fluctuations.

Affordability

Arguably the most controversial element of MIH is the affordability of the units it creates. Mixed-income developments have primarily produced "low-income" (1,748 units) and "very low-income" units (1,202 units), with only 50 "extremely low-income" units. In 100 percent affordable developments the MIH units are mostly "low-income" (2,263 units) and "very low-income" (1,809 units), but 609 units are "extremely low-income," a higher share than in mixed-income projects. Other subsidies layered into 100 percent affordable projects have delivered far deeper affordability, producing an additional 5,147 "extremely low-income" and 3,545 "very low-income" units beyond MIH requirements.[10]

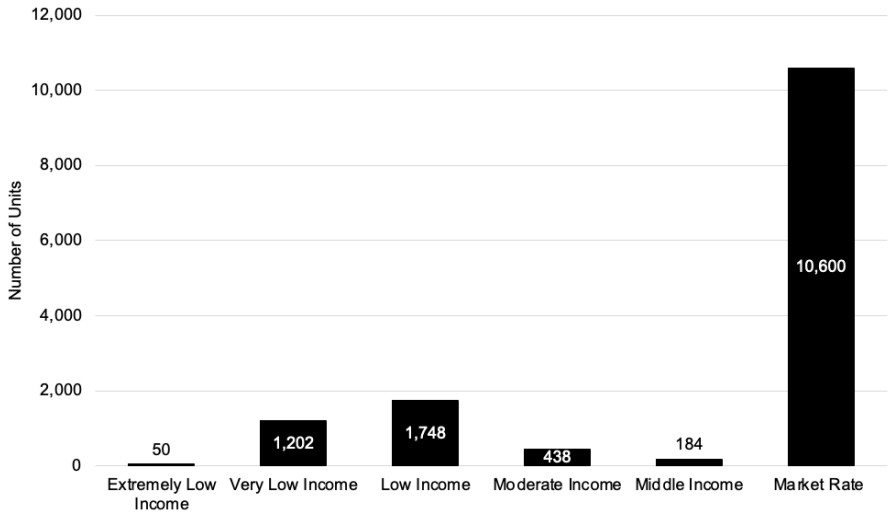


Figure 2. Distribution of MIH Units by Affordability in Mixed-Income Developments in New York City (2016-2024)

Overall, MIH's ability to generate "low-income" and "very low-income" units is a crucial addition to the housing stock. These income brackets represent 36 percent of New York City renters and rent-burdened households, including essential workers like teachers, healthcare professionals, and public sector employees. However, MIH units are not creating "extremely low-income" affordable units—the largest subset of rent burdened renters—is problematic.

Unit Size

An additional factor in evaluating MIH is the size of the units. This has become even more important as New York City loses families due to high costs of living. Although the average household size in New York City has shrunk in the last decade, it remains at 2.6 people and 39 percent of households

are three people or greater.[11] In order to accommodate families, the MIH text amendment required that 50 percent of units be two-bedrooms or larger, and 75 percent be one-bedroom or larger.[12] However, nearly half of 100 percent affordable developments did not meet the requirement that more than half of units be two bedrooms or greater and instead matched the smaller unit size of the rest of the building. This demonstrates a lack of family units in MIH developments.

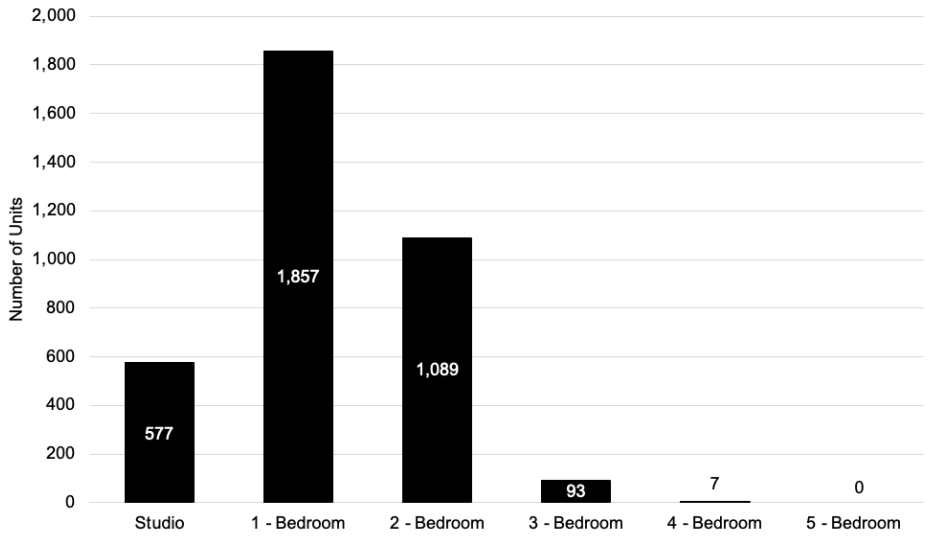


Figure 3. Distribution of MIH Units by Unit Size in Mixed-Income Developments (2016-2024)

Figure 3 depicts the breakdown of MIH units by bedroom size in mixed income redevelopments. In such developments, MIH has primarily produced one-bedroom units, two-bedroom, and studio units. Only 32 out of the 79 mixed-income developments have more than 50 percent of units with two or more bedrooms. This indicates that most developments are opting to create units that mirror the market-rate mix, which predominantly favors studios and one-bedroom units. Thus, MIH is not adequately addressing the housing needs of families.

Integration

Mixed-income MIH developments are more evenly distributed across poverty and race, while 100 percent affordable projects cluster in high-poverty, predominantly non-white neighborhoods. While located 100% affordable development in high poverty neighborhoods is an important investment in lower-income neighborhoods, it does not contribute to the broader economic integration goals of MIH.[13]

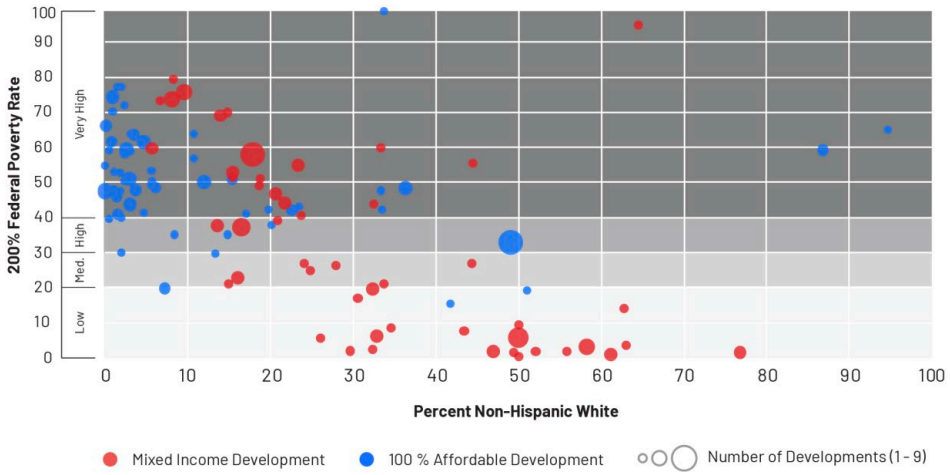


Figure 4. Distribution of MIH Developments by Poverty Rate Below 200% of Federal Poverty Level and Percent Non-Hispanic White Population by Census Tract in New York City (2016 - 2024)

Conclusion

MIH is a contentious policy that many critique. Many argue that its requirements are too stringent, slowing housing growth, while others believe they are not sufficiently ambitious to meet the need. Ultimately, the finding of this thesis show that Mandatory Inclusionary Housing is a valuable housing policy that has provided affordable housing to New Yorkers who might otherwise have been left without options. Yet, MIH has notable limitations, including the quantity and types of units it produces, their locations, and the speed at which they are built.

For MIH to make strides towards its dual goals, New York City must adopt a comprehensive housing location strategy. MIH is only as effective as where it is mapped, which is driven by the political will of those involved in the ULURP process and the profitability of the developer. New York City must implement more stringent requirements that compel stronger market neighborhoods—often wealthier and predominantly white—to upzone and build more affordable units through MIH. This approach would serve both as an affordable housing production strategy and as a tool for economic and racial integration.

PLANNING FOR LOW-INCOME COMMUNITIES: A REFLECTION OF PLANNING PROCESSES AND HOUSING IN EAST NEW YORK

Sage Dumont

Introduction and Context

In 2014, the De Blasio Mayoral Administration announced a series of upcoming rezoning studies for neighborhoods across New York City, aimed at spurring new housing development in response to the city's growing affordability crisis. The Administration promised unprecedented community engagement, mandatory affordable housing, and comprehensive goals to address the housing, economic development, land use and zoning, and community resource concerns of the neighborhood.[14] This approach marked a departure from a past era of rezonings that focused narrowly on land use, generating optimism among community leaders and technical assistance providers. City officials heralded the rezoning as a "watershed moment," framing it as a model for future neighborhood rezonings.[15] Yet the rezoning proposed for the East New York and Cypress Hills neighborhoods in eastern Brooklyn, "the East New York rezoning", was met with deeply rooted skepticism from residents.[16]

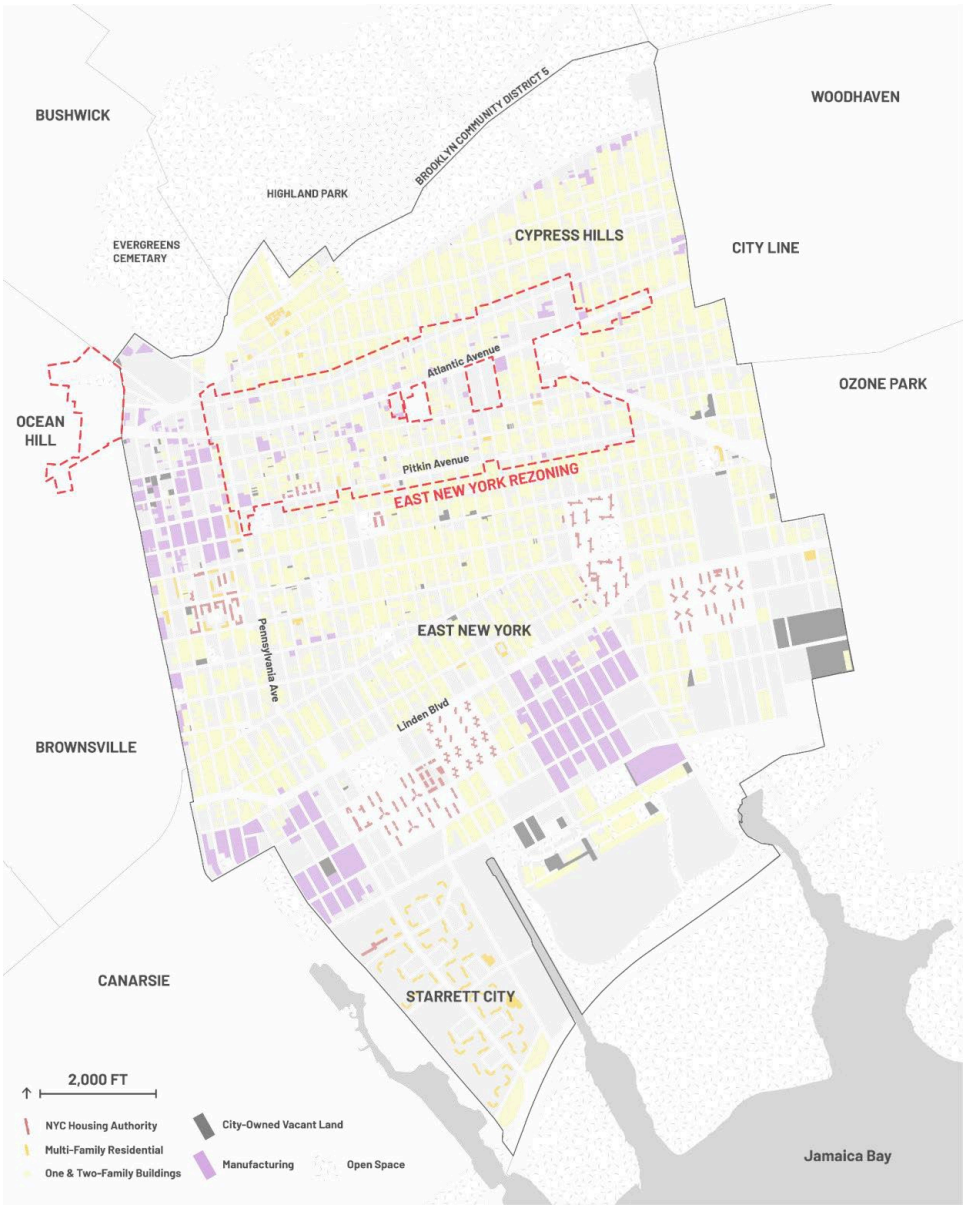


Figure 5. The East New York Rezoning Area in Brooklyn, New York City

Past upzonings in New York City, accompanied by targeted neighborhood investments, sparked real estate speculation and drove up local land and rent prices.[17] Without sufficient protective policies and affordable housing options in place, existing residents were left at risk of displacement. East New York and Cypress Hill residents feared that the City's plan for the 2016 rezoning would neglect to fully capture community needs and instead, create conditions to incite displacement. In response, community members and advocates created an alternative plan with dozens of strategies to safeguard against these risks, which they pressed the city to adopt during the planning process.[18]

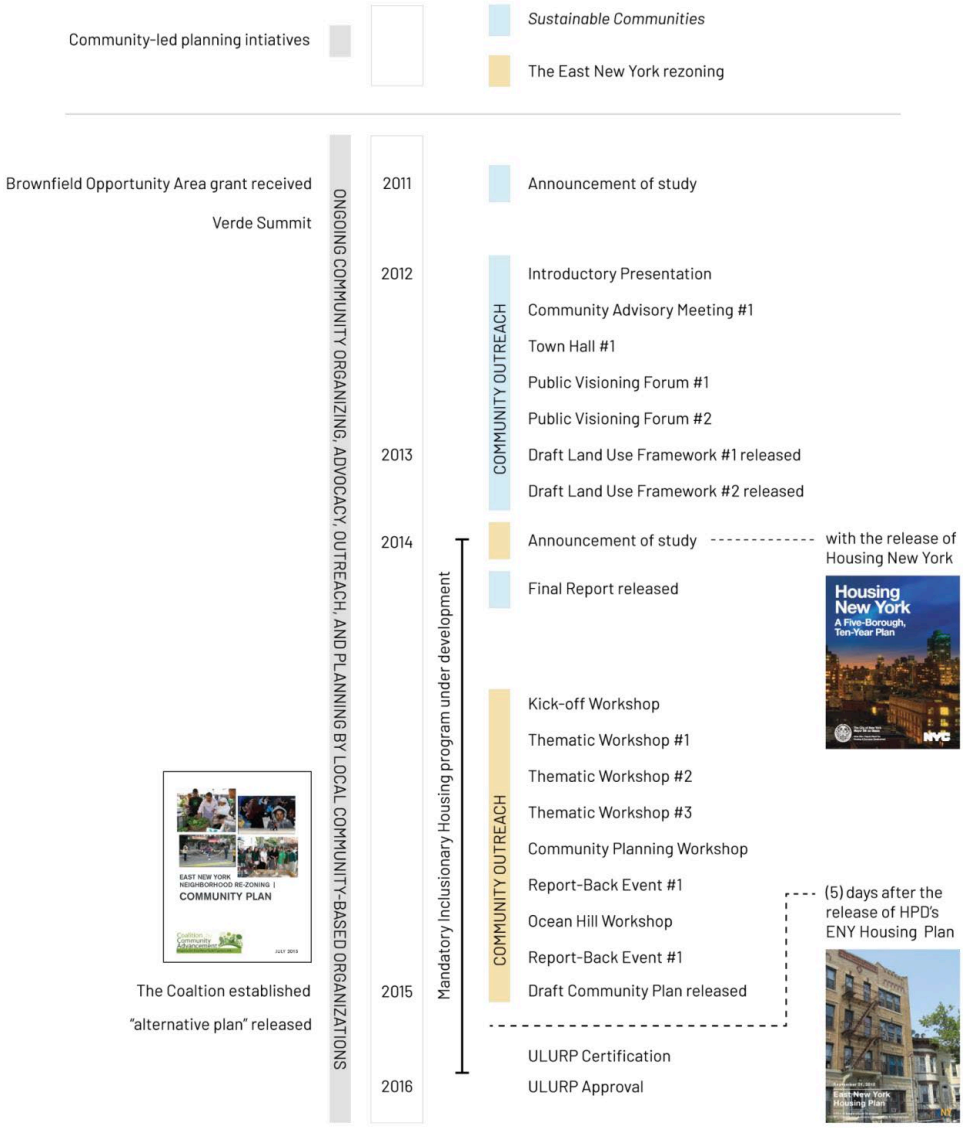


Figure 6. Timeline of Planning Initiatives in East New York, 2011-2016

Prompted by the lack of existing research that evaluates the 2016 East New York rezoning, this thesis reflects on the cumulative planning processes leading up to the adoption of the rezoning, assesses the effectiveness of the City's finalized strategies to address community needs, and analyzes their effects on the area's housing landscape and community a decade later. The goal of this thesis is to determine how to reform neighborhood planning processes and housing policy to better align with community needs and priorities. Housing affordable to low-income households has long been limited in New York City. In the last century, targeted disinvestment, widespread community displacement at the behest of urban renewal policy, and the failure of long-term governmental support has maintained racial inequities.[19] The consequences of this housing deficiency and history are manifest in East New York and Cypress Hills. While the City has taken steps to reconsider its approach to planning and low-income housing, considerable work remains to ensure that neighborhood plans truly deliver housing affordable to low-income households and meaningfully center community voices.

Research Method

This research employs a mixed-methods approach, including a literature review, data analyses, cumulative planning processes and policy analyses, and interviews. The literature review situates this study within existing research and debates relevant to the central issue of the study, specifically regarding the role of the private sector in planning and housing plans, rezonings and their effects, displacement and gentrification, and community voice in planning. Analysis of the city's planning processes evaluates interagency coordination, capital funding, and community outreach. Analysis of community planning processes evaluates the ecosystem of community actors and their community engagement. Policy analysis reveals the abilities and restrictions of certain strategies to address community needs. Quantitative data analysis evaluates relevant housing stock and development trends, housing affordability, housing vulnerability, and population changes before and after the 2016 East New York rezoning. Interviews with city employees, planning technical assistance providers, and individuals involved in the Cypress Hills and East New York community planning efforts reveal the disconnect between parties, skepticism, and misaligned confidence in the city planning, rezoning, and community engagement processes.

Findings

The research findings reveal New York City's ability to address the affordable housing crisis is limited by the absence of a coordinated, resourceful vision to keep New York City affordable and livable for low- and moderate-income households. City agencies lack the adequate tools, clear policy communication, interagency coordination, and effective evaluations of their assets to fully address the needs of New York City communities.

Despite the City's promise of the private sector to deliver affordable housing thanks to the Mandatory Inclusionary Housing program, data illustrates that the large majority, 87%, of affordable units created between 2016 and 2024 reside in 100% affordable developments which relied on deep subsidies from the City to be feasible.[20] This underscores the fallacy that relying primarily on the private market to produce affordable housing adequately serves low-income New Yorkers in high-need neighborhoods such as East New York.

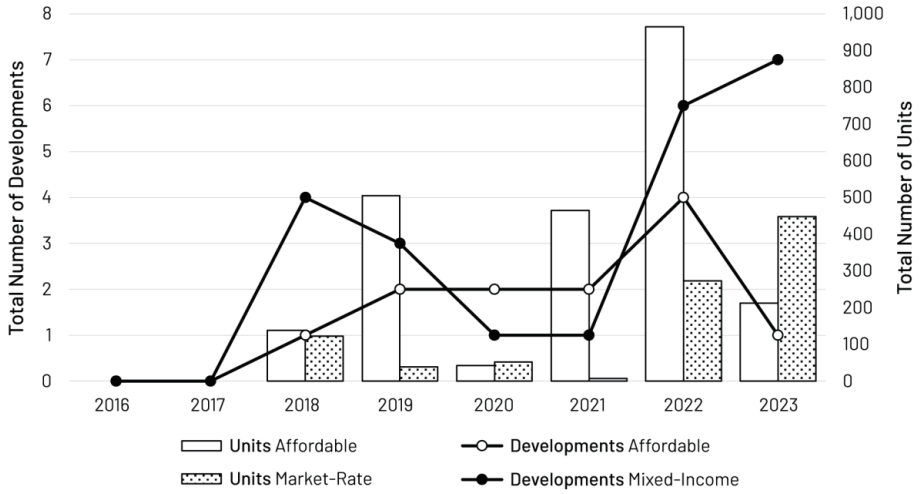


Figure 7. Affordable Units and Market-Rate Units Created as a Result of the East New York Rezoning between 2016-2024

Conclusion

New York City must restore community trust in city processes, stabilize low income-communities, empower community-based organizations and their members, and re-envision a coordinated, community-driven, interagency approach to planning. Specific recommendations include the requirement of a comprehensive planning framework and the coordination of agencies, conduct and regularly update an affordable housing development feasibility analysis for citywide underutilized private and publicly owned land for rezoning, strategize the city-wide approach to assist and protect low- and moderate-income homeowners, and dedicate investments towards local population-based, workforce development.

ACKNOWLEDGEMENTS

We gratefully acknowledge the support of the Pratt Institute Graduate Center for Planning and the Environment (GCPE), whose assistance made it possible for us to attend the AMPS conference in Barcelona and learn from global conversations on planning and community development.

We extend our deepest thanks to our professors, Ron Shiffman, FAICP, Hon. AIA, Professor Emeritus at the Pratt Graduate Center for Planning and the Environment and Juan Camilo Osorio, Associate Professor at the Pratt Graduate Center for Planning and the Environment, whose teaching and mentorship instilled in us the importance of community-based planning, equity, and the values that guide the work of GCPE. Their commitment to participatory and socially just planning continues to inspire our practice.

We also wish to acknowledge our colleague, Danielle D Baez, with whom we had the privilege of presenting this work along with her thesis, “Tools for Adapting New York City's Post-Disaster Housing Prototype as a Long-Term Housing Strategy,” at the AMPS conference in Barcelona.

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THE CRISIS OF MICRO LIVING SPACES – QUESTIONABLE RESULTS DUE TO QUESTIONABLE DESIGNS

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INTRODUCTION

Housing affordability has emerged as one of the most pressing socio-economic and urban design challenges of the twenty-first century. A host of complex and interrelated factors – including rapid urban migration, escalating land costs, speculative development practices, and limited availability of land in urban cores – continue to drive pressures on housing markets worldwide.[1] Within this context, one of the most frequently promoted strategies has been the proliferation of micro-apartments. Positioned as an efficient response to affordability concerns, micro-units allow developers to maximize yield per square foot or metre, while ostensibly providing tenants with lower entry costs to urban living. Despite these promises, however, uptake has often been slower than anticipated, with emerging evidence pointing to correlations between micro-living and declines in mental health, social wellbeing, and overall quality of life.[2]

The relationship between housing and wellbeing requires a broader and more holistic conceptualization. As early as the 1970s, Bhutan's Fourth King, Jigme Singye Wangchuck, argued that Gross National Happiness (GNH) should be valued above Gross Domestic Product, reframing prosperity as a multidimensional condition rooted in wellbeing rather than material output.[3] This principle has since shaped global discourses on happiness and development, exemplified in the United Nations' *World Happiness Reports*.[4] While it would be simplistic to attribute declines in reported happiness directly to housing affordability crises, the connections between poor-quality housing, loneliness, and social isolation remain statistically significant and socially consequential.[5]

Given these concerns, this paper contends that design practice must shift beyond economically reductive approaches to affordability and embrace methodologies that foreground human experience. Rather than prioritising micro-unit production as a material solution, architects and designers should pursue strategies that cultivate a deep sense of home, belonging, and community. Such an approach requires situating the end-user and the wider community at the beginning of the design process, not as an afterthought, so that housing typologies are developed around lived experience, wellbeing, and connectivity.

In line with Patrick Jordan's theory of pleasure-based design, which emphasizes emotional and experiential triggers as key to product success, this paper argues for the application of similar principles in architectural and housing design.[6] If design teams systematically identify and integrate users' desired experiential outcomes at the inception of projects, they can establish frameworks that explain not only *what* needs to be created but also *why*. Such frameworks also offer pathways for balancing human-centered priorities with economic feasibility, enabling developers to sustain

profitability while producing housing that contributes positively to wellbeing, happiness, and social trust.

Housing Affordability Strategies

Within Canada, as in many other countries around the world, housing affordability is conventionally defined by the "30 per cent rule" – that is, housing is considered affordable when households spend no more than 30% of their gross income on shelter.[7] Yet, this threshold is frequently exceeded. In 2016, nearly one-third of Canadian households allocated more than this benchmark to housing costs, with almost a quarter spending 31.4% or more.[8] This pressure is compounded by persistently low vacancy rates, estimated nationally between 1.5% and 2.2% in recent years, creating scarcity that fuels price escalation.[9] As Andrew Sakamoto, Executive Director of the Tenant Resource and Advisory Centre of British Columbia, has observed, evictions tied to "renovictions" or redevelopment remain among the most common challenges faced by renters.[10] These dynamics illustrate the widening gap between the profit-oriented priorities of developers and the social imperative of affordable, secure, and dignified housing.

The consequences of this crisis extend well beyond economic stress. Public health research has consistently demonstrated that housing is a fundamental determinant of wellbeing. As Krieger and Higgins argue, "the quality and accessibility of housing is, however, a particularly appropriate area for public health involvement," with mounting evidence linking housing to both physical and mental health outcomes.[11] More recently, social psychologists have identified loneliness and social isolation as risk factors with health impacts as severe as, or greater than, obesity, and these effects are expected to grow in the coming decades.[12] Poor-quality or insecure housing not only threatens affordability but can exacerbate these forms of isolation, compounding declines in wellbeing.

Recognising the urgency of this crisis, the Government of Canada launched its National Housing Strategy in 2017, a ten-year plan committing $40 billion to new and rehabilitated units.[13] While this marked a significant policy commitment, three interrelated questions challenge its effectiveness. First, will broad-based funding mechanisms meaningfully reduce affordability pressures across diverse demographics and regions? Second, can design and architectural strategies ensure that such housing enhances, rather than erodes, wellbeing, happiness, and community prosperity? And third, does the current model inadvertently accelerate the displacement of lower-income households and creative communities from urban cores, thereby undermining cultural vibrancy and social equity?

Despite positive political intentions and large-scale financial commitments, the National Housing Strategy has often incentivised the production of shelters rather than homes. Grant and funding assessments reward price-sensitive construction and rental rates, but they rarely prioritise qualitative dimensions such as community wellbeing, mental health, or social trust. This reflects a siloed and economically reductive approach to a complex socio-ecological problem. As the Gross National Happiness framework and subsequent *World Happiness Reports* remind us, addressing affordability in isolation from broader human needs risks producing housing that is materially accessible but experientially impoverished.[14] The guiding objective of these initiatives should therefore evolve from the narrow pursuit of "affordable housing" to the more holistic aspiration of "human-centered, community-driven housing" – housing that actively cultivates wellbeing, happiness, trust, connectivity, and long-term affordability.

Questionable Design Strategies and Results

With these more comprehensive and human-centered goals in mind, it is important to understand why more human-centered and affordable housing units have not reached the market – specifically, the combinations of design and development strategies that have prevented construction of these unit

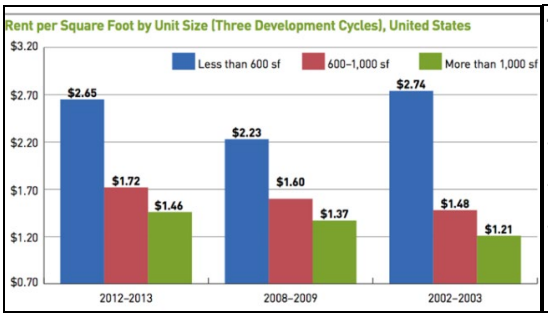
types. Despite clear and ongoing demand for affordability, major Canadian cities such as Toronto continue to deliver record numbers of doors that are not considered affordable – the dominant focus has been on higher-margin, more expensive condominiums and apartments. Recent federal market surveillance underscores this imbalance, noting that **rental supply "grew at a record pace in 2024 due to new completions,"** but these higher-priced additions were ***"unaffordable to many renters and primarily served higher-income households,"*** and, despite slower rent growth, **affordability did not improve because rent increases outpaced wage growth for the 25–44 core renter cohort.**[15]

Toronto, now a metropolitan region of **over seven million** people, exemplifies a development market historically reluctant to de-risk production by testing alternative, lower-yield typologies.[16] While demand for top-priced units has softened and investor dynamics have shifted, the need for design-led affordability has intensified.[17] In parallel, smaller architectural practices, industrial designers, and makers have advanced practical solutions that explore how to live well in smaller spaces and on constrained budgets.[18]

As early as 2013, the Urban Land Institute synthesized demographic and performance data showing that micro-suites command **higher rent per square foot** and, under specific market conditions, can outperform conventional unit mixes.[19] (Images: 1, 2, 3). This bolstered the perception that micro-units could increase developer returns while meeting urban demand from tech-savvy, sustainability-oriented demographics concentrated in creative cores. However, the strategy too often equated **small** with **satisfactory**, overlooking the crucial alignment between **price, lived experience, and spatial quality.**

The flaw, therefore, was not only economic but **design-driven**: product-price expectations diverged from delivered experience. Even where the target segment and unit typology were plausible, many buildings underperformed on **experiential quality**, failing to resolve how functional optimization at very small footprints must integrate *with* ***emotional and relational touch-points.*** The literature increasingly links **constrained dwelling size** with diminished mental-health and quality-of-life outcomes; recent peer-reviewed evidence associates floor areas below ~13 m² with elevated anxiety/depression risks and lower health-related quality of life.[20] In short, consumers did not simply want "small and cheap"; they expected **inexpensive, high-quality, and experientially compelling** – with spatial choreography, furnishings, and shared amenities designed to produce a durable sense of "home."

Industry commentary has acknowledged the investor-led skew toward **very small units** in recent cycles, reinforcing the argument that a single product logic dominated production.[21] Official analyses likewise document shifting investor risk/returns in Toronto's condominium market, further challenging the assumption set that sustained the micro-unit pipeline. Together, these dynamics explain why the **market success of micro-units is conditional**, and why ***experience-first*** design *and* ***community-scaled*** amenity systems are decisive for uptake.



Rent Comparison

	Conventional studio	Micro-unit studio
Size	500 square foot	300 square foot
Sticker price	$2,000	$1,500
Rent per square foot	$4.00	$5.00

Figures 1 & 2. "Urban Land Institute, The Macro View on Micro Units (Washington, DC: ULI, 2013), 12 & 24.

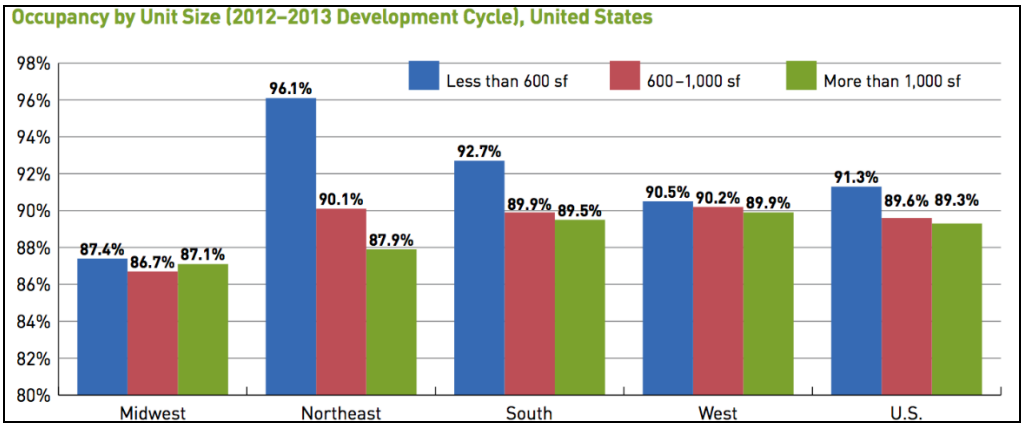


Figure 3. "Urban Land Institute, The Macro View on Micro Units (Washington, DC: ULI, 2013), 10.

The Creative Communities and Interactive Micro Apartments

For those not directly engaged in research on micro-housing, or those not personally confronting the realities of living in constrained spaces, the solution to affordability may appear deceptively simple. Within a supply-and-demand paradigm, it is often argued that those able to pay for desirable urban housing should remain in such areas, while those unable to afford rising costs must relocate to peripheral zones. From a market perspective, this aligns with the logic of economic liberalism: housing as a commodity, with market forces determining access and distribution.[22] Yet, such a reductionist perspective assumes that short-term economic drivers necessarily support diverse forms of long-term growth, wellbeing, and happiness.

The limitations of this view are stark when examined through the lens of urban equity. If affordable housing is only available in peripheral districts, large numbers of low-wage workers face extended commutes to city centres where their labour is required for service-based economies.[23] More profoundly, when creative communities (artists, designers, and cultural producers) are displaced from downtown cores, cities risk losing the very vibrancy and authenticity that initially made those areas attractive.[24] This dynamic has been observed across global cities: cultural districts and artistic enclaves generate neighbourhood desirability, but rising property values and redevelopment displace these same communities, often replaced by larger commercial chains, resulting in a homogenisation of urban space.[25]

A central issue with strictly economically-biased housing strategies is that they fail to account for the ***social commons***: the networks of trust, reciprocity, and creativity that underpin vibrant urban communities. Without design or policy mechanisms that preserve affordability and social diversity, development goals will continue to prioritise short-term profits over long-term cultural and civic resilience.[26] In this regard, research into the ***creative economy*** has been particularly illuminating. John Howkins introduced the term in *The Creative Economy* (2001), defining it as the generation of value from ideas and intellectual property.[27] Subsequent scholars, such as Richard Florida in *The Rise of the Creative Class* (2002), emphasized the economic and cultural contributions of creative professionals to urban renewal, while Charles Landry stressed the importance of cultural vibrancy as a driver of city competitiveness.[28] Together, these works underscore that creative communities are not marginal to economic growth but central to sustainable and desirable urban development.

The global economic significance of creative production has been further evidenced by reports from the United Nations Conference on Trade and Development (UNCTAD – Image 4 & 5). The *Creative Economy Outlook 2024* highlights that cultural and creative industries account for ***over 3% of global GDP*** and employ nearly ***50 million people worldwide***, with particular importance for developing

nations seeking diversified economic growth.[29] When examined through human-ecological and ethnographic perspectives, these findings reinforce that creative and cultural diversity is not merely economically advantageous, but also socially essential to building resilient, livable, and equitable cities.

The implications for housing design are profound. If micro-housing strategies ignore the needs of creative communities, they risk eroding the very ecosystems that sustain urban vibrancy. Conversely, by integrating principles of inclusivity, cultural diversity, and experience-driven design, micro-apartments and other innovative typologies can become instruments for sustaining the social commons. The task is thus not only architectural but socio-economic: to align affordability with policies and design practices that embed creative communities at the heart of urban development.

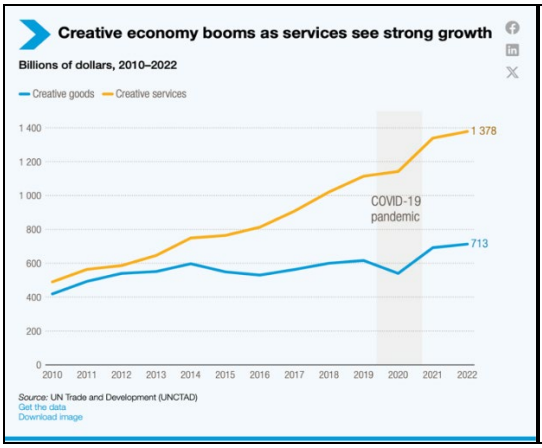


Table 3
Developed economies: top ten creative services exporters in 2022

	Developed economies	Exports of creative services (US$ billion)	Share from world exports of creative services (percentage)	Share of creative services from country's total exports (percentage)
1	United States	244.3	17.7	26.3
2	Ireland	231.3	16.8	65.1
3	United Kingdom	87.0	6.3	17.6
4	Germany	78.6	5.7	19.1
5	Netherlands	53.7	3.9	19.7
6	Japan	53.6	3.9	32.1
7	France	35.4	2.6	10.5
8	Switzerland	33.8	2.5	22.9
9	Israel	33.2	2.4	36.5
10	Sweden	31.9	2.3	33.7
	Total	882.8	64.1	

Source: UNCTAD.

Figures 4 & 5. United Nations Conference on Trade and Development (UNCTAD), Creative Economy Outlook 2024 (Geneva: United Nations, 2024), accessed August 19, 2025, https://unctad.org/publication/creative-economy-outlook-2024.

Research Facility – The "Micro Habitation Lab" (mHabLab) – University of Alberta

In *The Tipping Point*, Malcolm Gladwell argued that "The Law of the Few says that there are exceptional people out there who are capable of starting epidemics. All you have to do is find them."[30] His analysis of social contagion highlights how certain groups – such as creatives – can play disproportionately large roles in shaping cultural adoption, mainstream acceptance, and ultimately consumer demand. In the context of urban housing, this insight reinforces that particular demographics, notably designers, artists, and cultural producers, not only drive creative economies but also influence the types of environments, buildings, and products that society increasingly desires. Their collective practices contribute billions of dollars annually to the global economy while also shaping aesthetic preferences and social habits.[31]

This raises a series of critical questions for urban development and design research: What if these communities could reliably access affordable housing in downtown and creative cores? Would their presence help sustain the vibrancy and economic diversity of those neighbourhoods? How might developers respond if creative professionals were empowered to think holistically about living well in smaller spaces rather than narrowly through the lens of market efficiency?

These questions underpin the design philosophy and research agenda of the **Micro Habitation Lab (mHabLab)** at the University of Alberta, which has been prototyping and testing micro-housing concepts for over seven years under the direction of Professor Antoniuk (Image 6 & 7). More than a conventional product-testing lab, the mHabLab functions as a **conceptual and perceptual test**

centre, interrogating the thresholds where *hard tissue* (material systems, products, architectural interventions) meets *soft tissue* (human cognition, memory, and affect). The laboratory is grounded in an exploratory ethos: it resists disciplinary boundaries between interior architecture, industrial design, and product innovation, seeking instead to understand the complex relationships between perception, interaction, and the emotional engagements people form with places, spaces, and objects.[32]



Figures 6 & 7. Micro Habitation Lab, UofA (Moving Wall Unit with 60" Expanding Table) © Author of Paper

One distinctive outcome of the lab's research is the operationalization of **macro- and micro-experience design (MacUx and MicUx)** as front-loaded stages in the architectural process. Rather than introducing experiential considerations at the end of development – as an aesthetic "add-on" – the mHabLab situates them at the inception of project design. This approach parallels methodologies such as *Integrated Project Delivery (IPD)*, which emphasize early-stage collaboration, iterative prototyping, and the principle of "moving slow at the beginning to move fast later."[33] Within this framework, designers are encouraged first to act as **experience designers**, then as **service designers**, and only after this reframing, as the creators of supporting material places, spaces, and objects.

This "inside-out" approach allows for the embedding of additional agents and action points that can enhance wellbeing, promote meaningful human-to-human and human-object interactions, and deepen emotional bonds with designed environments.[34] Through the use of **interactive architectural elements** – such as moving wall systems, expanding furniture units, and in some cases sensor-enabled, touch- and voice-activated technologies – the lab has demonstrated that a 23m² (250 sq. ft.) suite can function at two to three times its apparent footprint (Images 8 & 9). More importantly, participants in these research experiments consistently formed unexpected **affective attachments** to the interactive elements themselves. These micro-environments not only expanded spatial utility but also created emotional resonances reminiscent of heirlooms or cherished objects.[35]

Such findings align with broader discourses in design and architectural theory concerning the **psychological and phenomenological dimensions of space**. Scholars such as Juhani Pallasmaa have long argued that architecture is not merely about utility but about how environments engage memory, embodiment, and affect.[36] Similarly, Donald Norman's work on emotional design highlights that attachment to objects emerges when functionality is combined with pleasure, meaning, and memory.[37] The mHabLab's experimental findings suggest that interactive micro-apartments may overcome one of the central shortcomings of contemporary micro-housing developments: their failure to foster durable, meaningful connections between residents and their living environments. By integrating interactivity, adaptability, and emotional resonance, these designs point toward a future where micro-housing is not merely tolerated as a compromise but embraced as a desirable lifestyle.

Detail Design and Major Case Study

As research data from the *Creative Economy Reports* began to inform and influence the human- and emotion-centered design thinking that has been previously discussed in this paper and tested through the mHabLab, an opportunity emerged in 2019 to extend these ideas into a real-world development. The commission involved designing fifty (50) micro-studio suites within a major residential tower in Edmonton, Canada.

Early discussions with the development team revealed a narrowly framed priority – to increase the functional efficiency of their existing studio layouts. However, after sustained dialogue and workshops with both the developer and the design team, consensus was reached to broaden the project's scope. A comprehensive **ethnographic and psychographic analysis** was commissioned to better understand the anticipated user group. Such methods, increasingly recognized within design research, emphasize "understanding people's lives, practices, and aspirations as the foundation for generating new design opportunities."[38]

The resulting research proved invaluable. Beyond standard demographic data, the study uncovered that the target community was highly digitally connected, socially media-savvy, and environmentally conscious. Lifestyle aspirations emerged as central: participants cared deeply about living well, reducing their carbon footprint, and ensuring their living environment reflected their identity and values. These findings align with consumer identity research, which emphasizes that individuals often use possessions and living environments to construct, negotiate, and communicate their sense of self.[39]

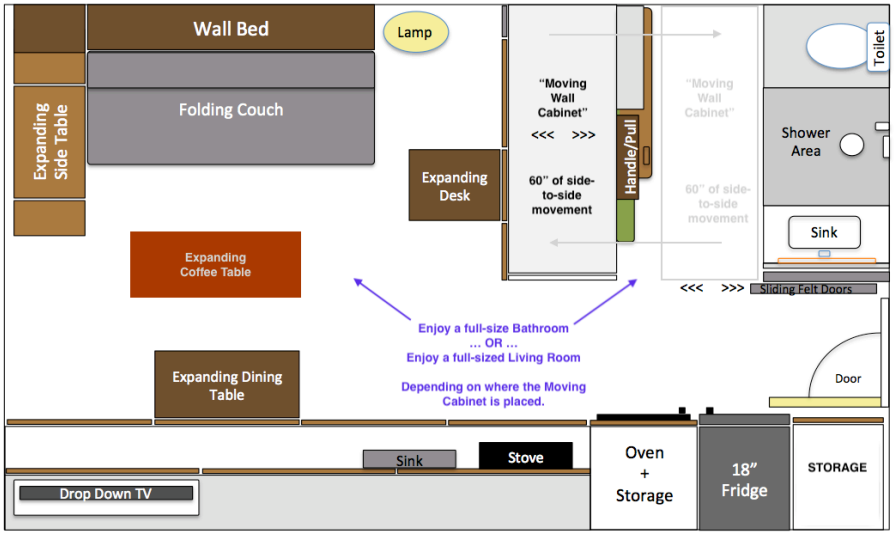


Figure 8. Micro Habitation Lab, 23m2 //250sf - V3.0 Prototype space.

Methodologically, the project followed a three-part design sequence:

1. **Design for enhanced experiences** within the suite and throughout the building. This stage drew directly from the MicUx/MacUx framework tested in the mHabLab, ensuring that perceptual, sensory, and memory-based experiences guided spatial concepts.[40]
2. **Design supporting services** to enable multiple realizations of these experiences. In practice, this meant embedding flexible communal spaces, co-working zones, and digital platforms that extended the experience of the micro-suite into the broader building ecosystem.[41]
3. **Design supporting material artifacts, spaces, and places.** Only once the experiential and service layers were fully developed were tangible architectural and product design interventions introduced – such as interactive walls, convertible furniture, and environmentally responsive systems.[42]

This sequence ensured that the ***material design was subordinated to the experiential and service design.*** In effect, the material architecture became an enabler, not the sole focus of design.
The results were transformative. The project not only responded to the identity and lifestyle of its intended residents but also yielded significant financial outcomes: it became one of the most profitable residential developments of its scale in Edmonton. From an academic perspective, this outcome validates the proposition that embedding **ethnographic research, creative economy insights, and human-centered design methodologies** into micro-apartment projects can simultaneously generate **greater end-user satisfaction** and **developer profitability.** It suggests that micro-housing failures to date may be less a problem of market demand than of insufficient design methodologies that fail to integrate the experiential and cultural lives of residents.[43]

Design Contributions, Strategy and Value

Although it is challenging to assign a direct monetary value to the research and design processes underpinning this project, several important financial and experiential outcomes demonstrate the measurable impact of design strategy.
The original studio suites were re-envisioned as **"New Studio Suites"**—a name that, while marketing-driven, accurately reflected their enhanced functional and experiential qualities. Perceptually, these units resembled one-bedroom apartments – *typically rented at a **20% premium*** – but were delivered within a studio footprint. The differentiation was not only spatial but also experiential: the suites embodied a methodological commitment to designing for ***experience and service first***, and only subsequently for physical form. This aligns with service-dominant logic in design, where "value is co-created in use" rather than embedded solely in material artefacts.[44]



Figure 9. Moving Wall System (Edmonton, Alberta, Canada) © Author of Paper

The pivotal design innovation was the **Moving Wall Cabinet System** (24"d × 109"h × 96"w). By providing a flexible partition that doubled the perceived floor area of either the living or sleeping zone, the system capitalized on the principle that a resident cannot occupy two zones simultaneously. The wall system also engendered an enduring ***person–product relationship***, echoing findings from design psychology that interactivity and adaptability enhance attachment and satisfaction.[45]

Tenant response confirmed the design's resonance: the New Studio Suites became the fastest-leasing units in the building. Beyond occupancy metrics, the system generated unexpected social value. A tenant's social media post showcasing the wall's functionality garnered over **two million views**, providing organic marketing reach and reinforcing the argument that design-led differentiation translates into cultural and economic capital.[46]

In this sense, the project exemplifies what Buchanan has described as "design's fourth order" – designing not only artefacts but also ***interactions, services, and experiences that generate systemic value.***[47]

CONCLUSION

All too often, design researchers and practitioners advocate for holistic and integrated approaches, warning against the pitfalls of insular, siloed methodologies. While such calls are frequently reiterated in academic and professional discourse, the project and research presented here demonstrate why this methodological orientation must now be taken more seriously than ever.

The crisis of micro-living spaces – often characterized by constrained environments, questionable assumptions about affordability, and insufficient regard for human experience – has highlighted the limits of narrowly economic development models. This paper has argued that the exclusion of ethnographic, psychographic, and human-ecological insights results not only in diminished wellbeing and community vibrancy but also in compromised long-term economic performance. The creative economy, as documented in international research and United Nations reports, provides tangible evidence that cultural and social capital are inseparable from financial capital in the formation of desirable, resilient communities.[48]

The Edmonton case study demonstrated that design-led interventions which are grounded in human-centered research and supported by creative economy data can generate measurable financial returns. The Moving Wall System and "New Studio Suites" exemplify how designing for experiences and services first, and for material artefacts second, translates into both enhanced tenant satisfaction and significant asset value. These findings reinforce the broader principle articulated in service-dominant logic and design theory: that value is co-created in use, not embedded passively in form.[49]

For designers and architects, the implications are twofold. First, we must embrace roles as **educators and translators**, extending beyond the academy to communicate with developers, policymakers, and allied professions about the tangible and intangible impacts of design. Second, we must accept new responsibilities as participants in the financial and planning processes of development and learn to speak the language of return on investment, risk management, and asset valuation, while simultaneously advocating for human experience, wellbeing, and social trust. This requires a methodological patience: to begin with experience design, extend into service design, and only then, with clarity, arrive at the creation of materials, products, and buildings.

Ultimately, this research argues for a reorientation of the design and architectural professions toward an **ecology of design practice**, where economic, social, cultural, and psychological dimensions are treated not as competing priorities but as interdependent systems. By positioning ourselves as **experience designers first**, we not only mitigate the risks of poorly conceived micro-living environments but also contribute to the creation of vibrant, inclusive, and economically resilient communities. Such a reframing of design's purpose is no longer optional; it is an imperative for the future of both the discipline and the societies it serves.[50]



Figure 10. The Augustana Building (Edmonton, Alberta, Canada) © Nicole Lawlord

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CO-CREATING AND IMAGINING LIVABILITY: VISIONS AND NEEDS OF HOUSEBOAT RESIDENTS IN THE ENERGY TRANSITION

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INTRODUCTION

The European Union aims to achieve carbon neutrality by 2050, and cities play a key role in realising this ambition. In the Netherlands, Amsterdam has committed to becoming climate neutral by 2050. Core strategies include phasing out natural gas, expanding renewable energy sources, and improving energy efficiency in the built environment. Currently, the adoption of such measures is not yet high enough, and behavioural change will be key in this transition.[1] Such societal transitions, however, also require changes at the level of relations, networks and infrastructure,[2] and in power dynamics, attitude and culture.[3]

To understand how we can foster behaviour change, thus asks for a deep understanding of what drives behaviour and habits, as well as how behaviour is embedded in structures, infrastructures and cultures. In this paper, we share our insights from a specific case where we research how energy transition measures resonate—or fail to resonate—with residents' lived realities. We report on a case study of the centrally located Stadhouderskade in Amsterdam, where the current Green Mile initiative seeks to transform the street from a congested and polluted transit corridor into a green, sustainable, safe, vibrant, and future-proof environment for people, animals, and nature.

We researched what moved houseboat residents living in this area to adapt (or not) more sustainable practices and technologies, as part of the European project Envision Change. This project was funded from within the scheme "Building transformation capacity through arts and design: Unlocking the full potential for urban transitions", and this call stressed the "importance of imagination, creativity and the cultural sector in urban change. Our contribution from the research group Creative Media for Social Change in the project "Envision Change" was to develop and test participatory and creative methods through which the needs of residents could be understood deeply, and from which residents could start to envision new futures in creative ways.

In this paper, we share the insights that we gained from employing creative methods, and we consider how sustainability measures do or do not resonate with citizens. In this way, we aim to contribute to building the insight needed to foster the development of interventions that start from the role that energy and energy measures play in the messy, situated contexts of everyday life.[4]

TIDES OF TRANSITION: HOUSEBOATS AND THE PUSH FOR SUSTAINABILITY

This research is part of the larger EU-funded *Envision Change (EC)* project, which explores energy transition and urban liveability across Latvia, Sweden, and the Netherlands. The project aims to design interactive media such as Virtual Reality and energy games that can stimulate inclusive and imaginative approaches to energy transition, engaging communities in envisioning sustainable and resilient urban futures. To inform the design of these interventions, a needs analysis was conducted across the three locations, aimed at identifying community-specific needs, aspirations, and collective goals, thereby supporting more context-sensitive and inclusive engagement with these measures.

Such context-specific knowledge is needed as the uptake of CO2-reduction measures faces several challenges:

- There is no one-size-fits-all approach in climate change, as what works for people is highly dependent on individual, situational and social.[5]
- People experience climate ambivalence: they have conflicting thoughts and feelings about their actions that are harmful for the climate.[6]
- Having more knowledge does not mean that residents automatically change their behaviour.[7]

We focus specifically on the Amsterdam context, examining these issues in the context of the ongoing urban renewal efforts of The Green Mile project.[8] This initiative, led by key stakeholders such as the Heineken Experience, the Rijksmuseum, UNStudio, De Nederlandsche Bank, seeks to transform the specific area called the Stadhouderskade into a safer, greener, and more sustainable public space.

Currently, the Stadhouderskade is one of Amsterdam's most polluted and hazardous streets, characterised by high traffic volumes, frequent accidents, and severe air and noise pollution. The neighbourhood hasn't always looked this way. Historical sources—including 18th-century paintings now in the Rijksmuseum—depict it as a green, open space where people once strolled along the canal. The Green Mile initiative seeks to restore liveability by redesigning the area into a pedestrian-friendly zone that fosters walking, social interaction, and nature experiences, while also serving as a "living lab" for urban innovation. This aligns with Amsterdam's broader sustainability goals, which emphasise the reduction of energy, sustainable and green public spaces, and nature-inclusive design—contributing to a resilient ecological infrastructure and improved quality of life.

Within this area, there are initiatives that aim to increase the sustainability of houseboats along the Stadhouderskade, promoting measures such as insulation, green roofs, solar panels, and extracting heat from canal water. Houseboats are an integral part of Amsterdam's identity, shaping the city's canals for centuries. Although houseboat residents have never been large in number, their cultural and social impact has been substantial—shaping Amsterdam's maritime heritage and contributing to its distinctive urban character.[9] Houseboats face unique challenges in becoming more energy efficient. Given the complexity of implementing such measures, and the social-cultural nature of this housing community, they provide a highly interesting case for researching what is needed for people to adopt energy measures.

A DESIGN ANTHROPOLOGICAL APPROACH TO SUSTAINABILITY

We approach the uptake of energy efficiency measures not as behavioural challenges or barriers, but as embedded in local values, daily routines, and the specific conditions of everyday life.[10] Sustainability is then not simply about implementing the right policies or encouraging better behaviour—it is a deeply cultural, situated commitment.[11] As Sarah Pink argues, energy use is never isolated: it is shaped by habits, routines, cultural norms, and the material design of domestic spaces.[12] Similarly, Escobar[13] critiques one-size-fits-all approaches to sustainability, emphasising that sustainable practices must emerge from within communities and reflect their own ways of knowing.

He notes that for many social movements, sustainability is not merely about changing behaviour but about upholding entire ways of life.

This perspective helps us understand how residents assess sustainability measures—not as abstract targets, but as part of their ongoing negotiations with place, infrastructure, and environment. It is then important to attend to the affective and often invisible connections that shape how energy transitions are lived and imagined. Engagement with energy measures emerges from entanglements with neighbours, state actors, and other stakeholders, as well as how responsibilities are distributed across these interconnected relationships.[14] It is shaped by time, history, and memory, including previous experiences, trust in institutions (or its absence), and long-standing knowledge of what works in people's own living situations.

We adopted a design anthropology perspective, viewing design as an iterative, collaborative process that connects cultural understanding with material practices. This approach highlights the complex, situated experiences of sustainability by fostering dialogue and meaning-making among diverse stakeholders, revealing its cultural and relational dimensions.[15] Using this lens, we developed creative, participatory methods to explore how houseboat residents on Amsterdam's Stadhouderskade interpret, negotiate, and enact energy-efficiency measures in their daily lives.

Creative research methods

We conducted fieldwork from January-July 2024 by designer Bodil Liesdek and researcher Nick Verouden. We employed creative research tools that were designed to attune to the everyday rhythms of houseboat life: informal interviews, participant observation, photo-elicitation, neighbourhood walks, and collaborative mapping. Our entry point was the houseboats themselves—everyday sites where lived experience and sensory engagement shape the adoption of sustainable measures. We interviewed 12 residents in total. Conversations and mappings took place in and around their houseboats, allowing us to observe spatial layouts, liveability conditions, and sustainable adjustments (see fig. 1). Where possible, we used photographs to capture tacit aspects of how residents perceive and navigate sustainability—inviting them to highlight objects, renovations, or issues that reflected their experiences.



Figure 1. Residents and designer engaging in a mapping session at one of the houseboats, exploring local sustainability issues

We also engaged with residents in informal, community-organised settings. For example, we joined a local clean-up day and a "straatcafé" (Street Café) gathering (see fig. 2), where we introduced a low-threshold creative mapping activity to prompt reflection on the neighbourhood and future aspirations. To inspire forward-looking thinking, we organised a guided walking tour with 7 residents to Schoonschip—Europe's most sustainable floating neighbourhood. The visit introduced advanced ecological and social practices of living on water. A follow-up reflection session allowed residents to share insights, questions, and concerns, enriching the broader creative mapping process by linking present realities to aspirational futures. Beyond resident-led events, we interviewed Green Mile representatives and joined formal sustainability sessions hosted by the initiative, including presentations by urban environmental initiatives such as Natuur Milieuteam Zuid, Het Groene Loket, and Amsterdam Weerproof, which offered insight into current municipal approaches to sustainability.



Figure 2. Residents during their self-organised clean-up day, picture by Bodil Liesdek.

SUSTAINABILITY AND LIVEABILITY: INTERCONNECTED CONCERNS

Our research shows that to understand citizens' attitudes and willingness to adopt sustainability measures we need to adopt a relational approach: sustainability and liveability prove to be interconnected concerns for residents, which means that any interventions to increase the adoption of energy measures need to be relational too.

Houseboat residents have taken basic and affordable insulation measures—many have double-glazed windows, insulated floors, or have done other practical upgrades. Residents perceive such measures as aligning well with the broader appeal of houseboat living, which predominantly lies in the tranquillity, sense of freedom, and proximity to nature as central to residents' experience: "You're oriented toward the water, and you notice it's different from being oriented toward the city." Sustainable upgrades are welcomed, if it enhances the lifestyle that residents chose when living on the houseboat. Measures, such as offering insulation and ecological contribution, are seen as adding to the quality of life rather than disrupting it.

The hesitation toward adopting additional (and often more expensive) measures, such as switching to electric cooking, installing heat pumps or extra solar panels, or implementing green roofs, is present

when there is no clear addition or connection to the desired lifestyle and liveability. Of interest here is that familiar barriers were mentioned, such as high costs, technical constraints, the risk of damaging their boats, and uncertain returns on investment, but more interestingly, the interviewees would bring up other concerns relating to liveability: how their immediate surroundings shaped what felt possible, desirable, or worth the effort in everyday life. We here address how sustainability and liveability are deeply connected for residents, entangled with practices of care, shared responsibility, and complex histories of participation.

Care for the Immediate Environment

The concerns that residents turn the conversation to range from trash and junk left on the street and in parking areas, to noise and congestions, to tourists they feel treat the houseboat inhabitants as if they are actors. They also indicate how they take measures to respond to such intrusions on liveability, such as planting tall conifers, closing off spaces with mesh, or planning to install surveillance cameras. For the residents, first the care of the immediate surroundings needs to be addressed, before they can consider the energy measures. Many of them recognise the urgency of sustainability measures and express a willingness to make their houseboats more sustainable but see a disconnect between long-term environmental goals and the neglected state of their immediate surroundings.

For them, liveability is a basic condition that should be in place before or alongside sustainability efforts. Investing in energy-neutral homes feels paradoxical when everyday issues like littering, street pollution, and overlooked public maintenance persist (see Figure 3). “I think it’s great to talk about sustainability, but some basic things just aren’t taken care of yet… I find that frustrating,” one resident noted. Another added: “Sustainability is a beautiful and necessary goal—without it, the planet won’t survive. But while we invest in all sorts of green upgrades, the street stays filthy, covered in plastic.” This sentiment captures a key point: for residents, sustainable choices only become meaningful when they are part of an environment that is already liveable—clean, safe, and cared for. And this is something, they see as a shared responsibility, as we will outline in the next section.



Figure.3 Litter and garbage collected during a community clean-up day along the houseboats, picture by resident.

Shared Responsibility

When asked about sustainability measures, residents bring up what they consider failings of the municipality for the immediate environment, such as inadequate cleaning efforts outsourced to private contractors with limited oversight. These frustrations reflect a broader critique of how governments increasingly shift the burden of sustainable urban development onto citizens—especially in informal or less-regulated spaces—by promoting self-organisation and civic participation without providing sufficient support. In this context, residents' attitude toward sustainable actions are guided not by policy mandates, but by a strong sense of fairness, reciprocity, and care for their environment.

Responsibility is not an abstract value but a lived, everyday practice for the residents. They take pride in contributing to the neighbourhood's upkeep—cleaning shared spaces, maintaining public areas and gardens, and making practical improvements that enhance liveability. However, residents are clear: their initiatives are meant to complement—not replace—public responsibility. Participating in monthly cleanups, for instance, brings a sense of solidarity, but also reveals frustration with systemic neglect: "I really like our initiative, and it gives a feeling of doing something about it. But I also think it's very wrong—well, it's an urban problem—cleaning up someone else's mess that the city doesn't address." They relate where the municipality falls short directly to the call for them to take sustainability measures: "My interest should also be the interest of the municipality of Amsterdam. If I become sustainable, Amsterdam becomes sustainable."

Complex histories of participation

Houseboat residents have long navigated a complex legal and regulatory landscape, shaped by shifting policies and ambiguous relations with the municipality, which is important to consider when making sense of residents' relation to sustainability measures.[16] Throughout our fieldwork, residents repeatedly expressed frustration at the lack of clarity around rules and decisions that directly affect their lives. There were recurring frustrations over delayed repairs, vague policies, and poor communication. Residents pointed to a history of broken promises about subsidies, ignored maintenance requests, and general neglect of communal areas such as fences and shared gardens. One example stood out: the municipality hired a private company to plant greenery, but the company used the budget on just five tree pits without consulting the community. Residents had to restart the initiative themselves and reapply through formal channels.

Many residents could name moments when they felt excluded from decision-making processes and were left wondering about the rationale behind certain regulations. "All the rules are made without considering those who live here," one resident remarked. The scepticism is reinforced by a pattern of inconsistent enforcement, tokenistic participatory processes, and a history of unmet promises. As one resident put it, "They claim to support resident participation, but only within their predefined frameworks. Step outside of that, and you face resistance." Many residents spoke of participation fatigue, shaped by long-term dependencies and an enduring sense that their contributions are undervalued or ignored. Several have lived on the canals for decades and shared stories of arbitrary decisions and missed opportunities for genuine collaboration.

This erosion of trust not only impacts on resident's relation to sustainability measures but also affects their ability to care for their environment themselves. For instance, residents had informally, and over a longer period, transformed the buffer zone houseboats and the busy Stadhouderskade into green gardens (see Figure 4)—part of an unspoken deal: they maintained the space, and the municipality looked the other way. But the arrangement is very fragile as residents feel that at any moment, this could be revoked by municipality, since it was never officially authorized. For residents this means that care and commitment offer no protection when institutional recognition is absent.



Figure.4 Strip of land between houseboat and street, used by residents for informal green space and gardening

CONCLUSION AND RECOMMENDATIONS

Our findings show that for houseboat residents sustainability resembles what Puig de la Bellacasa[17] calls a "*matter of care"*: an ethical and practical commitment entangled with the maintenance of place, the environment, and community well-being. We see that residents speak about the liveability of both their inner and outer environment when considering energy measures. We have presented how the care and action in the inner and outer environment are interconnected for the residents, and how sustainability and liveability are entangled for them.

This is key to consider when developing new energy measures and interventions aimed at increasing the adoption of existing measures: when residents hesitate to install solar panels in canals that are polluted with waste or resist sustainability measures in neglected public spaces, they are not opposing sustainability itself, or unwilling to adopt new measures. Rather, they are drawing attention to the fragile infrastructures of care that support it. We have highlighted how residents call for mutual responsibility—where sustainable living is grounded in collective investments in liveability, safety, and respect for the environment.

This means that to build sustainable cities entails investing in building institutional trust, collective care for the immediate environment, and transparent communication and relations that foster and recognise the value of self-organised forms of care and maintenance. In this way sustainability can become the shared responsibility that it is, while acknowledging the effort of all involved to build more sustainable and liveable cities.

NOTES

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DIGITAL PLATFORMS FOR COMMUNITY-LED TOURISM: CO-DESIGNING LIVEABLE RURAL COMMUNITIES IN MARGINAL TERRITORIES

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INTRODUCTION

The conceptual framework of liveable cities emerged in the 1970s as a response to urban quality-of-life crises, emphasizing resident participation, sustainable economic development, and quality of life indicators.[1] Contemporary urban studies have developed comprehensive multidimensional frameworks for assessing and promoting livability through measurable indicators and participatory approaches.[2]

However, this discourse has predominantly focused on urban contexts, leaving rural territories under-theorized despite facing equally pressing challenges regarding community sustainability, demographic decline, and social cohesion.[3] Rural territories demonstrate alternative models of human-environment interaction that may require fundamentally different livability frameworks than those developed for metropolitan contexts.[4]

The Italian Abruzzo region, with its predominantly mountainous and rural landscape, represents a paradigmatic case for investigating livability in rural areas. Community-based cooperatives operating in these territories have experimented with digital platforms to support community-controlled development, creating opportunities to investigate how digital infrastructure can support rural livability.[5]

This paper investigates how territorial livability elements in rural contexts are reflected in a digital platform (AbiTerrò) designed through participatory methods involving eight Abruzzo community cooperatives. This research expands livability frameworks beyond urban contexts while contributing to literature on how digital infrastructure can enhance territorial livability and maintain community autonomy.

TERRITORIAL DIMENSIONS OF COMMUNITY-LED TOURISM IN RURAL AREAS

The geographic configuration of the Abruzzo Region, with its predominantly mountainous landscape (65%) and extensive rural territories (34%), represents a paradigmatic case of territorial marginality within the contemporary Italian context.[6] This complex mosaic of spatial fragmentation reveals how isolation and demographic decline intersect to create conditions of peripherality that challenge conventional livability frameworks.The territorial structure reveals a demographic polarization: over

21% of Abruzzo municipalities remain below the critical threshold of 500 inhabitants. These scattered settlements epitomize the condition of marginal rural areas—territories characterized by limited accessibility to essential services, progressive demographic erosion, and structural disconnection from major economic centers. The resulting settlement pattern reflects not merely geographic constraints, but the ongoing process of socio-economic marginalization that has progressively hollowed out the demographic and productive fabric of these rural communities, creating what Vendemmia[7] et al. term a "demographic desert" within the broader regional landscape.

These ultra-small municipalities embody the essence of rural marginality, where population density drops below 10 inhabitants per km² and traditional economic activities struggle to maintain demographic viability. Of these municipalities, 53 fall within the provinces of L'Aquila (30) and Chieti (23), specifically concentrated in the predominantly hilly and mountainous areas. Extending the analysis to all "small municipalities"—those with populations up to 5,000 inhabitants that constitute the backbone of rural Abruzzo—reveals the territorial dominance of rurality: 254 municipalities, equal to 83.2% of the total regional administrative units, collectively hosting 339,922 residents (slightly more than a quarter of the regional total).

However, marginal territories also possess distinctive assets that position them uniquely for community-based tourism" (CBT), in which local communities directly manage tourism activities to ensure economic, social, and environmental benefits while preserving cultural and natural heritage[8] through historical cooperative structures, and resistance to external commodification pressures maintained through collective land ownership models.[9] These characteristics create favorable conditions for tourism models that prioritize community control and territorial authenticity while leveraging endogenous cultural-ecological knowledge systems, as demonstrated by the National Strategy for Inner Areas.[10]

THEORETICAL FRAMEWORK: FROM URBAN TO RURAL LIVABILITY

Urban Livability: core dimensions and spatial characteristics

The concept of livable cities emerged in the 1970s as a comprehensive framework for understanding urban quality of life, emphasizing measurable indicators that determine residents' well-being in metropolitan contexts. This conceptual development occurred as urban scholars began recognizing that traditional economic indicators were insufficient for capturing the complexity of urban life quality.[11] Contemporary urban livability research has systematically identified five fundamental dimensions that operate interdependently to create environments supporting diverse populations, economic activities, and social practices while maintaining environmental sustainability.[12]

Accessibility and connectivity encompass transportation systems, digital infrastructure, and efficient access to employment, services, and opportunities. Urban livability research demonstrates that integrated mobility networks fundamentally determine residents' quality of life by reducing travel times, environmental impact, and spatial inequalities while connecting residents to metropolitan opportunities and resources.[13] The literature emphasizes how transportation accessibility functions as a prerequisite for other livability dimensions, enabling access to employment markets, social services, and cultural amenities that characterize urban quality of life.

Economic opportunities and affordability involve access to diversified employment markets, affordable housing, and sustainable income levels that enable residents to meet essential needs. Urban economics literature reveals how metropolitan areas generate livability through agglomeration effects that create job diversity, entrepreneurial opportunities, and economic resilience while managing cost-of-living pressures.[14] Research demonstrates that economic livability depends on balancing employment accessibility with housing affordability, requiring policy interventions that can maintain economic diversity across urban neighborhoods.

Public services and social infrastructure include healthcare, education, cultural facilities, and institutional services delivered through centralized systems. Urban studies emphasize how metropolitan livability emerges through economies of scale that enable specialized service provision, professional expertise, and comprehensive coverage of resident needs through institutional frameworks.[15] The literature demonstrates that service accessibility requires both spatial distribution and institutional coordination that can deliver standardized quality across diverse urban populations.

Environmental quality and green spaces encompass air quality management, climate control, and environmental health factors. Urban environmental research reveals how cities achieve livability through planned green infrastructure, pollution control systems, and environmental management technologies that mitigate density-related environmental impacts. Studies demonstrate that environmental livability requires systematic approaches to managing the environmental consequences of urban concentration while providing access to green spaces that support resident well-being. Social cohesion and civic participation involve community networks, cultural diversity, safety systems, and governance structures. Urban sociology demonstrates how metropolitan livability depends on institutional frameworks that enable democratic participation, social integration across diverse populations, and collective decision-making through representative and participatory mechanisms.[16] Research reveals that social livability requires institutions capable of managing diversity while creating opportunities for civic engagement and community formation.

These dimensions operate through spatial concentration, institutional specialization, and infrastructure efficiency—characteristics that emerge from urban density, metropolitan scale, and centralized governance systems that can coordinate complex service delivery across large populations. Urban livability literature demonstrates that these mechanisms create interdependencies between dimensions that require systematic coordination to achieve comprehensive quality of life outcomes.

Interrogating rural livability: different spatial logics, alternative mechanisms

The direct application of urban livability frameworks to rural territories reveals fundamental conceptual limitations that have increasingly concerned rural development scholars.[17] Rural and marginal areas operate through different spatial configurations, demographic patterns, economic structures, and governance systems that require alternative analytical approaches. This recognition has led to growing criticism of what Copus et al.[18] term “urban-centric bias” in livability research, which assumes universal mechanisms while neglecting the distinctive spatial ontologies that characterize peripheral territories.

While urban livability emerges through concentration, specialization, and institutional coordination, rural livability operates through fundamentally different spatial and social mechanisms. Rather than density-based efficiencies and centralized service provision, rural territories achieve livability through dispersed networks, place-based knowledge systems, and community-scale governance that emphasize direct relationships over institutional mediation.[19] This distinction reflects alternative rationalities of space that resist metropolitan organizational logics while maintaining community sustainability through different operational principles.

The macro-dimensions of livability—accessibility, economic opportunity, services, environmental quality, and social cohesion—remain analytically relevant across urban and rural contexts. However, their specific characteristics and operational mechanisms differ significantly, requiring frameworks that can accommodate territorial diversity while recognizing alternative pathways to community well-being.[20] This perspective challenges universalist approaches to livability measurement that assume standardized indicators can capture the diversity of spatial practices through which different communities achieve sustainability and quality of life.

Territorial accessibility operates through local self-sufficiency networks and seasonal adaptation strategies rather than connectivity to external centers. Rural development literature demonstrates how rural livability depends on communities' capacity to meet essential needs through distributed resources, mutual support systems, and place-based problem-solving rather than efficient transportation to metropolitan services.[21] This accessibility model emphasizes community resilience and adaptive capacity over connectivity optimization, requiring analytical frameworks that can recognize local resource mobilization as a legitimate livability strategy.

Embedded economic systems transcend urban employment concentration through locally-rooted productive activities, seasonal work patterns, and community-controlled resource circulation. Economic geography research reveals how territorial livability emerges through value retention within local economies, diversified production systems that integrate multiple sectors, and economic activities that maintain harmony with ecological cycles rather than seeking metropolitan market access.[22] This economic model challenges growth-oriented development paradigms by demonstrating alternative pathways to economic sustainability that prioritize local control over external integration.

Reciprocal care networks extend beyond institutional service delivery through mutual aid systems, collective resource management, and community-controlled support provision. Social geography literature demonstrates how rural livability depends on direct social relationships and shared responsibility for community welfare rather than specialized institutional services.[23] These care systems operate through informal networks that can substitute for institutional services while maintaining community autonomy over care provision and social support coordination.

Ecological integration replaces urban environmental management with direct participation in seasonal ecological cycles, landscape-specific resource stewardship, and adaptation to geographical constraints. Environmental sociology research reveals how territorial livability emerges through harmony between human activities and ecological processes rather than technological mitigation of environmental impacts.[24] This environmental approach emphasizes adaptive co-evolution with natural systems over environmental control, requiring recognition of ecological embeddedness as fundamental to territorial sustainability.

Place-based governance transcends urban civic participation through consensus-building practices, intergenerational knowledge transmission, and collective decision-making rooted in shared territorial commitment. Political geography literature demonstrates how territorial social cohesion emerges through direct participation in community governance rather than representative democratic institutions.[25] These governance systems operate through face-to-face deliberation and consensus-building processes that can maintain community coherence while accommodating internal diversity and external pressures.

Distinctive elements of rural livability

From this analysis, three distinctive elements emerge as particularly characteristic of rural livability, differentiating it from urban frameworks while maintaining relevance to community well-being and territorial sustainability:

- Seasonal responsiveness and temporal adaptation;
- Proximity-based social architecture and mutual support systems;
- Territorial knowledge integration and place-based problem-solving.

Seasonal responsiveness depends on communities' capacity to adapt their spatial practices, economic activities, and social organization to seasonal rhythms and environmental variations. Rural territories better achieve livability through flexible adaptation to ecological cycles, weather patterns, and resource availability fluctuations. This temporal dimension represents an ecological temporality that

resists standardization while maintaining community sustainability through adaptive coordination with environmental rhythms. This seasonal responsiveness manifests across multiple dimensions of territorial life. Agricultural cycles organize community labor and resource distribution, with planting, cultivation, and harvest periods requiring collective coordination that determines community availability for other activities.[26]

Accessibility patterns vary with weather and elevation, creating temporal variations in territorial connectivity that require adaptive transportation strategies and flexible service provision. Economic activities shift between seasonal tourism and agricultural production, requiring communities to develop diversified income strategies that can accommodate temporal variations in economic opportunity.[27] Social gatherings organize around harvest cycles and seasonal festivals, creating temporal patterns of community interaction that maintain social cohesion while accommodating ecological rhythms. Communities that successfully maintain livability demonstrate sophisticated temporal coordination systems that enable collective adaptation to environmental variability while maintaining social cohesion and economic viability. These coordination systems operate through collective decision-making processes that can anticipate seasonal challenges, resource sharing mechanisms that can accommodate temporal variations in individual capacity, and cultural practices that maintain community identity across seasonal cycles.[28]

Research demonstrates that seasonal responsiveness requires institutional flexibility that can accommodate temporal variation while maintaining community commitment to collective welfare and territorial sustainability. Seasonal responsiveness requires place-based knowledge systems that integrate ecological understanding with community organization, enabling residents to anticipate environmental changes and coordinate collective responses. This knowledge integration involves weather prediction systems based on local ecological indicators, resource management strategies adapted to seasonal availability patterns, and social coordination protocols that can maintain community function across temporal variations.[29]

The knowledge dimension of seasonal responsiveness reflects sophisticated understanding of local ecological systems combined with social organizational capacity to implement adaptive responses that maintain community livability across environmental variation. This temporal dimension of livability challenges universalized approaches that assume standardized service delivery and constant accessibility, instead requiring frameworks that can accommodate cyclical variations and community-controlled adaptation strategies. Urban-derived development models that prioritize year-round standardization may inadvertently undermine seasonal responsiveness by imposing temporal logics that conflict with ecological rhythms essential to territorial sustainability. Recognition of seasonal responsiveness as fundamental to rural livability requires policy approaches that can accommodate temporal variation while supporting community adaptation capacity.

Proximity-based social architecture is based on direct interpersonal relationships, mutual aid networks, and collective resource management rather than institutional service provision. Unlike urban contexts where social cohesion operates through institutional mediation and diverse network connections, rural territories depend on proximity-based relationships that create comprehensive mutual support systems. This social dimension reflects what the relational territoriality that prioritizes direct social relationships over institutional coordination while maintaining collective capacity to address community needs and challenges. This social architecture operates through multiple interconnected mechanisms that create comprehensive community support systems.

Intergenerational knowledge transmission maintains community expertise and cultural continuity through direct mentorship relationships that transfer practical skills, cultural knowledge, and territorial understanding between generations. Reciprocal assistance systems distribute labor and resources according to community needs through informal networks that can mobilize collective capacity to

address individual challenges, seasonal labor requirements, and community infrastructure needs. Collective decision-making processes enable consensus-building and shared governance through face-to-face deliberation that can accommodate diverse perspectives while maintaining community coherence and territorial commitment. Reputation-based trust systems regulate social cooperation and resource sharing through long-term relationship networks that create accountability mechanisms and conflict resolution processes. These trust systems operate through extended personal knowledge that enables assessment of individual reliability, reciprocity commitment, and community contribution, creating social regulation mechanisms that can maintain cooperation without formal institutional enforcement.

Research demonstrates that reputation-based trust requires sustained residence and territorial commitment that enables the development of comprehensive interpersonal knowledge essential to community cooperation and mutual support coordination. Proximity-based social architecture requires sustained residence and territorial commitment that enables the development of long-term reciprocal relationships. This residential stability creates conditions for developing comprehensive interpersonal knowledge, multi-generational relationship networks, and collective capacity for community problem-solving and resource management. The residential dimension of proximity-based social architecture challenges mobility-oriented development models that assume individual optimization through geographic mobility, instead requiring recognition that territorial commitment enables social architecture development essential to community livability. This social dimension of livability depends on community members' willingness to prioritize collective welfare over individual optimization, creating social conditions that can substitute for institutional services through distributed care provision and mutual support. This collective orientation requires cultural values that emphasize community responsibility, resource sharing, and mutual aid over individual accumulation and competition.[30] The value dimension of proximity-based social architecture reflects community commitment to collective welfare that enables mutual support systems to function effectively while maintaining individual dignity and community cohesion.

Territorial knowledge integration depends on communities' capacity to integrate place-specific knowledge systems with contemporary challenges, enabling locally-appropriate solutions that maintain territorial sustainability while addressing current needs. Unlike urban contexts that rely on professional expertise and standardized solutions, non-urban territories achieve livability through place-based innovation that combines traditional knowledge with adaptive problem-solving. This knowledge dimension reflects the territorial intelligence that enables communities to develop locally-appropriate responses to challenges while maintaining cultural continuity and environmental sustainability. This knowledge integration manifests across multiple domains of territorial life. Landscape-specific resource management techniques optimize local environmental conditions through agricultural practices adapted to soil conditions, climate patterns, and ecological relationships specific to particular territories. Traditional craft knowledge adapts to contemporary economic opportunities through artisanal production that maintains cultural authenticity while creating income opportunities that support territorial sustainability. Place-based governance systems coordinate collective decision-making according to territorial specificities through consensus-building processes that accommodate local social dynamics, environmental constraints, and cultural values.[31] Cultural practices maintain community identity while enabling selective engagement with broader networks through festivals, traditions, and social customs that preserve territorial distinctiveness while creating opportunities for cultural exchange and external relationship development. These cultural practices operate as mechanisms for maintaining community coherence while enabling adaptive responses to external challenges and opportunities that can support territorial sustainability without undermining community autonomy or cultural integrity. Territorial knowledge integration requires community-

controlled learning processes that can incorporate external innovations while maintaining place-based appropriateness. This learning capacity involves evaluation mechanisms that can assess external innovations for territorial compatibility, adaptation processes that can modify external solutions to local conditions, and transmission systems that can integrate new knowledge into existing community knowledge systems.

Research demonstrates that successful knowledge integration requires community control over learning processes to ensure that innovation enhances rather than undermines territorial sustainability and community autonomy. This knowledge dimension of livability challenges expert-driven development models that assume professional expertise supersedes local knowledge, instead requiring approaches that recognize community expertise and support locally-controlled innovation processes that strengthen rather than undermine territorial sustainability. Urban-derived development models that prioritize standardized solutions may inadvertently undermine territorial knowledge systems by imposing external expertise over place-based understanding essential to territorial livability. Recognition of territorial knowledge integration requires development approaches that can support community-controlled innovation while respecting place-based expertise and territorial autonomy.

Digital platforms and Community-based tourism

Digital infrastructure can either support or undermine the distinctive elements of rural livability, depending on design principles and implementation approaches. Mainstream digital platforms often impose urban-derived organizational logics that conflict with seasonal responsiveness, proximity-based social architecture, and territorial knowledge systems, potentially disrupting the mechanisms through which non-urban territories achieve livability.

However, participatory digital design processes can create a technological infrastructure that enhances rather than replaces the distinctive elements of non-urban livability. Community-controlled digital platforms can support seasonal responsiveness through flexible content organization and temporally adaptive functionality, strengthen proximity-based social architecture through digital tools that amplify existing mutual support networks, and enhance territorial knowledge integration through platforms that enable place-based information sharing and community-controlled innovation.

The challenge lies in developing digital infrastructure that operates as an extension of existing territorial practices rather than as a replacement for place-based livability mechanisms. This requires co-design processes that position communities as primary decision-makers in digital platform development, ensuring that technological infrastructure supports rather than undermines seasonal responsiveness, social proximity, and territorial knowledge integration that characterize sustainable non-urban communities.

Community-based tourism emerges as particularly relevant to non-urban livability when implemented through frameworks that strengthen rather than commodify the distinctive elements of territorial sustainability. Unlike mass tourism, which often disrupts seasonal rhythms, social architectures, and territorial knowledge systems, community-controlled tourism can enhance non-urban livability through economic activities that integrate with existing territorial practices.

Community-based tourism supports seasonal responsiveness by organizing visitor activities according to agricultural cycles, ecological patterns, and community availability rather than year-round standardization. It strengthens proximity-based social architecture by creating structured opportunities for meaningful interaction between visitors and residents while maintaining community control over tourism development. It enhances territorial knowledge integration by enabling communities to share place-based expertise with visitors while generating economic value that supports territorial sustainability.

The implementation of community-based tourism through digital platforms creates opportunities to examine how technological infrastructure can support the distinctive elements of non-urban livability while enabling selective engagement with broader tourism networks. This intersection provides a concrete context for investigating how participatory digital design can create tools that enhance territorial livability rather than imposing external organizational logics onto local communities.

METHODOLOGY: PARTICIPATORY CO-DESIGN WITH COMMUNITY COOPERATIVES

We employed a transformative methodological framework integrating Design Thinking principles with participatory action research, operationalized through Design Sprint workshops—a systematized five-phase participatory process for identifying territorial challenges, establishing collective objectives, generating contextually embedded solutions, and prototyping community-controlled outcomes.[32] This methodological choice represents a deliberate departure from extractive research paradigms, positioning community cooperatives as co-researchers and primary decision-makers, while researchers functioned as methodological facilitators and collaborative documentation specialists.

Our approach synthesizes participatory design theory[33] with territorial development frameworks, creating what we term "territorial co-design"—a methodology that recognizes digital platforms as socio-spatial infrastructures requiring community epistemologies rather than external technological impositions. This theoretical positioning aligns with recent advances in participatory planning that conceptualize communities as distributed cognitive systems capable of generating place-based innovation through collaborative knowledge construction.

Research participants comprised representatives from eight strategically selected Abruzzo community cooperatives operating across diversified sectors including tourism, agriculture, cultural preservation, and social services: La Maesa (Aielli), Vallis Regia (Barrea), Oro Rosso (Navelli), Vivi Calascio (Calascio), La Chiave dei Tre Abruzzi (Popoli), Tavola Rotonda (Campo di Giove), Cuore delle Valli (Goriano Valli), and Sette Borghi (Sante Marie). Selection criteria emphasized: established collaborative experience; demonstrated commitment to community-led territorial development; operational diversity representing territorial complexity; and geographic distribution across Abruzzo's distinctive ecological-cultural zones.

The methodological framework operationalized five sequential yet iterative sessions based on Design Sprint principles. Data generation employed multimodal ethnographic approaches, combining participant observation with collaborative documentation strategies including visual sketches, digital prototypes, recorded discussions, and co-created analytical exercises.[34] This methodological triangulation enabled the capture of both explicit knowledge articulations and tacit territorial understandings embedded in cooperative practices. Analytical procedures followed iterative thematic coding protocols designed to identify emergent patterns in participants' territorial values, community-development visions, and platform design preferences, while maintaining collaborative interpretation processes that validated findings through participant feedback loops.[35]

LIVABILITY ELEMENTS IN THE ABITERRÒ DIGITAL INFRASTRUCTURE

The co-design process resulted in *AbiTerrò*, a platform prototype that demonstrates how digital infrastructure can support the three distinctive elements of rural livability identified in our theoretical framework. Analysis reveals the systematic integration of seasonal responsiveness, proximity-based social architecture, and territorial knowledge systems into platform functionality. The resulting platform reflects what Barns[36] terms "place-based digital infrastructure"—technological systems that extend rather than replace existing territorial practices while maintaining community control over development processes.

Seasonal responsiveness in digital architecture

Participants embedded seasonal adaptation directly into platform organization, creating digital infrastructure that responds to temporal variations rather than adhering to year-round standardization. This challenges are the temporal universalism of mainstream digital platforms. The platform's activity framework organizes content according to elevation-specific conditions and seasonal accessibility patterns, reflecting central Apennine ecological cycles rather than universal tourism calendars.

Indeed, AbiTerrò aims to offer only services that are in harmony with the rhythms of the seasons: the choice of activities is guided by the natural filter of the four seasons (Fig. 1). This is influenced by various elements, such as climatic conditions, flora and fauna. Wildlife rhythms, for example, shape appropriate outdoor activities, with information about breeding seasons, migration patterns, and conservation protocols. This temporal organization enables visitor coordination with territorial rhythms rather than imposing external demands that conflict with seasonal community practices. In doing so, it preserves communities' ability to prioritize territorial needs over visitor demand while maintaining seasonal responsiveness, which is essential to non-urban liveability.

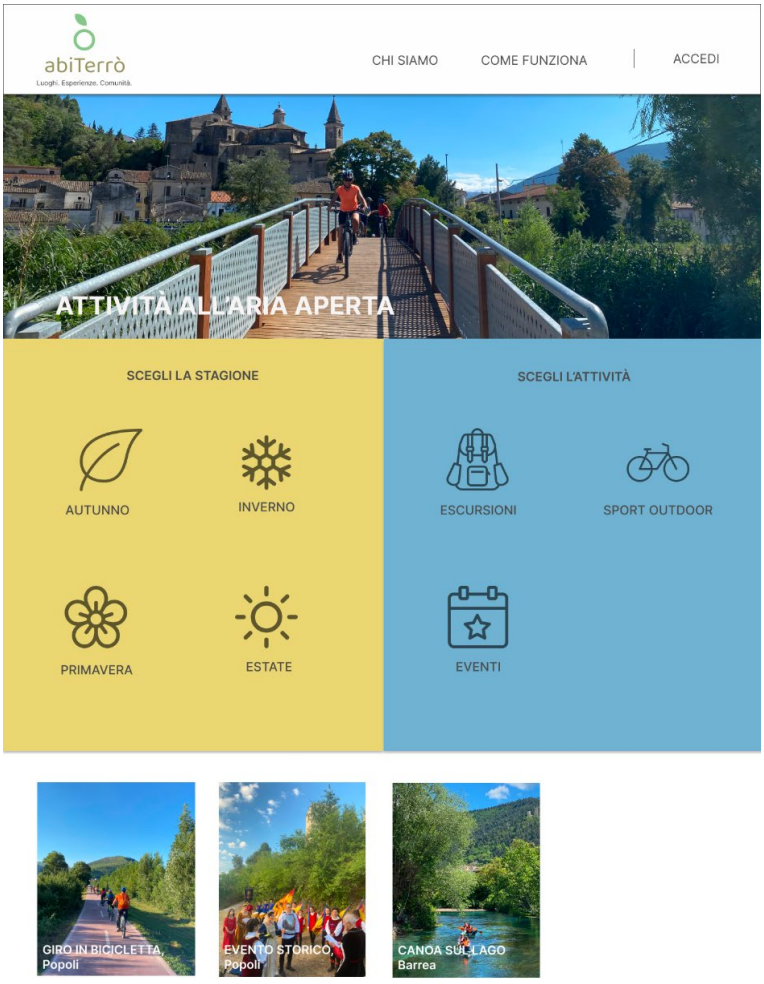


Figure1. Outdoor activities for tourists following seasonal rhythms

This approach is also reflected in additional elements of the booking process, which is not automatic but depends on a booking request to confirm actual availability. In this way, visitors are invited to embrace a different logic, closer to the reality of the territory (Fig. 2). Indeed, the "check availability" feature enables service providers to maintain seasonal flexibility through multi-step confirmation

processes assessing request appropriateness according to current territorial conditions, community capacity, and visitor preparation levels.

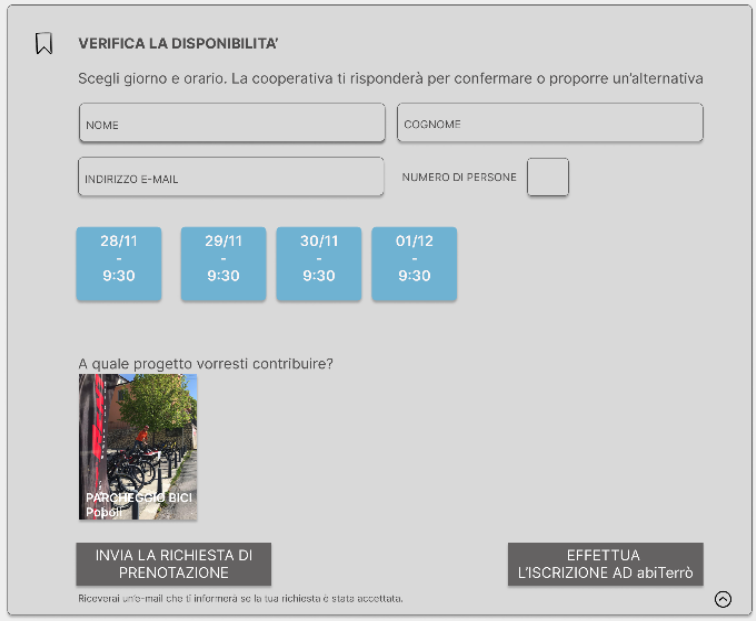


Figure 2. "Check availability" request

The overall framework follows the principles of authenticity: providing real experiences consistent with seasonal cycles, it goes beyond merely offering products aligned with the seasons. This is particularly evident for agricultural activities. Indeed, agricultural cycles determine community activities, combining (in specific periods) farming with tourism services, for example by involving tourists in the harvest. Oro Rosso cooperative detailed how October saffron harvest requires intensive community mobilization, potentially requiring tourists' engagement in these activities. This reinforces the central role of the "land" in authentic experiences.

Furthermore, there is a deliberate effort to eliminate folkloristic elements: authenticity does not mean promoting standardized or stereotypical images of the territory, and the same applies to the idea of seasonality, reinterpreted as a continuum of genuine experiences and values.

Proximity-based social architecture enhancement

The platform amplifies existing proximity-based social networks through digital tools that extend rather than replace direct interpersonal relationships, reflecting what Sandoval[37] terms "community-controlled digitization." The "proximity services" section functions as digital infrastructure for mutual aid coordination, enabling community members to organize collective resource sharing, support, and care provision while maintaining face-to-face relationships essential to territorial social architecture. The proximity services functionality operates through multiple coordination mechanisms. Resource-sharing coordination enables tool lending, equipment sharing, and collective resource management through digital bulletin board functionality,[38] through which people can simultaneously access services offered by others or by cooperative communities, and offer their own services (Fig. 3).

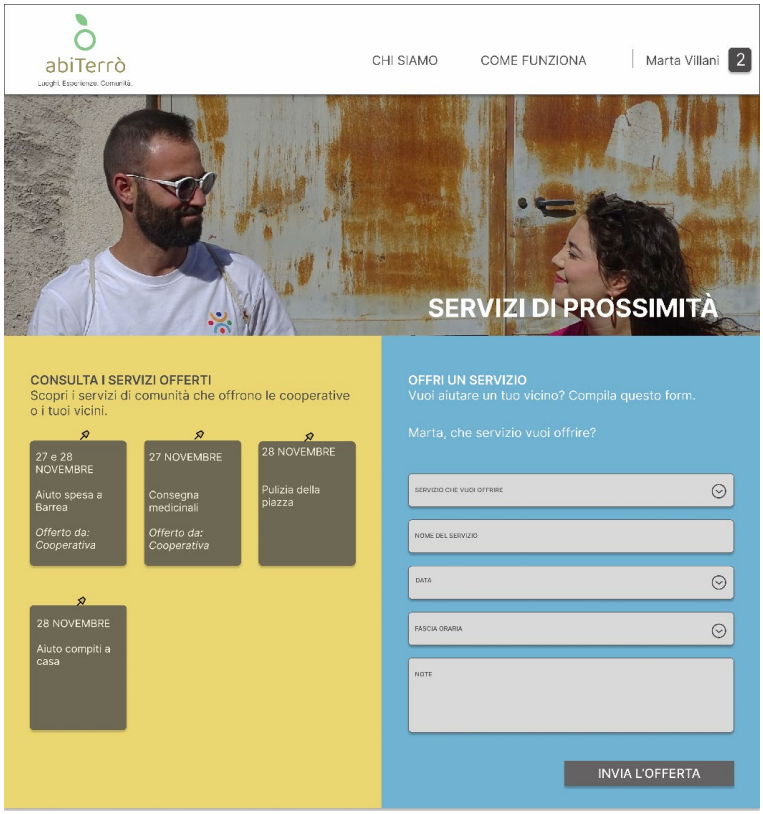


Figure 3. "Proximity services" functionality

Care provision coordination enables eldercare, childcare, and community support activities while maintaining both privacy and dignity. Rather than creating parallel digital communities, AbiTerrò maintains territorial social protocols through interaction designs requiring face-to-face confirmation, reputation-based trust systems, and community accountability mechanisms that preserve the direct relationship foundations essential to non-urban social architecture.[39]

The platform's unified navigation system reflects the fluidity of territorial identity, enabling users to transition between visitor and community member roles based on sustained engagement rather than predetermined categories. This supports proximity-based social integration processes, through which visitors can gradually participate in territorial mutual support systems while respecting community control over integration pathways.[40] One of the key features of AbiTerrò is the absence of a strict distinction between *"tourists"* and *"inhabitants"*. Tourists can gradually become inhabitants, while inhabitants are not limited to accessing only community services: they can also benefit from services and activities that are typically considered touristic. Accommodation, as a fundamental service, plays a central role within the platform and represents the starting point for enabling the integration of tourists as potential inhabitants of the territory.

Territorial knowledge integration and digital transmission

AbiTerrò operationalizes territorial knowledge as functional infrastructure rather than commodified content, creating digital systems that support place-based problem-solving and community-controlled innovation. This reflects what Scholz[41] identifies as "knowledge commons" which maintain community control over intellectual resources while enabling selective sharing.

In AbiTerrò, territorial knowledge integration and digital transmission emerge in the efforts of community cooperatives to design a digital platform that not only integrates the unique features of the

territory but also adapts its functionalities to these specific characteristics. The co-design process thus represents the very essence of this element of rural livability.

The platform aims to present and strengthen the identity of local communities, characterized by several key features. First, workshop participants highlighted the need to overcome the distinction between tourist and resident. As a result, the platform does not offer differentiated services for these categories, but rather provides the same opportunities for both. Figure 4 shows one of the key sentences on the AbiTerrò platform which summarises this concept (translation: "*Come live with us for an hour, a day... a lifetime*", emphasising how tourists may even become potential inhabitants of the area). In this sense, it acts as a tool for sharing and enriching local identity, considering visitors as bearers of innovative ideas for the territory.



Figure 4. Tourists as potential future inhabitants of the area

This enrichment also takes place through a functionality that allows a portion of the revenue from each activity or service to be allocated to local projects (such as the regeneration of specific areas or the creation of new public amenities). In this way, visitors' connection with the rural territory also materializes as a direct economic contribution to the community. Figure 5 shows that in the activity booking phase, users can decide the local project to sustain.



Figure 5. People can sustain local projects

The platform's economic mechanisms channel visitor contributions into territorial knowledge preservation and community development, through local spending incentives and collective contributions that strengthen the link between tourism experiences and territorial sustainability.[42] These mechanisms enable tourism to contribute to the transmission of local knowledge while preserving community control over cultural processes and intellectual property rights.

Rural activities constitute another distinctive element of territorial identity and therefore of the platform itself. All proposed experiences revolve around the idea of "the land": they mainly include outdoor and food-and-wine activities, but also cultural initiatives, educational experiences, and proximity services, all rooted in rural practices and knowledge. (Fig. 6. Translation: "*We care for the land, we cultivate ideas: you can do it with us*").



Figure 6. "Land" as a key characteristic of the territory

In addition, the individual profiles of each activity provide a wealth of information, not only of a logistical nature but also general knowledge. For example, in its profile, the Oro Rosso cooperative detailed how saffron cultivation requires knowledge integration across soil preparation, planting schedules, harvesting techniques, and processing methods, combining traditional expertise with contemporary quality standards. Profiles related to traditional crafts document knowledge integration in stone masonry, woodworking, and textile production, using multimedia resources that capture both technical procedures and cultural contexts.

The "experience diary" functionality (Fig. 7.) further supports territorial knowledge transmission by allowing participants to share comments on the activities they experienced. These narratives go beyond impressions and advice, providing practical information and reflections. Rather than reducing territorial knowledge to standardized reviews, they capture learning processes that foster collective knowledge integration and allow selective sharing with visitors seeking authentic engagement.[43]

Similarly, the use of *badges* associated with completed activities is not linked to economic value or competitive mechanisms, but rather intends to narrow the gap between people and the territory, encouraging mutual recognition among different user groups.

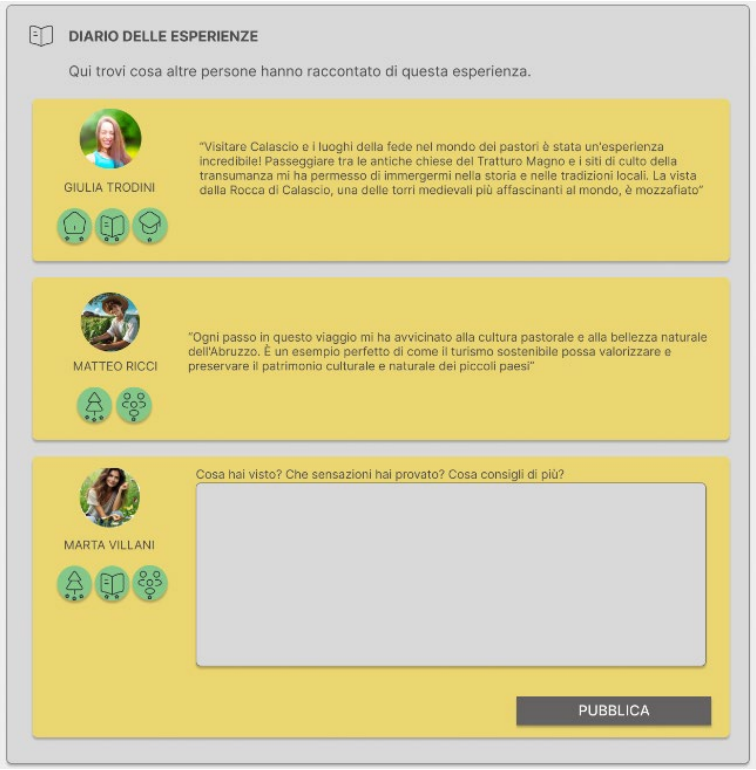


Figure 7. Experience diary

Finally, the platform integrates artificial intelligence tools, such as a bot that supports users in booking activities (Fig. 8.). This tool is designed with priority given to *content curation* over algorithmic optimization, suggesting experiences based on landscape appropriateness, seasonal timing, and community knowledge systems rather than behavioral patterns or commercial priorities.[44]



Figure 8. An artificial intelligence tool guiding users in booking activities

In conclusion, the platform seeks to convey the specific identity of the territory, positioning itself as an alternative to mainstream platforms from which it deliberately distances itself. A clear example of this is the registration process, which requires only essential information, with no intention of data collection, profiling, or integration with external platforms.

CONCLUSIONS

This research demonstrates how participatory co-design can generate digital infrastructure that supports the three distinctive elements of rural livability: seasonal responsiveness, proximity-based social architecture, and territorial knowledge integration. The *AbiTerrò* case reveals how community-controlled digital platforms can enhance territorial livability mechanisms, challenging which identifies as the metropolitan bias in development frameworks.

The identification of these three elements extends livability frameworks beyond universal livability models, providing analytical tools that accommodate territorial diversity while recognizing alternative pathways to community well-being. This expansion demonstrates how spatial context fundamentally shapes the mechanisms through which communities achieve sustainability and quality of life through organizational principles different from the urban concentration, specialization, and institutional coordination emphasized in metropolitan livability research.[45] The research contributes to a critical rural studies by revealing how temporal adaptation, direct social relationships, and place-based problem-solving create territorial sustainability through context-specific mechanisms rather than universalizable criteria.

The participatory co-design methodology demonstrates how community led cooperatives can function as effective research partners while maintaining community control over knowledge production processes, addressing the need for culturally appropriate design methodologies. The methodological approach offers alternatives to an extractive research paradigms, by positioning territorial communities as experts in their own development needs.

The findings suggest significant implications for rural development policy, particularly regarding the tension between digital infrastructure standardization and place-based development needs.[46] Current approaches that prioritize connectivity and standardization may inadvertently undermine non-urban livability by imposing urban organizational logics onto territorial contexts that operate through different sustainability mechanisms. Policy frameworks should recognize the community-controlled development, by prioritizing local control over digital infrastructure, seasonal flexibility in service provision, and territorial knowledge systems as legitimate expertise rather than obstacles to modernization. This requires identifying institutional approaches capable of accommodating territorial diversity while providing resources for community-controlled development processes.

Digital infrastructure investment in rural contexts should emphasize the community capacity building rather than external platform adoption, enabling territories to develop technological solutions that enhance rather than disrupt existing livability mechanisms. This approach suggests alternative development models that prioritize territorial sustainability over standardized modernization strategies that may undermine place-based sustainability mechanisms.

This study's focus on Abruzzo's mountainous territories and community cooperatives limits generalizability across different geographical contexts, economic structures, and social organization patterns. The temporal scope limits understanding of long-term impacts of community-controlled digital platforms on territorial livability, requiring what Guest et al.[47] identify as longitudinal research approaches to assess the durability of community-controlled digital infrastructure.

Future research could investigate how these livability elements manifest across diverse geographical contexts, examine the scalability of participatory co-design methodologies, and explore long-term impacts of community-controlled digital platforms on territorial sustainability. The intersection of territorial livability with broader sustainability frameworks, including climate adaptation and demographic change, represents important areas for continued investigation that could contribute to developing comprehensive approaches to rural sustainability in contexts of environmental and social change.

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CONTRASTING VIEWS ON DEVELOPMENT OF IMMOVABLE CULTURE HERITAGE? MANAGEMENT OF IMMOVABLE CULTURAL HERITAGE BETWEEN POPULISM AND SUSTAINABLE DEVELOPMENT

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INTRODUCTION

Modifications in the management, use, and oversight of immovable cultural heritage often spark intense debates among various stakeholders in local communities. This highlights the significant role and value of heritage in society and its contribution to overall quality of life. This impact is particularly evident in various locations, cities, regions that are deeply connected to the identity, cultural significance, and historical importance of immovable cultural heritage. Immovable cultural heritage from this perspective serves as a source of pride, a link to the past, and a crucial element in defining local identity. Consequently, decisions about its future inevitably elicit strong emotions and divergent perspectives. Due to the sensitivity of processes that seek to balance the interests of different groups in relation to immovable cultural heritage, any possible wrong action can have a strong impact on local development and significantly reduce the quality of life in the community. For instance, decisions that prioritize economic gains over heritage preservation can lead to the deterioration of historical landmarks, which in turn diminishes the character and uniqueness of a place. On the other hand, overly rigid conservation policies may hinder necessary development and adaptation to modern needs, causing frustration among residents and stakeholders.[1] Striking a balance between conservation and sustainable development remains a challenge that requires a nuanced approach.[2]

For this reason, any planned change in the management of cultural heritage must be thoroughly scrutinized by the population. Local engagement and participation in decision-making processes are crucial in ensuring that cultural heritage remains relevant and beneficial to the community.[3] Public consultations, surveys, and participatory planning are some of the tools used to incorporate local voices into heritage management.[4] The involvement of the local population not only fosters a sense of ownership and responsibility but also enhances the sustainability of cultural heritage projects.[5] Without public support and consensus, even well-intentioned heritage initiatives may face resistance and ultimately fail.[6] Although the information obtained through opinion surveys reveal many straightforward opinions and viewpoints on the management of immovable cultural heritage, it also reveals some seemingly paradoxical situations where respondents simultaneously accept and reject certain opinions in regard to the development of heritage.[7] This contradiction reflects the complexity

of cultural heritage management, where individuals may value historical preservation while also desiring modernization and economic growth.[8] For example, communities may advocate for the conservation of historical buildings while also supporting large infrastructure projects that may radically transform and threaten these structures. These conflicting perspectives highlight the need for a careful and context-sensitive approach when making decisions about cultural heritage.

Based on data from research project HEI TRANSFORM the paper explores how could perceptions of different management models potentially impact heritage preservation and community well-being. By putting it on display for various population groups and heritage users It considers the potential impact of introduction of new policy frameworks, new funding mechanisms, and the role of private and public institutions in managing heritage assets. By drawing comparisons between different options for immovable cultural heritage management, the study sheds light on the effectiveness of various approaches and identifies key challenges that policymakers and heritage professionals must address.

METHODS

The methodology is based on the analysis of a large panel survey from the HEI-TRANSFORM research project in Slovenia.[9] The key part of the research process was the preparation of a questionnaire on the role of immovable cultural heritage in ensuring the quality of life in local communities. In it, we asked individuals about their opinions and views on the current state and future of immovable cultural heritage, i.e. buildings (e.g. castles, manors, city centers), artifacts, archaeological remains and other physical objects of cultural heritage according to individual locations or places and Slovenia in general. The purpose of the research process was to obtain data on what would be the most appropriate arrangement and use of immovable cultural heritage. Furthermore, the intent was also to get introspection into what the public thinks about the potential advantages or disadvantages of changes and modernizations that were carried out on immovable cultural heritage in the last period. The accumulation of data set started in January 2024 and ended in February 2024. This part of the process was followed by cleaning of the database and preparation of data for further analysis. The panel survey covered the entire area of Slovenia and was based on a balanced panel sample by gender, age, location, income, education, age and other demographic variables. The total number of interviews included in the study is 1150 people (N = 1150). The acquired data were interpreted by using additional secondary case study analysis of specific sites in Slovenia, covering architectural heritage, archaeological sites, and other representative immovable cultural heritage. These secondary data complemented the research in terms of providing additional insights and explanatory dimensions which allowed the data to be usable for potential formation of policy recommendations or production of strategies for managing immovable cultural heritage in communities on local, regional and state level.

ANALYSIS

Data from the HEI TRANSFORM survey (2024) show that Slovenia is characterized by an exceptional attachment to immovable cultural heritage at the local level. Respondents particularly highlight how immovable cultural heritage is important for local identity or identity of the place. Respondents identify with the immovable cultural heritage, which with symbolic, cultural, architectural and urban elements constitute the core of representations of what is the place, locality and local community. This pronounced attachment of respondents to immovable cultural heritage indicates its exceptional role in shaping development strategies for places, cities and space in general – illustrated in Graphs 1 and 2.[10]

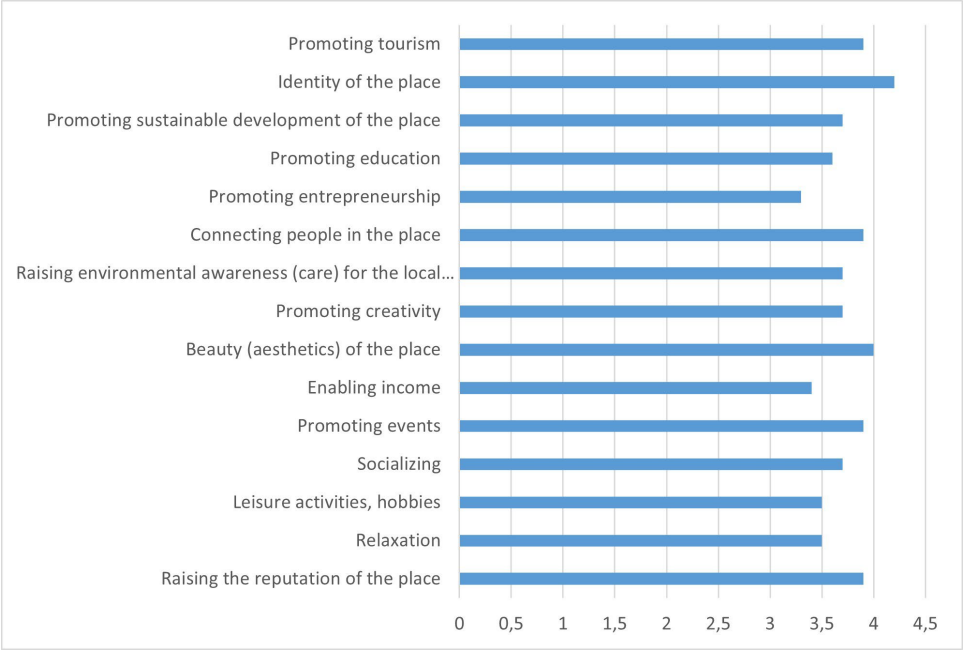


Figure 1. How important is immovable cultural heritage according to specific dimensions?

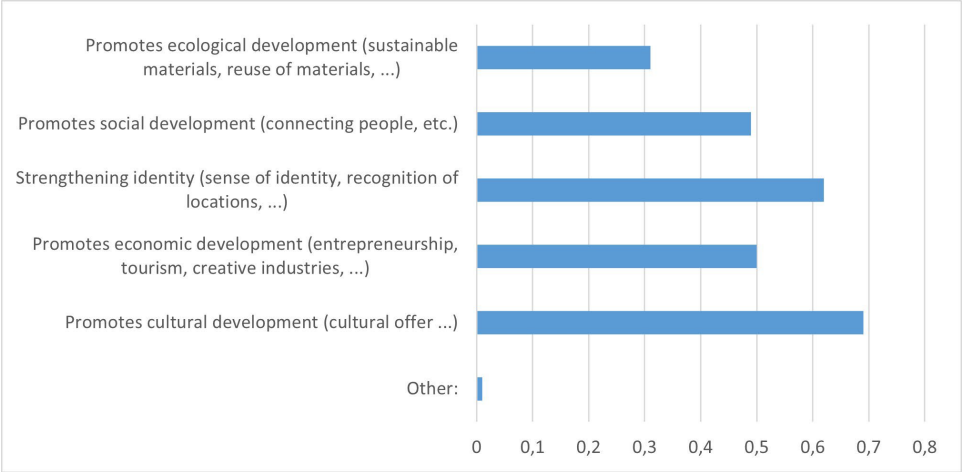


Figure 2. Why can immovable cultural heritage be an opportunity for?

The most important dimension of the immovable cultural heritage is therefore the identity of the place, followed by the beauty (aesthetics) of the place and other dimensions. The presence of several dimensions, many of which also relate to economic activities (e.g. promoting tourism, enabling income, promoting entrepreneurship), indicates that the key role of immovable cultural heritage, in addition to its symbolic-cultural value or symbolic cultural capital, is also represented by economic capital. If symbolic capital represents the basis for further networking of leisure activities (e.g. promoting events, connecting people in the place, promoting creativity, socializing, raising environmental awareness, other leisure activities, hobbies, etc.), economic capital complements the role of immovable cultural heritage for the development of places (e.g. promoting tourism, enabling income, promoting entrepreneurship, etc.). It is precisely this dual role of immovable cultural heritage that understandably often causes tensions regarding appropriate further development strategies for places, as different interest groups seek different advantages in managing immovable cultural heritage. This can be seen through a more detailed analysis of the data on the attitudes of respondents regarding the ways of potential use of the immovable cultural heritage in their immediate

surroundings. The analysis reveals how they see the development of places, or what their development vision is in connection with immovable cultural heritage, how they assess the importance of the immovable cultural heritage and its role in the development of a place – as illustrated in Graph 3.

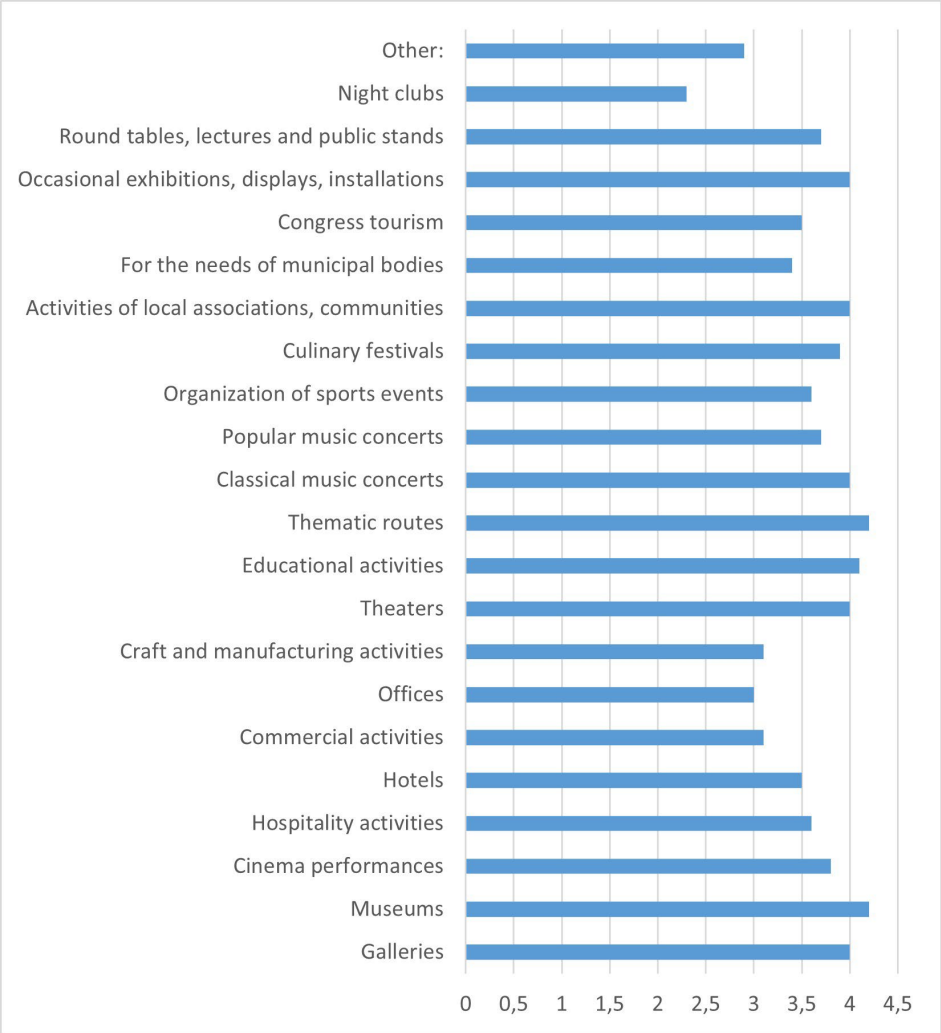


Figure 3. Immovable cultural heritage objects can have different uses, they can be intended for exhibitions, galleries, or they can for example offer hotel accommodation. To what extent do you support the use of immovable cultural heritage in your locality for the following activities?

By explaining what they consider as appropriate uses, methods of management, and changes to the immovable cultural heritage, respondents indirectly reveal their views on the potential development of the place, the pace of development, and visions for promoting different types of jobs, services, and various economic activities related to the immovable cultural heritage (Graph 3). Despite the fact that public and semi-public services dominate the top of the list (e.g. education, local associations, museums, thematic trails, etc.), it should be noted that there is also a strong emphasis on gainful activities related to the economic development of the place (e.g. hotels, catering, congress tourism, etc.). A good insight into how they see the potential development of the place and the consequent changes to the immovable cultural heritage is also the question of the opportunities and burdens that the immovable cultural heritage represents for a place – illustrated in Graphs 4 and 5.

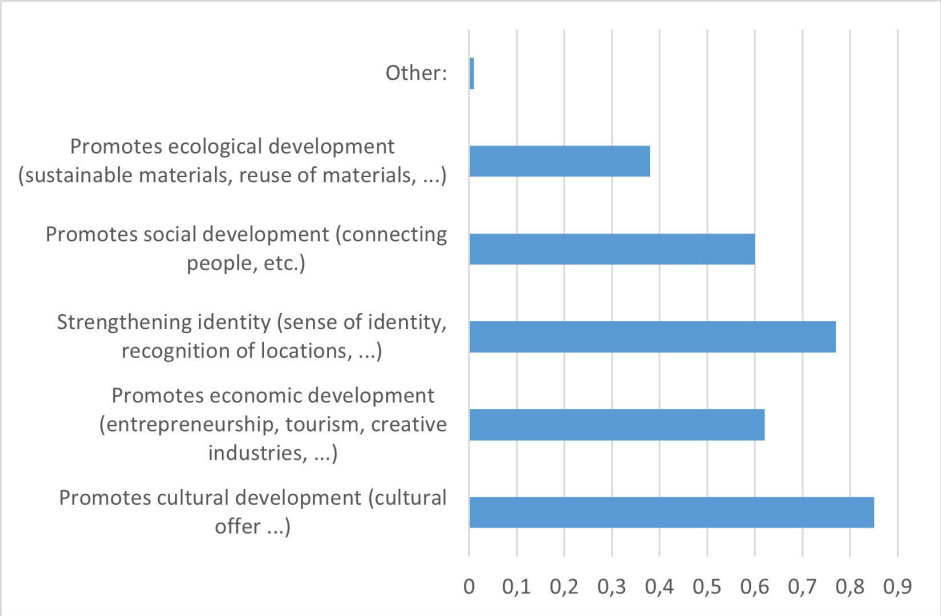


Figure 4. What can immovable cultural heritage be an opportunity for?

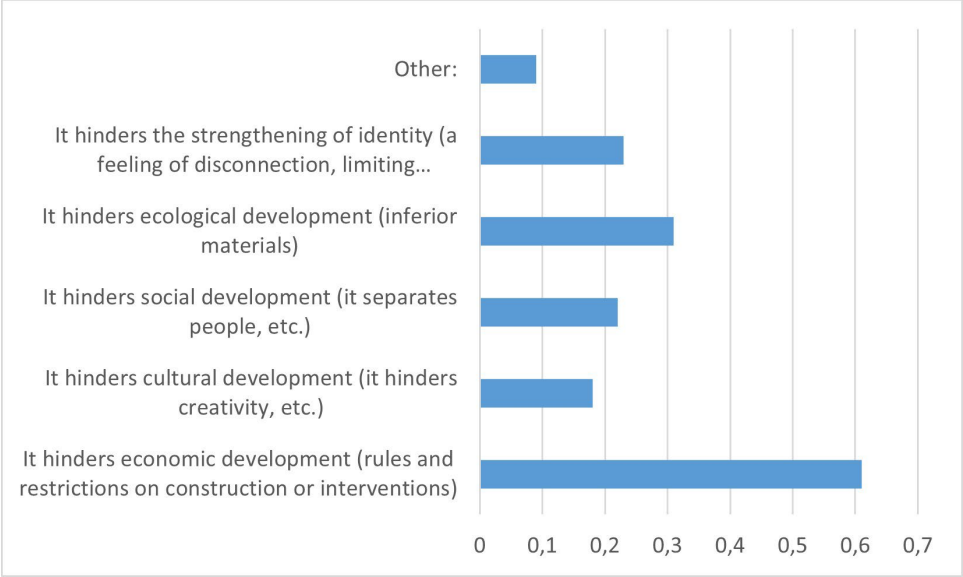


Figure 5. What can immovable cultural heritage be a burden for?

The combination of both questions (Graphs 4 and 5) reveals some elements of the potential of immovable cultural heritage, which respondents sometimes conceal by highlighting or elevating the importance of other characteristics of cultural heritage. When combining the question of the advantages and burdens brought by immovable cultural heritage, the component of economic development stands out in particular. Despite the fact that respondents highlight the cultural and identity aspect of immovable cultural heritage, they also note that immovable cultural heritage can potentially also significantly inhibit economic development and represent a financial burden. For example, they pointed out that it inhibits ecological development through the excessive use of certain materials that may not be part of modern construction procedures and construction methods. Despite the exceptional influence that immovable cultural heritage has on the cultural and identity image of the respondents, we can therefore confirm that economic development is linked to immovable cultural heritage and represents the second most important component of the structure of the value system

linked to the use of immovable cultural heritage, which at times (according to certain circumstances and situations in which a particular case of immovable cultural heritage is placed) also occasionally overrides and prevails in relation to the needs of civil society or economically less important, less influential, less empowered stakeholders. This is also clearly demonstrated in the case of individual statements that express a high level of tolerance towards the provision of economic services linked to the use of immovable cultural heritage in Graph 6.

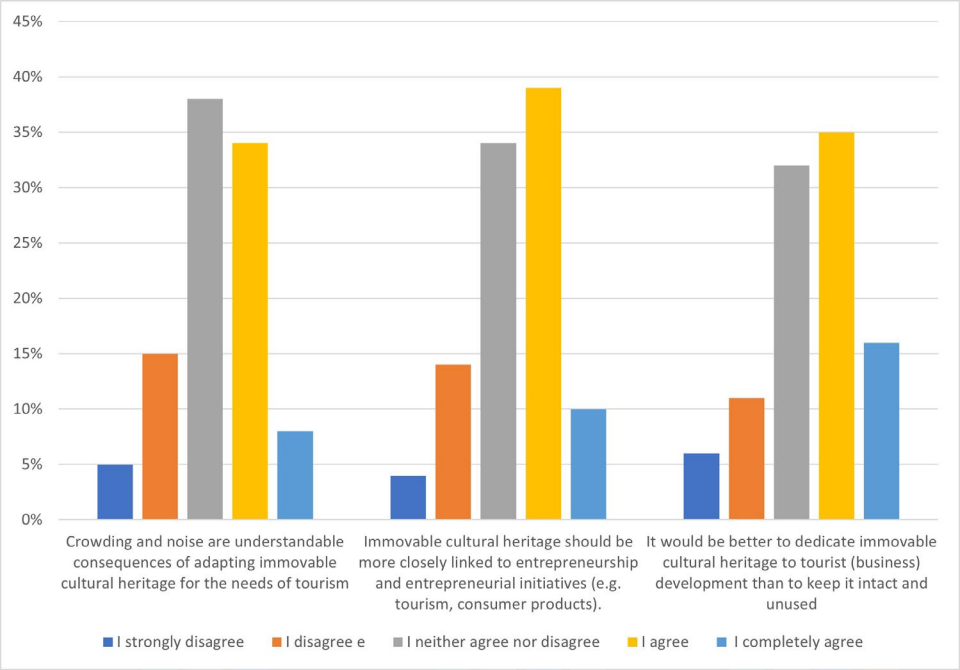


Figure 6. Please indicate the extent to which you agree with the following statements

The second set of secondary data that supplemented primary data from the panel research complements the presented views on duality of approaches to management of immovable cultural heritage. This set of secondary data is represented by results from a HEI-TRANSFORM study on a compendium of multiple case studies i.e. local communities in Slovenia dealing with management of immovable cultural heritage on their ground. From this perspective, the focus of analysis won't be on specific cases but rather on overview of reactions of representatives of local communities towards management monuments that have not yet been assigned a proper use and are in majority of cases owned by the state. Local communities are in this case mainly represented by municipalities, which function as partial caretakers of immovable cultural heritage on sites. The cooperation between state and local communities is in this regard limited and spans from mere occasional use of immovable cultural heritage for various purposes to more intense uses and supports where municipalities partially support preservation of heritage owned by the state or private party (investors). The current cooperation between state and local communities is very complex, which can be revealed from research conducted on the issue in 2016.[11] The study contained semi-structured questionnaires that were filled by key employees in municipalities and various experts that deal with immovable cultural heritage. The questionnaire consisted of closed questions but the respondents were given the possibility to upgrade each of their answers with supplemental information. The names of municipalities, monuments and the official answers of the local communities to specific questions related to management of cultural heritage of the study are presented in Table 1.[12]

QUESTION	Location: Dolane – Grad Borl/ Municipality Cirkulane	Location: Črnomelj– Kulturni dom/ Municipality Črnomelj	Location: Dornava – Dvorec Dornava/ Municipality Dornava	Location: Dvor pri Žužemberku – Železarna Dvor/ Municipality Žužemberk	Location: Leskovec pri Krškem – Grad Šrajbarski turn/ Municipality Krško	Location: Spodnji Slemen – Grad Viltuš/ Municipality Selnica ob Dravi	Location: Turjak – Grad/ Municipality Velike Lašče
Are you satisfied with the current care provided by the state for the cultural monument?	YES	NO	NO	NE (partially)	NO	YES	NO
Would you like the state to transfer the cultural monument into the ownership of the municipality?	NO	NO (Until the local community is organized in a way that it can serve its purpose)	NO	NO	NO	YES	YES
Would you like the local community to take over the management of the cultural monument?	NO	NO REPLY (Note: same as in answer 2 above)	NO	YES	YES	NO	YES (In case it is not transferred into ownership)
What programs/activities would you implement in the monument if you owned or managed it?	Historical presentation, museum, events, catering services, wedding ceremonies, education, accommodation services.	Historical presentation, exhibition space, events	Historical presentation, museum, exhibition space, events, catering services, wedding ceremonies, education	Historical presentation, museum, exhibition space, events, catering services, education	Exhibition space, events, catering services, wedding ceremonies	Historical presentation, museum	Historical presentation, museum, exhibition space, events, catering services, wedding ceremonies, education
Is the cultural monument important for the development of cultural activities in your area?	YES	YES	YES	YES	YES	NO	YES
If you owned or managed the monument, would you invite a business company to participate in its management?	YES	YES	YES	YES	YES	NO	YES (In the case of catering services only)
Would you be willing to cooperate with the municipality's activities (cultural, tourist) even if the monument was leased to another tenant?	YES	YES	YES	Depends on the tenant	YES	NO	YES

Table 1. Responses from local communities on the management of cultural heritage

The answers from the municipality representatives regarding the management of immovable cultural heritage indicate some problematic aspects that are not sufficiently discussed in heritage studies. Primarily, the data expose the issue of financial and physical maintenance of heritage. The

municipality representatives clearly express dissatisfaction with the maintenance of cultural heritage that is run by the state but are at the same time not willing to transfer the maintenance and ownership to the local community and hence into their area of responsibility. In this perspective, Immovable cultural heritage is seen as a type of financial burden and the municipalities are not willing to risk further rise of costs in the municipal treasury. Although the municipalities recognize the great importance of immovable cultural heritage for the development of municipal cultural activities, they are not willing to engage more into the management of cultural heritage owned by state. In this regard, the municipalities rather renounce to part of the sovereignty or autonomy in terms of control over cultural capital originating in immovable heritage than have to deal with complex strategies that would require knowledge and resources to manage it. Respondents at the same time also indicate support to deeper integration of PPP (public-private-partnerships) to elevate financial benefits for the municipality but do not want to take greater responsibility for this process of transfer of ownership of functionality of heritage. This interplay between marketization, commodification of heritage and preservation, use of heritage for the development of cultural activities and improvement of quality of life is very sensitive and fragile as it easily surpasses the expectations of specific groups within local communities and provokes potential conflicts. Due to these problematic aspects, the municipalities prefer to keep the status quo and generate chaotic ambivalence while at same time supporting state dependence and independence when it comes to the management of immovable cultural heritage.

CONCLUSIONS

The paper analyses the perceptions of multiple groups of stakeholders in order to produce a view i.e. model that could potentially strike a balance between various parties in the process of management of immovable cultural heritage in local communities. This optimization of the model could on the long-term lead to more sustainable management of heritage in terms of preservation or even improvement of the quality of life in communities. In this paper, we thus understand heritage-based sustainable development as the social sustainability of cultural heritage. This approach seeks to achieve a balance between the quality of life in the local community and the management of physical cultural heritage. This approach is much more complex and unpredictable, as it involves close cooperation with local communities, experts, owners and various institutions (local, municipal, state) that are involved in the process of cultural heritage management. According to many authors,[13] this approach has been greatly weakened and neglected in recent decades compared to other approaches that are linked to the physical conservation of cultural heritage through the use of green materials and approaches that do not disrupt physical natural ecosystem cycles.[14] From the perspective of social sustainability, a sustainable model of cultural heritage management must enable such capacities that, based on the inclusion and balanced participation of all stakeholders, enable the long-term development of local communities, while at the same time assisting the general public by preserving and making cultural heritage accessible to wider groups of users. Needless to say, striking a long-term balance between local and general benefits is the most difficult part of the process of developing a sustainable heritage model, which is contextually unique to each case.[15]

We can conclude that the findings of research contribute to a broader understanding of how cultural heritage is perceived and valued in different contexts and provides insights into best practices for achieving sustainable heritage management. Furthermore, this research emphasizes the importance of adopting a holistic and participatory approach to cultural heritage management. The interplay between historical preservation, economic development, and social well-being requires careful navigation, and the insights gained from this study can inform future spatial planning strategies for managing immovable cultural heritage in a way that respects both the past and the future. By fostering inclusive

dialogue and integrating diverse perspectives, communities can ensure that their cultural heritage remains a source of pride, identity, and inspiration for generations to come.

ACKNOWLEDGEMENTS

The article was supported by the HEI-TRANSFORM project, part of research scheme of Slovenian Research and Innovation Agency (ARIS, project title: “Heritage for Inclusive Sustainable Transformation - HEI-TRANSFORM”; code: J7-4641).

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URBANISTAI IN ACTION: A CASE STUDY OF PARTICIPATORY URBAN PLANNING

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INTRODUCTION

The use of generative AI tools is increasingly recognised as an innovative approach that enhances interactions between residents and urban planners within urban planning practice. New technologies are helping cities involve residents through apps that, for instance, facilitate reporting maintenance issues and collecting local feedback on current projects.[1] Indeed, the growing use of these technologies in participatory processes raises significant questions concerning access, diversity, and the material culture of these digital tools within communities.[2] As digital tools become more prevalent, cities must consider how to make them accessible to all community members, regardless of their technological literacy or socioeconomic status.

Addressing potential biases embedded within AI algorithms is also critical to ensure equitable representation and inclusion. Moreover, fostering a culture of transparency in the process of determining AI-driven decisions is likely to increase trust between residents and urban planners, which, in turn, can engender a more inclusive form of participatory design processes.

Aligned with the *Livable Cities* conference theme on "The Urban Experience: From Social Policy to Design," this paper offers a comprehensive reflection on the subject, grounded in a detailed case study involving *UrbanistAI*. This creative tool aims to foster participatory planning by generating visualisations that incorporate input from residents. The study's analysis of *UrbanistAI* contributes to the broader discourse on ensuring that technological progress aligns with the principles of socially engaged technology development. Furthermore, it considers the potential outcomes of failing to uphold these key objectives, emphasising the importance of equitable engagement and the role of material culture in urban planning.

Exploring UrbanistAI in Kaarina, Finland

In 2024, the city of Kaarina in Finland engaged its residents in a participatory planning process supported by the AI-based platform *UrbanistAI.* The workshops held in the local library required residents to create concise textual prompts that conveyed their ideas for the neighbourhood marketplace. The municipality gathered adult residents from the neighbourhood, cooperating with the *UrbanistAI* team and *SWECO* Finland, a consultancy responsible for coordinating the participatory process. *SWECO* Finland is part of the *SWECO Group*, which operates across Europe and manages numerous engineering and architecture consultancy projects.[3]

The area in Kaarina is currently undergoing a redesign aimed at transforming it into a green public space capable of hosting community events. According to *SWECO*, "the City of Kaarina is renewing

its market area as part of the development of the city centre. Until now, the market has primarily been a parking and sales area, but the goal is to make the area a green and sheltered outdoor living room that attracts visitors with its events and activities all year round."[4] As a small town near Turku, the municipality invited residents to participate in ideating new designs for this marketplace.[5]

During the initial phase of the participatory workshops planned for spring 2024, the community identified the fundamental attributes their marketplace should possess. They then proceeded to formulate plans with the assistance of *UrbanistAI*. After this phase, *SWECO* developed three preliminary designs for the public space, incorporating diverse conceptual elements into each draft. As a third phase in the project, the community was invited once more in autumn 2024 to evaluate the drafts, in collaboration with the design team and *UrbanistAI,* as illustrated in Figure 1.

In general, the *UrbanistAI* tool transformed the prompts provided by residents into engaging visual representations. These visualisations served as a starting point for further meaningful discussions with city officials and urban planners. This approach emphasises the potential of generative AI to organise resident contributions into a format that can be translated into visual material. Consequently, this factor influences the manner in which participation is expressed and interpreted. The project aimed to stimulate residents' imagination and enhance visual engagement, especially for those unfamiliar with complex technical documents and three-dimensional models of urban spaces.



Figure 1. Workshop scenario at the library in Kaarina, Finland.

CRAFTING DIALOGUE WITH AI

The following reflection is based on qualitative data gathered from semi-structured interviews with residents, *SWECO* staff, and the founders of *UrbanistAI*. Additionally, the study included participatory observation during one of the workshops. The analysis demonstrates how inclusive urban engagement can shape social policy and design.

Although participants were selected through open calls without targeting gender or diversity criteria, there was significant involvement from individuals with disabilities, demonstrating a commitment to inclusive outreach. Moreover, data collection at educational institutions, involving schoolchildren engaging with the tool, further highlights efforts to gather diverse urban experiences. The use of the *UrbanistAI* tool enabled speculative co-creation, but its success relied to a great extent on facilitators from *SWECO* who guided residents through the process.

Their role was vital in helping participants express their needs and interpret the generated insights, bridging the knowledge gap between technology and community. This facilitation emphasised the

importance of expert support in translating social dynamics into design interventions, demonstrating how effective communication and tailored assistance can promote a more inclusive and reflective urban experience. Ultimately, this approach illustrates the potential of integrating social policy considerations into participatory design processes to develop more equitable urban environments.

UrbanistAI is designed to be accessible, requiring no advanced software skills from residents. Instead, it relies on the simple act of describing a place or vision in words, with facilitators assisting residents in refining vague ideas into prompts that lead to meaningful results. Residents provide prompts, which a generative AI model interprets. The model produces visual renderings, which residents can modify. The process is intentionally open-ended, aiming to foster creative and speculative thinking.

While the tool typically produces high-resolution, realistic images, it also encourages discussions about interpretation and values, positioning *UrbanistAI* as more than just a design generator. It serves as a facilitator of dialogue for participatory frameworks. The team also launched "UrbanistAI Mobile" which is an app designed for government use in local campaigns.[6] An example is the "Denk Züri neu" project in Zurich, Switzerland, where residents can use the app autonomously.[7] For residents of Kaarina, the idea of an app appeared to be the most natural next step for future improvements, aligning well with the project's mission.

Overall, *UrbanistAI's* aim contributes to building a liveable city by ensuring that diverse voices are actively involved in urban planning: "our core mission is to democratize [urban design and planning] processes, empowering residents and non-experts to move from mere commentators to active co-designers. By using the universal language of images, we aim to deepen public participation, enabling a more inclusive and democratic approach to urban development."[8] This inclusive engagement fosters community relevance and social cohesion, creating environments that better meet residents' needs. The use of tools like *UrbanistAI,* supported by skilled facilitators, helps translate social dynamics into meaningful design interventions. This collaborative and reflective process promotes equitable and accessible urban spaces, key factors in developing a liveable city.

Visions for the Marketplace through UrbanistAI

Unlike traditional AI generators that operate independently and produce images in isolation, *UrbanistAI* is embedded into the city environment. In interviews, residents of Kaarina reported a positive experience with the AI tool, often describing the process as engaging and motivating.[9] They notably highlighted its perceived accessibility, finding it surprisingly intuitive. It was clear that the visualisations produced by the tool were valued for helping to articulate ideas that might not otherwise have been expressed, as well as for stimulating new ways of thinking.

The integration of visions into the physical space has significantly expanded the ability of community members to engage in open-ended thinking through AI-driven speculation. Moreover, it provided valuable insights into the creative process and promotes innovative exploration beyond standard decision-making, thereby nurturing a more inclusive and lively space for idea generation.

During the implementation of the tool, challenges emerged that revealed the complexities of engaging a community through visual means. While it proved efficient in producing images quickly, it required moderation and contextual interpretation to achieve substantial output for the design of the new marketplace. This moderation was crucial because it ensured that the generated images aligned with the community's values and goals. However, the need for interpretation also raised questions about who was responsible for this moderation and whether their perspectives might inadvertently shape the outcomes in ways that did not fully reflect the community's diverse views.

Residents expressed concerns regarding the extent to which their input genuinely influenced future planning and decision-making processes. Many questioned whether the initiative delivered real impact or merely functioned as a communication platform without tangible results.[10] This scepticism

highlights the importance of transparency in the feedback loop. For residents to feel their contributions matter, there needs to be clear communication about how their input is utilised and how it translates into actionable changes within the community. Without this clarity, trust in the process may wane, possibly resulting in disengagement in future initiatives.

In addition, reliance on visual language brought to light issues of aesthetic bias, prompting important discussions about inclusivity and representation within the process. Visual representations often reflect the perspectives of those who are more vocal or dominant in the conversation, potentially sidelining marginalised voices. Consequently, it became essential to implement strategies that ensure a broad range of perspectives are included and that the visual language used resonates with the entire community. This approach could involve workshops that educate facilitators on diverse representation or methods for soliciting additional feedback from underrepresented groups.

Overall, *UrbanistAI* successfully engaged residents in creative thinking, encouraging a sense of community ownership over the planning process. Nevertheless, addressing these challenges is essential for maintaining its effectiveness and fairness in the long run. Ongoing reflection on the process, combined with flexible strategies to incorporate feedback and improve inclusivity, is vital for ensuring the initiative remains relevant and empowers all community members to contribute meaningfully to their shared environment.

In comparison to a conventional AI image-generating tool, *UrbanistAI* entails the following advantages:

Context: Grounded in a specific urban site (e.g., Kaarina marketplace), *UrbanistAI* provides a localised framework that enhances the relevance and applicability of its outputs. Unlike generic image generators that may produce visuals lacking contextual specificity, *UrbanistAI* focuses on the unique characteristics and needs of the community in question. Facilitators can feed the AI with context-specific details.

Purpose: The tool is designed to facilitate active involvement from residents in the urban design process. This application contrasts with conventional tools that may prioritise aesthetic appeal over community engagement.

Input: UrbanistAI uses resident-written prompts directly tied to lived experiences and local needs. This user-generated input ensures that the visual scenarios produced are grounded in the realities and aspirations of the community, providing a richer and more authentic representation of potential urban futures.

Output: The tool generates visual scenarios that represent possible futures of a place, allowing residents to visualise and explore various design options. This capability empowers communities to understand the implications of different planning decisions more effectively, fostering informed discussions around urban development.

Function within the workflow: Within the in-situ context, *UrbanistAI* serves as a tool for co-creation and situated imagination. It integrates seamlessly into the urban planning workflow, enabling collaboration between residents, planners, and stakeholders to co-create visions for their shared spaces.

Value of the tool: It has demonstrated a dual function in participatory planning. Firstly, *UrbanistAI* has been shown that this approach increases resident acceptance, thereby facilitating the emergence of innovative and context-sensitive design solutions. Secondly, the outputs of *UrbanistAI* are rooted in the specific geographical context of the city, ensuring that the visions generated are not only imaginative but also feasible and relevant to the local environment. Establishing this connection to the physical space illustrates how it facilitates the translation of abstract ideas into tangible urban realities.

The culmination of these advantages may lead to the realisation of urban futures that reflect the community's desires and needs. By providing a platform to visualise potential developments, the integration of *UrbanistAI* ultimately fosters more sustainable and vibrant cities.

Trust in AI Technology

As previously mentioned, AI technology offers many benefits; however, community members raised several questions during the implementation of the workshop. Despite the efficacy of *UrbanistAI* in rapidly generating images, its utilisation necessitated moderation and a sophisticated understanding of context to guarantee that the outcomes were both meaningful and suitable. In interviews, Damiano Cerrone placed particular emphasis on the pivotal role of trust in the integration of such tools into creative or professional workflows. He argued that trust fosters confidence in the accuracy and relevance of the outputs produced by these tools.[11]

Consequently, it is unsurprising that residents expressed concerns regarding the extent to which their contributions influenced future planning and decision-making processes. Critical voices questioned the validity of the process, doubting its actual impact and suggesting that it merely served as a medium of communication. Furthermore, the use of visual language gave rise to concerns about aesthetic bias, thereby initiating deliberations on inclusivity and representation. It is evident that, despite the tool's success in fostering creative thinking among residents, addressing these challenges remains imperative to ensuring its continued effectiveness and fair use. In conversations with Cerrone and Ruoppila, they indicated that challenges encompass balancing the rapid development of generative AI models with preserving their visual fidelity, in addition to effectively managing the financial expenditures associated with their operation.[12]

Tong Wang and Neil Yorke-Smith from Delft University of Technology argue that AI developers should be aware of the human-computer interaction that usually occurs in such contexts: "AI system design must also consider the interactions between human agents and technology-driven agents in urban settings."[13] Their study emphasises that transparency about the process of resident input, such as how AI models handle it, is essential for building trust and accountability.

Additionally, digital literacy remains a vital issue that warrants further investigation. For example, the UNDP Accelerator Labs' study highlights that during the *UrbanistAI* workshops in Betania, Panama City, students introduced the tool to local residents who had limited familiarity with AI technology.[14] When discussing digital literacy, it is also essential to consider the long-term effects of socially engaged technologies within democratic urban planning, rather than focusing solely on immediate project results. A forthcoming study from Greece indicates that the risks and challenges of incorporating AI into participatory democracy underscore the importance of adopting a careful and deliberate approach to its use in urban planning.[15]

In a nutshell, *UrbanistAI* highlights both the potential and challenges of using AI to enhance participation. It can lower entry barriers and make complex planning more accessible; however, technology alone cannot resolve the underlying power dynamics inherent in participatory activities.

CONCLUSION

The Kaarina case prompts a thorough and nuanced examination of the ethical considerations inherent in the design of emerging technologies. It brings to light the crucial question of who has the authority to shape the prompts that guide these technologies.

For AI tools to be perceived as socially responsible and ethically sound in participatory urban planning processes, they must be embedded within transparent, dialogue-driven frameworks that prioritise active listening, responsiveness, and mutual trust. The interpretation of outputs produced by such systems requires careful scrutiny. Consequently, *UrbanistAI* not only enhances conventional

participatory methods but also acts as a catalyst within broader co-creative frameworks. Its ability to inspire imagination and foster engagement is highly motivating, enabling deeper interactions and the development of innovative solutions. When these tools are thoughtfully incorporated into accountable systems and complemented by effective facilitation, they can significantly boost creativity and ensure that communities feel genuinely empowered and involved. In fact, the *UrbanistAI* workshops exemplify the transformative potential of digital tools in promoting inclusive and socially responsible technology development.

This research advances the conversation on designing and deploying digital participation tools that encourage creative expression and empower individuals to shape urban futures. It highlights the crucial, though sometimes biased, role of AI in this process. Additionally, further research is essential to explore the complexities of AI tools in participatory design within urban planning initiatives. Future studies should focus on understanding how AI biases influence public participation, developing methods to mitigate these biases, and assessing the long-term impacts of AI-enabled participatory tools on urban spaces.

As part of the *Livable Cities* Conference 2025 in Barcelona, this paper explores contemporary approaches to urban planning through digital participation tools such as *UrbanistAI.* The study emphasises the importance of inclusive, socially responsible, and community-driven urban planning, which aligns with the conference's focus on creating sustainable and liveable urban environments.

ACKNOWLEDGEMENTS

The present paper was delivered as part of the "Socially Engaged Tech" track at the *Livable Cities* Conference 2025 in Barcelona. The data were collected as part of my ongoing doctoral research project.

I sincerely thank the residents of Kaarina, Finland, for participating in the workshop and for their openness during the interviews. Furthermore, my deep gratitude goes to Sampo Ruoppila at *UrbanistAI* and the *SWECO* team for providing access and sharing their perspectives. I also acknowledge *UrbanistAI* for their critical reflections and for granting me the opportunity to observe their tool in action.

Special thanks go to my peer scholars from the conference community for their stimulating discussions and constructive feedback. Finally, I am thankful to my supervisors, Prof. Dr Ursula Kirschner and Prof. Dr Sarah Teasley, whose guidance has been essential in conducting this research. The Qualification Fund of Leuphana Graduate School kindly provided funding for attending the conference in person.

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THE AFFECTIVE EXPERIENCE OF ARCHITECTURAL AND URBAN SETTINGS: AN ECOLOGICAL-ENACTIVE PERSPECTIVE

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INTRODUCTION

Architecture is more than the arrangement of materials and forms; it is a medium that scaffolds human experience and everyday practice. While traditional architectural discourse has often centered on structural efficiency, function and aesthetic composition, a growing body of scholarship now emphasizes the psychological, sensory, and affective dimensions of spatial experience. This shift reflects a broader reorientation in architectural inquiry: moving away from abstract notions of the "universal user" toward a recognition of embodied, situated individuals whose minds and emotions are deeply entangled with the environments they inhabit. Walter Gropius anticipated this perspective as early as the 1950s, asserting that "psychological experiences […] are as real as any material problems of structure and economy […]. I consider the psychological problems, in fact, as basic and primary".[1]

In contemporary scholarship, these concerns have expanded to encompass insights from ecological psychology, embodied cognition, neuroscience, environmental psychology and affect studies. Several scholars have contributed to this cross-disciplinary integration including, for example, John Eberhard,[2] whose work in neuroarchitecture emphasized how knowledge from neuroscience can inform architectural design and Colin Ellard[3] whose work on the intersection of environmental psychology and urban design, explores the psychogeography of everyday life and how architectural features evoke emotional responses ranging from awe to anxiety. Collectively, the ongoing research in neuroarchitecture and neurourbanism[4] underscores a growing consensus: that architecture is not merely a static arrangement of forms, but a dynamic interface between mind, body, and environment, one that demands both scientific inquiry and humanistic reflection on human values, experiences, and cultural meanings

By placing perceptual and affective experience at the center of architectural analysis, we can begin to understand built space as a dynamic field of opportunities for action and emotional engagement, experienced through movement, touch, smell, sight, and sound. This perspective invites us to reconsider how the resonating brain-body system can become attuned to environmental features, how the design of built environments disrupts, or enhance our embodied interactions with the world, and why such insights are vital to the future of architectural thought and practice.

Drawing on ecological and enactive approaches, as well as recent empirical findings in neuroscience and psychology the paper first examines the concepts of resonance and attunement and how rhythmic interactions unfold between brain-body-environment. The concept of the resonant brain suggests a sensitivity to environmental rhythms and a fundamental human capacity to actively sense and attend, to tune-in to subtle differences that we perceive through sensorimotor and affective engagement. These approaches foreground the relational nature of the architectural experience and the need to explore further relevant relational structures – namely, affordances, affect, and atmospheres – as key mediators of perception and emotion. Through this discussion the paper highlights recent situated approaches to affectivity that further illuminate how individuals engage in affective sense-making through embodied interaction with space. Finally, the paper considers the implications of these insights for architectural and urban design.

EMBODIED AND MULTISENSORY EXPERIENCE OF ARCHITECTURAL SPACE

Post-cognitivist frameworks such as ecological psychology and enactivism challenge brain-centric models by emphasizing that perceiving, acting, and knowing are emergent properties of the agent-environment system. They highlight the role of the environment in shaping perception, cognition and behaviour. Cognition emerges as a relational phenomenon constituted by the history of sensorimotor couplings between the brain-body-environment system. Sensorimotor dynamics, the self-organizing phenomenon of cyclical perception-action coupling, is a key concept to understanding how we interact and detect environmental information. The way we move, how we walk, reach, or turn, is shaped by (and shapes) what we see, hear, feel, and smell. Our bodies are constantly picking up signals (rich in value and meaning) from the environment, which guide our actions. A bench invites sitting; a staircase invites climbing. These possibilities for action are called *affordances* [5], and they depend not just on the physical features of a space, but on how we perceive and engage with it. This view aligns with 4EA cognition (embodied, embedded, enacted, extended, affective), which emphasizes that perception, action, and affect are reciprocally shaped by both the organism's capabilities and the environmental context.[6]

The ecological-enactive approach offers a powerful lens for understanding how architectural multisensory experience emerges through *active and affective sense-making*. It emphasizes how individuals attune to subtle environmental differences through sensorimotor and emotional engagement. This perspective carries significant implications for design, inviting architects to look beyond visual or functional aspects and consider how materials, textures, scale, acoustics, and spatial rhythms shape perceptual experience. These elements can momentarily even disrupt habitual patterns of movement and interaction, prompting deeper awareness. For instance, Carlo Scarpa's unconventional stairs at the Brion Cemetery (see Figure 1) require visitors to consciously adjust their posture and gait, triggering a moment of recalibration—a kind of "attentional switch" that heightens awareness of both space and self. In such moments, architecture invites us into a richer experience of embodiment that goes beyond form and structure. Viewed through this lens, the affective dimension—shaped by movement, sensory exploration, and the dynamic interplay between body, brain, and environment—becomes a central concern of architectural inquiry.



Figure 13. Brion-Vega Cemetery, San Vito Carlo Scarpa, 1972, Photo by Trevor Patt, Flickr, licensed under CC BY-NC-SA 2.0.

The resonant brain

The concept of the *resonant brain* builds on Gibson's view that "[…] the perceptual system simply extracts the invariants from the flowing array; it *resonates* to the invariant structure or is *attuned* to it".[7] This approach challenges traditional cognitive models that treat the brain as an isolated processing unit, framing cognition as a relational process emerging from dynamic interactions between brain, body, and environment. This perspective suggest that it is not unreasonable to assume that the brain-body system can become sensitively attuned to the varying rhythms of the (built) environment.[8] Recent research shows that physiological rhythms, such as breathing, heart rate, and circadian cycles, play a key role in shaping perception, emotion, and cognition through coupling mechanisms that link slower bodily processes with faster neural activity across different timescales.[9] Crucially, this coordination may extend beyond the boundaries of the skin, influencing and being influenced by interactions with the surrounding environment.

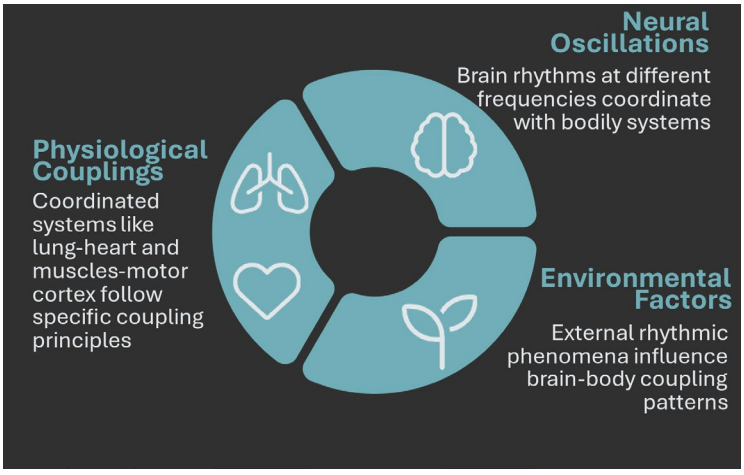


Figure 14. The rhythmic coordination of different oscillations associated with neural, non-neural and environmental sources

For example, respiratory rhythms can synchronize with faster brain oscillations and can also be modulated by factors of the external environment.[10] This process (known as cross-frequency coupling) enables coordination and temporal alignment across different temporal scales, much like two dancers moving in harmony despite differing tempos. Breathing, in this context, serves as a bridge between internal physiological states and external sensory environments, reinforcing the idea that cognition is deeply embedded in rhythmic exchanges between organism and surroundings.

Environmental rhythms

Empirical studies further reveal how environmental rhythms (such as sound patterns, light pulses, the spacing of environmental features) guide behavior and perception. When our brain rhythms become phase-locked to external rhythms, our perception fluctuates in synchronization with this rhythm—that is, we become more sensitive or aware at regular intervals.[11] Furthermore, subtle changes in the direction of floor tile patterns can cause individuals to veer from a straight path.[12] In another study the researchers found that participants changed their walking speed in response to change in the frequency of repetition of vertical stripe patterns and the same effect was also observed in a driving simulation task where decreasing stripe spacing the route resulted in reducing driving speed.[13] These findings suggest that environmental rhythms shape sensorimotor feedback loops, influencing how we make sense of space; affecting how we feel, perceive, and move within it.

These findings underscore the importance of considering how features of architectural spaces, like calming gardens, natural light or acoustic atmosphere and soundscapes, can influence physiological rhythms and brain activity. They invite a reconsideration of how the temporal, spatial, and sensory qualities of built environments can foster attunement and entrainment,[14] guiding perception, emotion, and behavior in subtle yet profound ways. In architectural and urban settings, rhythmic elements, such as alternating light and shadow or repetitive structural patterns, can subtly guide behavior and shape perception. The rhythm of a space tunes our attention and influences how we feel, notice, and respond as we move through it. Design features that engage peripheral vision, like textured flooring or patterned lighting, can direct movement and awareness without explicit cues, simply by orchestrating environmental rhythms. This creates a kind of *spatial choreography*, where layered rhythms shape our perceptual and affective experience in motion.

RELATIONAL STRUCTURES IN ARCHITECTURAL INQUIRY

Architectural approaches that foreground relational structures challenge conventional notions of space as static or purely visual. Instead, they emphasize the dynamic interplay between body, mind, and environment. Shūsaku Arakawa and Madeline Gins exemplify this shift through their concept of the *architectural body*—a hybrid entity formed by the intermingling of the "architectural surround" and the "body proper". As they write, "What emanates from the body and what emanates from the architectural surround intermixes",[15] underscoring the co-constitutive nature of spatial experience. Similarly, Sarah Robinson's approach to architecture as a verb advocates for an embodied and relational approach to architecture, one that prioritizes what a building *does* over what it *looks like*, "what kind of interactions does it enable, afford, provoke, modulate, intensify, augment or strengthen?"[16] Her question foregrounds the multiplicity of affective experience across different spaces implying at the same a variability across individuals, as different individuals may experience the same spatial atmosphere but attune to it in distinct ways. Her emphasis on interaction aligns with ecological psychology's view of perception and action as emergent from agent-environment coupling. This perspective is further explored by the Rietveld Architecture-Art Affordances studio, whose experimental projects investigate how spatial design can shape behavior through affordances. Their installation *The End of Sitting* exemplifies this by offering a landscape of postural possibilities,

inviting users to engage with space in novel, embodied ways. It demonstrates how architecture can actively scaffold diverse modes of interaction. Conceptual frameworks that foreground the relational dynamics between body, brain, and environment such as *affordances, affect, and atmospheres* offer powerful lenses for examining how individuals interact with built space as embodied agents.

Affordances

The concept of *affordances* originates in James Gibson's ecological psychology, where it refers to the actionable possibilities offered by the environment: "The affordances of the environment are what it offers the animal, what it provides or furnishes, either for good or ill".[17] Over time, this idea has evolved into a rich interdisciplinary framework.[18] For example, Harry Heft emphasizes a cultural view, framing affordances as relational and intentional, shaped by culturally derived meanings and practices.[19] Chemero， offers a relational perspective, describing affordances as dynamic interactions between an agent's abilities and environmental features[20] while Van Dijk and Rietveld describe affordances as fields of possibility that become salient through context-specific interactions involving objects, people, and situational dynamics.[21] Consequently, perceiving affordances is not merely about detecting physical features; it is a relational concept that involves evaluating, adapting, and making sense of value-rich ecological objects.

Affective sense-making

Active engagement with environmental features and tendencies to move or act in particular ways – both individually and collectively – are closely linked to how the agent's environment affords specific actions and behaviors as well as affective states. The process by which individuals navigate, interpret, and respond to architectural affordances is inherently affective. As Giovanna Colombetti notes, "one is affected when something merely strikes one as meaningful, relevant, or salient".[22] Affective states thus operate as "psychological tensions" that orient us toward or away from environmental features, motivating action, attention, and evaluation. Thus, much like cognition, affectivity is not confined to the brain or external structures but "is the *relational process* of sense-making that takes place between the system and its environment". The sense-making activity regulates our interactions with the world. It is through active engagement with environmental cues and affordances that agents appraise meaning, value, and relevance—processes that are themselves shaped by cultural norms, social practices, and individual histories. In architectural experience, this is evident in the way certain spaces provoke curiosity, discomfort, awe, or reflection, depending on the context and the person's prior experiences.

Theories of situated affectivity, draw on the broader framework of situated cognition and emphasizing that emotions are *embodied, enacted, and environmentally scaffolded* and can be reconceptualized as forms of *skillful engagement with the world.* [23]Building on this foundation, several related concepts have emerged to deepen our understanding of how affect is co-constituted through interaction with the environment. *Affective scaffolding*[24] refers to the way physical and social structures support and extend emotional and cognitive processes beyond the boundaries of the individual. *Affective affordances*[25] describe environmental features that offer opportunities to regulate, enrich, or modulate emotional experience. *Affective arrangements*[26] capture the complex socio-material settings—comprising people, objects, spaces, discourses, and behaviors—that shape and sustain affective interactions. Together, these frameworks challenge the view of emotions as purely internal states, highlighting instead how human affectivity is dynamically co-regulated by external resources and structured environments.

Affective atmospheres

Atmospheres, closely related to the concepts of affective affordances and affective arrangements, are understood as extra-individual phenomena that shape and invite affective engagement. Rather than being reducible to isolated sensory inputs, atmospheres emerge from the orchestrated interplay of elements such as sound, air, materiality, light, people and spatial form. These qualities coalesce to produce a mood or ambience that is often sensed before it is consciously registered. The affective power of natural light, shadow, and spatial rhythm can induce subtle emotional transformations, guiding how we feel and move within a setting. Atmospheres thus operate as a "shared ground from which subjective states and their attendant feelings and emotions emerge".[27] They exist simultaneously as spatial configurations and as affective tonalities that resonate in the pericorporeal space of the feeling body, that is, *felt in the region of one's body.* [28] Furthermore, as Juhani Pallasmaa[29] observes, architectural atmospheres articulate our experience of time as much as space, giving rise to "slow and patient spaces as well as hurried ones". While affect refers to a body's relational engagement with the world, atmospheres extend beyond individual experience, encompassing the "meshwork of all bodies (and worlds) in a shared situation".[30] In this way, atmospheres reveal how affective experience is not only embodied, but also spatially and socially distributed—woven into the fabric of collective life and architectural presence.

DESIGNING AFFECTIVE AFFORDANCES

Adopting conceptual frameworks that foreground relational structures—such as affordances, affective scaffolding, and atmospheres—can deepen our understanding of how environmental design supports, regulates, and extends cognitive and emotional processes. Such frameworks invite us to consider how environmental rhythms, spatial features, and affective affordances can be intentionally designed to guide behavior, foster attunement, and promote well-being. For instance, tactile vibrations in urban paving help visually impaired individuals attune to auditory-haptic rhythms, guiding their movement through the city. Similarly, the *Urban Carpet* installation in Aarhus (as illustrated in Figure 3) is a woven textile of charred wood placed at a crossroad, which demonstrates how affordances and atmospheres can be modulated through material and sensory interventions. By altering texture and smell, the installation shifts walking pace and invites spontaneous actions like foot tapping and dancing.[31] These examples show how environmental features, behavioural setting or atmospheres can act as thresholds, shaping a body's capacity to act and engage.



Figure 15. Urban Carpet Installation by Polina Chebotareva in collaboration with Elias Melvin Christiansen, Aarhus, Denmark. Photo credit: Rasmus Hjortshøj

Yet not all atmospheres or behavioral settings are equally inclusive. Personal tendencies, habits, and broader social, cultural, and gender dynamics influence how individuals attune to affective atmospheres. Neurodivergent individuals, for example, may struggle in environments that are overly noisy or brightly lit. In *Care as Active Architectural Practice*, Jos Boys calls for a reconceptualization of architecture as an explicitly embodied practice, urging us to ask: "What kinds of work do we each do that perpetuates or challenges which bodyminds are valued and which marginalized or ignored?"[32] Designing for (neuro)diversity means recognizing that some settings may not accommodate different styles of "bodily being-in-the-world," potentially limiting opportunities for social connection, attunement, and the feeling of *being at home*. This feeling is scaffolded both synchronically—through immediate sensory engagement—and diachronically—through social, cultural, and historical practices that shape lived experience. Through repeated participation in these practices, individuals develop *affective trust* in the reliability of environmental resources to support emotional regulation.

The capacity to manage affective states by modifying one's surroundings is central to the concept of *affective scaffolding*, which describes how environments provide mediating structures that extend emotional processes beyond the individual. It also connects to the idea of *niche construction*, which refers "more to how an animal lives than to where it lives".[33] In this view, *affective niche construction* involves the deliberate shaping of material, social, and cultural environments to support emotional life (Figure 4). Considering these insights, it becomes crucial to reimagine urban environments as constellations of affective niche functioning as *wellbeing and healing hubs*—accessible public spaces that offering opportunities for emotional regulation, sensory comfort, and social connection.



Figure 16. Navarinou Park in Athens. A kind of urban affective niche; a former parking lot, squatted and transformed into a neighborhood park by a grassroots citizens' initiative. Photo from Wikimedia Commons, licensed under CC BY-SA 4.0 (left). Photo by Aesthetics of Crisis, Flickr, licensed under CC BY-NC-SA 2.0 (right)

CONCLUSION

The recognition that affective experience is relational, embodied, and situated carries profound implications for architectural and urban design. It encourages designers to think in terms of "fields of affordances" and "atmospheres," rather than isolated objects or functions. The ecological-enactive approach, grounded in both empirical research and theoretical reflection, provides a powerful framework for understanding how affordances, rhythms, and atmospheres support the coupling of body, brain, and environment shaping the ongoing process of "affective sense-making". This paper contends that it is important to advance architectural inquiries and design practices that adopt an embodied relational understanding of space, and approach potential users not as an abstract category but as situated individuals with diverse bodies, histories, and dispositions whose emotional and sensory experiences are shaped by their interaction with specific environments. These environments are understood not just as physical spaces, but as relational fields that are "co-constituted" by the bodies and practices that inhabit them; as rich fields of affective affordances that actively influence perception, behavior, and affective experience.

ACKNOWLEDGMENTS

This paper is based on research conducted as part of a project funded by the European Union's Horizon 2020 Research and Innovation Programme under the Marie Skłodowska-Curie Grant Agreement No. 101034403.

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[5] James Jerome Gibson, *The Ecological Approach to Visual Perception* (Boston: Houghton Mifflin, 1979), 127.
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[14] The concepts of entrainment, attunement, and resonance all stem from the dynamics of coupled systems. *Resonance* refers to a system's sensitivity to structured environmental information, often experienced as a felt, bodily awareness. *Attunement*, implies a more intentional engagement, encapsulating the qualitative aspect of self-tuning to environmental variables—how individuals align with environmental rhythms based on their dispositions. For instance, while both devotees and tourists may resonate with the atmosphere of a contemplative space, their attunement will differ according to their intentions and embodied histories. *Entrainment*, the temporal alignment of internal oscillatory activity with external rhythms, often underpins these experiences and operates across neural, physiological, and behavioral levels.
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THE DESIGN SPACE OF INFORMATION AND DATA COMMUNICATION IN PUBLIC SPACES

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INTRODUCTION

One of the premises of public space is to make things available to all by creating a common ground. Thus, through its inclusion in this common ground, information may become available to all and be part of the shared encounter[1] among people. Information communication in public spaces occurs in various ways, one of which is through its visual representation and display. The research in the field has shown that displaying visualizations that represent information in public spaces draws people's interest and triggers public discussions;[2] motivates people to think about local matters, engage with others, and raise the level of knowledge about them.[3]

The inclusion of information in public spaces through its visual display has gained particular importance over the last two decades. During which different approaches have been developed, technologies utilized, and topics communicated. Therefore, this research aims to reveal the design space of information and data visualizations displayed in public spaces by systematically reviewing the literature on various dimensions related to system, display, content, and space.

METHODOLOGY

The goal of this research is to explore the design space of information and data visualizations displayed in public spaces. To achieve this, a literature survey was conducted on a corpus of thirty publications, based on defined dimensions related to the system, output content, display, and the relationship with the space. The study was conducted in two main stages, which are selection and analysis. The selection stage aimed to define the corpus. It was conducted in two steps: document search, where documents were collected through a keyword search in Scopus, and elimination, where documents were filtered based on topic and content. In the first step, a document search was conducted to identify documents that include the terms' data visualization' or 'information visualization' together with 'public space' or 'public place' or 'public environment' in their title, abstract, or keywords. The term public visualization was also included in the search. To include different spellings and different forms of the word visualization, such as noun or verb, the terms were researched as data visuali* and, information visuali* and public visuali*. The search resulted in 135 documents that had been published until 2025. In the second step the documents that do not focus on information and data visualization designs in public space to share information with the public; that do not present new designs such as review papers; or that is about designs that had not progressed beyond the ideation stage, had not been implemented in a real world, or had not been interacted at any level by users were eliminated. Also, one publication couldn't be accessed.

In the analysis stage, the publications included in the corpus were examined based on the defined parameters, which were revised iteratively.[4] These parameters belong to four main categories: system, display, content, and space, as shown in Figure 1.

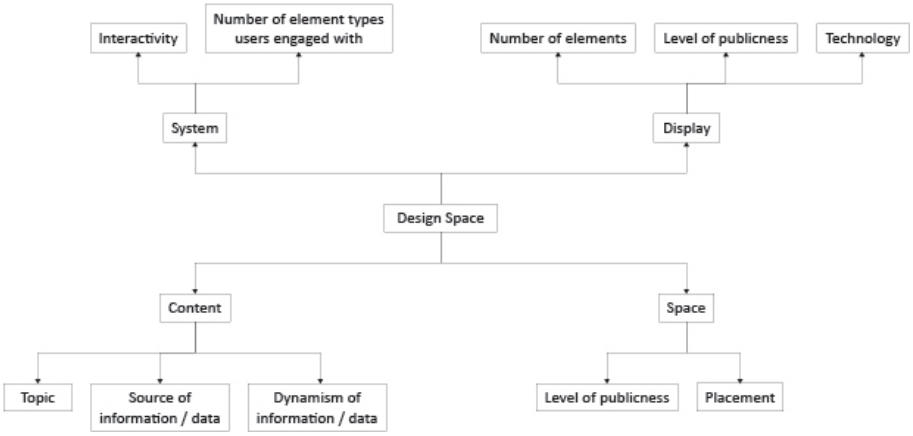


Figure 1. Categorizes and design dimensions

EXAMINATION AND FINDINGS

Overall, 35 designs from 30 publications were selected. In total, 10 dimensions across four main categories were defined which are interactivity and number of element types users engaged with under the system category; number of elements, technology and level of publicness under the display category; topic, source of information/data and dynamism of information/data under the content category and level of publicness and placement under the space category as shown in Table 1.

The System

Interactivity

In the scope of this research, interactivity means "input/output with a human"[5] thus referring to the system feature to get input from users and react accordingly. Thus, in such systems, the user experience moves beyond taking what output by the system. Furthermore, user behaviour moves from passive to active through participation.[6] While the majority of designs were found to have interactive features, two motivations behind the use of interactive features were also identified. First is to reveal information, such as in the case of EMDialog, in which users moved between different pieces of information through a touch-enabled screen.[7] Second is to enable data input to the system, such as in Mood Squeezer, in which users input data on their mood by squeezing one of the different colored balls.[8]

Number of element types users engaged with

The examination revealed that while some of the developed systems consist of a single type of element for people to engage with, namely the display itself, such as one by Skog et al.,[9] the others include various kinds of elements that took different roles within the system. This varied from revealing information through another visual[10] or audio output,[11] to collecting content through a video-camera,[12] to enabling the functioning of a display, such as a physical graphic element, to activate to enable content display through augmented reality,[13] selecting data to be displayed through buttons,[14] or inputting data through them.[15] Furthermore, it was found that in some cases the variety was created by incorporating the personal devices of participants. For example, in the research

conducted by Ferreira et al., participants were using their mobile phones to input their wishes to be displayed in the digital public displays[16].

Display

Technology

A variety of technologies were utilized to display visual content by the corpus, which were categorized into five groups: digital display, projection, physical graphic display, data physicalization, and others. Digital displays, encompassing a variety of display technologies including e-ink displays,[17] touch-enabled displays,[18] multi-touch displays,[19] head-mounted displays,[20] or mobile phones,[21] are the most used group by the corpus. While projection was found to be mostly used as a simple display device, Paulos et al. used it as an augmentation tool to incorporate an additional layer of visual content on the data physicalization that represents the expected user activity in a space.[22] It was also found that non-digital approaches have also been deployed, including physical graphic displays, such as spray-painted data visualization on streets,[23] and data physicalizations like transparent plastic sheets shaped to represent data.[24] Even though data physicalizations were encountered in four designs, it must be noted that corpus selection was focusing on visualization and did not intend to include data physicalization. Thus, this does not directly show the place of this approach in the field.

Lastly, it was found that in three cases, the systems include audio output technologies, thus supporting hearing besides seeing, to create an atmosphere to support the communicated content[25] or also to provide auditory feedback to user interaction.[26] We would like to note that while we recognize the use of audio outputs, they are not examined or coded under display-related dimensions, but they were taken into consideration as part of the overall system.

Number of elements

The technologies used to display content were found to be not always composed of a single element, such as a standalone digital display;[27] in numerous cases, multiple elements worked together to display content. Through further examination, three distinct reasons to combine multiple elements were identified: to display a single content; to display various sub-contents of a single narrative, and to repetitively display a single content.

In situations where multiple elements come together to display a single content, the content is meaningful and readable only when all the elements work together. For example, Sato et al. placed 3000 LEDs on the ceiling of an airport, which, by working together, displayed the content.[28] In cases where multiple elements were used to display various sub-contents of a single narrative, a single display element is still able to provide information that is meaningful by itself, yet the full narrative is only available through engagement with all of the display elements. For example, Claes et al. divided their narrative into multiple pieces and displayed the representation with multiple e-ink screens, some of which supported polling through their buttons.[29] The last and rarest defined reason for multiple elements to come together is to display the same content. For example, Hinrichs et al. used a projection to display the same visual content on the interactive display to make it visible across a larger space.[30]

Level of publicness

The examination showed that even though the setting of the visual communication of data is public spaces, the display technology was not always public. In some cases, while the content was aimed at the general public, the content was displayed through private displays, which in the context of this

research refers to privately owned displays or displays intended for the use of a single person at a time; as such, the use of mobile phones[31] or laptops with webcams,[32] mostly for augmented reality.

Content

Topic

It was found that communicated topics varied from environmental issues, including electricity consumption,[33] to societal or local issues, including harassment in public spaces,[34] to the use of space/activity in a space, such as how people move within an event space,[35] to general knowledge, and cultural information, such as geographic knowledge.[36]

The connections between the space of display and the topic of displayed content were also noted. The connection with space and content was a direct one when the content was about the space, such as in the design of Skog, where the activities taking place in a café were visualized and displayed.[37] Another connection that was detected was related to the audience. By having different types of users, space also defines who is going to see the content. Thus, it can be argued that while the content that concerns the general public might be better communicated in fully public spaces, such as communicating homelessness in a building façade,[38] more targeted content, such as the mapping of co-authorship data of academic publications,[39] may be suitable for a more specific audience, thus to be displayed in a more specific setting, such as a conference.

Publications	System: Number of element types users engaged with: One	System: Number of element types users engaged with: Many	System: Interactivity: Non-Interactive	System: Interactivity: Interactive	Display: Number of elements: One	Display: Number of elements: Many	Display: Number of elements: to display a single content	Display: Number of elements: to display multiple content for a single narrative	Display: Number of elements: to display single content on different displays	Display: Level of publicness: Private displays	Display: Level of publicness: Public displays	Display: Technology: Digital displays	Display: Technology: Projection	Display: Technology: Physical graphic display	Display: Technology: Data physicalization	Display: Technology: Other
Claes et al., 2018		X		X		X		X			X	X				
Coenen and Vande Moere, 2021	X			X		X		X			X	X				
Morais et al., 2022	X		X			X		X			X				X	
	X		X		X						X			X		
Karuzaki et al., 2018	X			X	X						X	X				
	X			X	X						X	X				
	X			X	X						X	X				
Yang et al., 2022		X		X	X					X		X				
Claes and Vande Moere, 2015	X			X	X						X	X				
	X			X		X		X			X				X	
		X		X	X						X	X				
Gheorghiu and Ștefan, 2014	X			X	X					X		X				
Dávila et al., 2017	X		X		X						X	X				
Zhu et al., 2024		X		X	X					X		X				
Ferreira et al., 2024	X			X	X						X	X				
Claes and Vande Moere, 2017	X			X	X						X	X				
Liu et al., 2024		X		X		X		X			X	X				
dos Santos et al., 2024		X		X		X		X	X		X					X
Koeman et al., 2015		X		X	X						X			X		
Wilson Simao et al., 2023		X		X	X					X		X				
Lay et al., 2016	X			X	X						X	X				
Gallacher et al., 2015		X		X		X		X			X					X
Birliraki et al., 2019		X		X	X						X	X				
		X		X		X		X			X	X			X	
Paulos et al., 2007		X		X		X		X			X		X		X	
Valkanova et al., 2013		X		X	X						X		X			
Sato et al., 2011	X		X			X	X				X					X
Skog et al., 2003	X		X		X						X	X				
Ferreira et al., 2015		X		X		X		X			X	X				
Skog, 2004	X		X		X						X		X			
Hinrichs et al., 2008		X		X		X			X		X	X	X			
Viegas et al., 2004		X		X		X		X			X		X			
Iwai et al., 2006		X		X	X						X	X				
Nagel et al., 2011	X			X	X						X	X				
Boj et al., 2005		X		X	X					X		X				

No information X1, X2,X3 installation number incase of a multiple installation

Table 1. Design Space of the related literature

		Content									Space												
		Source of information/ data		Dynamism of information/ data		Topic					Level of publicness											Placement	
												Type of semi-public space							Type of public space				
		Outside sources	Project	Static	Dynamic	environmental issues	Societal or local issues	Use of a space / Activity in a space	General knowledge and cultural information	Other	Semi-public	Cultural	Educational	Commercial	Transportation hub	places of interest to society and the public	Other	Public	Streets	Squares	Parks	Attached	Stand alone
Publications	Claes et al., 2018	X	X		X	X												X	X			X	
	Coenen and Vande Moere, 2021	X	X		X					X	X						X						X
	Morais et al., 2022		X	X			X				X2		X2					X			X		X
			X	X			X											X			X		
	Karuzaki et al., 2018	X			X					X	X	X											X
		X			X					X	X				X								X
		X			X					X	X					X								X
	Yang et al., 2022	X	X		X				X		X	X											
	Claes and Vande Moere, 2015	X		X		X	X											X	X2	X1			X
		X		X		X	X											X	X2	X1			X
		X		X		X	X											X	X2	X1			X
	Gheorghiu and Ştefan, 2014	X		X					X		X	X											
	Dávila et al., 2017	X			X		X											X		X		X	
	Zhu et al., 2024	X		X						X	X		X										
	Ferreira et al., 2024	X	X		X	X					X			X									X
	Claes and Vande Moere, 2017	X		X				X			X	X											X
	Liu et al., 2024		X		X	X					X		X									X	
	dos Santos et al., 2024	X		X			X											X	X1	X2			X
	Koeman et al., 2015		X		X		X				X			X				X	X			X	
	Wilson Simao et al., 2023		X	X						X	X					X							
	Lay et al., 2016	X		X					X		X		X										X
	Gallacher et al., 2015		X		X					X	X						X					X	
	Birlıraki et al., 2019	X		X		X																X	
		X		X					X														X
	Paulos et al., 2007		X		X			X			X	X											X
	Valkanova et al., 2013	X	X		X	X					X	X1				X2,X3						X	
	Sato et al., 2011	X			X			X			X				X							X	
	Skog et al., 2003	X			X					X	X		X									X	
	Ferreira et al., 2015		X		X					X	X		X										X
	Skog, 2004		X	X				X			X			X								X	
	Hinrichs et al., 2008	X		X					X		X	X										X	X
	Viegas et al., 2004		X		X			X			X	X										X	
	Iwai et al., 2006		X		X			X			X	X										X	
	Nagel et al., 2011	X		X						X	X		X										X
	Boj et al., 2005		X		X					X								X		X			

No information X1, X2,X3 installation number incase of a multiple installation

Table 2. Design Space of the related literature (continued)

Source of information/data

The source of the represented data was examined, and it was found that, even though in most cases, the data was gathered from outside sources, as in Claes et al,[40] Dávila et al.,[41] Lay et al.,[42] there were also a significant number of designs in which all or some of the visualized data were collected within the research. Furthermore, in most of these instances, the data was collected through user participation. For example, Koeman et al. displayed the people's opinions on local issues, which they collected people's opinions on local issues through a polling system and then displayed on the streets.[43] The use of participatory data redefines the role of the user from an audience of the content to being part of the content.

Furthermore, it was also found that in some cases, both data from outside sources and data collected as part of the design were used. For example, Ferreira et al., while displaying climate change data in a marketplace, enable people to personalize the visualization by inputting their date of birth or country as a data humanism approach.[44]

Dynamism of information/data

The dynamism dimension of content refers to the change in the information/data that is displayed. In almost half of the designs, the content was found to be static, meaning available information remained the same. In some cases, even though the displayed information varied as the system supported transition between different pieces of content through its interactive features,[45] these were also found to be static, as the available content was predetermined and not open for change. In the rest of the designs, the displayed information was dynamic, thus changing to different extents, for example,

cumulatively through the addition of new content[46] or based on the user, by letting user input their data during their interaction.[47]

Space

Level of publicness

The examination revealed that the level of publicness of the spaces where information was displayed varied between semi-public and public spaces, and it was found that most of the studies used semi-public spaces rather than public spaces. Furthermore, a variation was seen in the functions of the spaces. Accordingly, the semi-public spaces were identified and categorized under five main categories: cultural spaces, such as museums;[48] educational spaces, such as university libraries;[49] commercial spaces, such as marketplaces;[50] transportation hubs, such as ports;[51] and society-related areas, such as community centers.[52] Those outside these groups were placed under the other group. It was found that cultural spaces are the most preferred spaces for information and data communication, which aligns with the function of these spaces.

On the other hand, the number of designs focused on data display in public spaces, such as streets, as in Claes et al.,[53] squares, as in Claes and Vande Moere,[54] or parks, as in Morais et al.,[55] is quite limited compared to designs placed in semi-public spaces. However, although these designs were intended to be placed in and evaluated in public spaces, in some cases, a certain degree of control can be observed during the evaluation process, such as in the study of Morais et al., due to conducting a controlled in-the-wild study.[56]

Placement

Placement dimension examines whether the displays were attached to the space or were stand-alone within the space. Accordingly, the majority of the designs were found to be stand-alone, as in Claes and Vande Moere,[57] while in rest of the displays were attached to the space, such as to the ceiling of the building[58] or its façade.[59]

Furthermore, the examination revealed that in some cases, even though the content was displayed in physical space, the display was not part of the physical space. It was found that this is the direct outcome of using private displays. For example, in the research conducted by Gheorghiu and Ştefan, displays were used for a location-based augmented reality experience developed for an archeological site.[60] As a result of the approach used to display information, the display did not become part of the physical space. On the other hand, it was detected that in some cases, the connection to the physical space was not made by the display itself but by another component of the system. This was the case in the projects that used marker-based augmented reality, where markers connected the system to the physical space, as in Wilson Simao.[61] It was also noted that with projections, the display technology and the displayed image were two separate entities. In this case, the placement was discussed for the projected image rather than the projection device. As the images were always projected on something, they were encoded as attached, as in Valkanova et al.,[62] excluding the design of Paulos et al.,[63] where the content was projected on a standalone physicalization.

CONCLUSION

This research shows the overview of the information and data visualizations in public space and reveals the design space through systematically analyzing the selected literature through defined dimensions about the system, display, content, and space. While we acknowledge that keyword-based document search and inclusion-exclusion decisions made by the researchers had impact on the corpus, the study was able to reveal important findings; some of which are that the level of publicity of the spaces included in the corpus varied and that the existing studies mainly took place in semi-public

spaces; that the systems were mostly interactive and that their interactive features that support participation allowed people to become part of the narrative rather than just spectators; that even when displayed in public spaces, the technologies used were not always public and were not placed in the space.

While this research focuses on the literature on the visual representation of data and information, further research by including other representation methods, such as physicalization, can provide a more comprehensive understanding of how information and data representations are included in public spaces.

ACKNOWLEDGEMENT

This study is a part of the doctoral thesis of the first author, which is being conducted at Istanbul Technical University and supported by TÜBİTAK (The Scientific and Technological Research Council of Türkiye) under the 2214-A International Research Fellowship Programme for PhD Students.

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INVESTIGATION OF THE IDM APPLICATION IN CONSTRUCTION MANAGEMENT: A SYSTEMATIC LITERATURE REVIEW

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INTRODUCTION

Construction projects consist of a complex series of processes involving multiple stakeholders and repetitive activities. Due to these issues, deficiencies in information transfers between stakeholders or confusions in the roles and responsibilities of stakeholders may occur. In this regard, facilitating integration between stakeholders in relation to newly developing technologies, standardizing processes and all documentation will ensure that data exchange between all stakeholders who will take part throughout the building production process can be effectively transferred without loss. Regarding the management of construction project processes; Information Delivery Manual; abbreviated as IDM, proposes a methodology that addresses business processes in a phased manner while also explaining detailed user definitions of information that should be exchanged at certain points within the process of a project.

In short, IDM can be reproduced separately as an effective guide that enables information exchange between stakeholders for all stages of a construction project or a specific stage and also different project types. This study aims to review the topics of studies focused on information management and construction management in the literature and to determine potential research areas related to information management and construction management. As a method of the study, a systematic literature review was conducted and a meta-analysis was completed according to the results of the review. In the completed meta-analysis, the construction project types for which IDM was recommended in the literature were analyzed according to the types of project and according to project life cycle phases and usage of the IDM tool. This literature analysis was completed as part of a doctoral thesis study.

Literature Review

Considering the multi-stakeholder and multi-stage processes of construction projects, effective data exchange becomes challenging. Therefore, IDM is an effective guide that can be developed to eliminate this confusion. According to BuildingSmartINT, IDM is a response to these issues it proposes a methodology that captures (and progressively integrates) business process whilst at the same time providing detailed user defined specifications of the information that needs to be exchanged at particular points within a project. To further support these user defined information exchange specifications, IDM also proposes a set of reusable modular functions that handle the basic

information ideas in AEC/FM and that can be used to assist the development of further user defined information exchange specifications.[1] In this part of the paper first of all the information will be given about the approaches before the IDM and after that IDM definitions and component will be explained.

Approaches Before IDM

The IDM outlines a method for defining exchange requirement (ERs) to support specific business processes or use case (UC)s. The initial IDM structure consisted of process map (PMs), an ER, and functional part (FPs).[2] A PM defines a business process, including the responsible actors and data flows to be developed, using the Object Management Group's Business Process Management Notation (BPMN) standard.[3] An ER is a set of information that needs to be exchanged to support a particular business need, and FPs are intermediate steps between ERs and model view definition (MVDs).[4] Before the IDM standard, several efforts were made to achieve the same goals. One example was Georgia Tech Process to Product Modeling (GTPPM), proposed in the early 2000s.[5] The central concept of GTPPM was to capture the information required by each activity in a PM and automatically produce a data schema from the captured requirements. Because GTPPM was developed before IDM was proposed, it did not support IDM standards. After the IDM was proposed, GTPPM adopted the IDM approach.[6] In a separate effort from GTPPM, Georgia Tech proposed a UC-based IDM development method based on the National Institute of Building Science (NIBS) IDM approach.[7] Whereas GTPPM used an activity diagram as diagramming notation, Georgia Tech's UC approach used a BPMN-like IDM and introduced the concept of a UC, defined as "an exchange scenario between two well-defined roles for a specific purpose, within a specified phase of a building's life cycle".[8] This UC definition is restrictive compared to the general UC definition because UCs generally include processes and not vice versa.[9] Extended Process to Product Modeling (xPPM) methodology was developed with a prototype software application in the late 2000s.[10] The goal of xPPM was to integrate PMs and ERs seamlessly and link them to MVDs. The xPPM proposals were accepted and reflected in International Standard Organization (ISO) 29481–1:2016, a revision of ISO 29481–1:2010. As a result, until the IDM standards are clarified, we can talk about three different approaches in the literature: GTPPM, UC-based and xPPM. If we compare them in terms of process map creation methods;

- GTPPM;
- It uses activity diagram to show the process map.
- UC-based;
- It uses BPMN to show the process map.
- xPPM;
- Process map is fully integrated with MVD data schema erXML and fpXML software compatible
- ISO 29481:2016;
- FP is not mandatory process map is shown with BPMN together with IM and TM

IDM Definitions and IDM Components

According to BuildingSmartINT IDM consist of process map, exchange requirement and functional part. In the Figure 1 shows that primary components of IDM. Process Maps; A process map describes the flow of activities within the boundary of a particular topic. The purpose of a process map is to gain an understanding of the configuration of activities that make it work, the actors involved, the information required, consumed and produced. Exchange Requirements; An exchange requirement is a set of information that needs to be exchanged to support a particular business requirement at a particular stage of a project. Typically, for IDM as presently established, the set of information should be defined within the Industry Foundation Classes (IFC) model. Functional Parts; A functional part is

a unit of information, or a single information idea, used by solution providers to support an exchange requirement. A functional part describes the information in terms of the required capabilities of the industry standard information model upon which it is based. For IDM as presently established, the functional parts are based on versions of the IFC model. A functional part is fully described as an information model in its own right as well as being a subset of the information model on which it is based.[11]

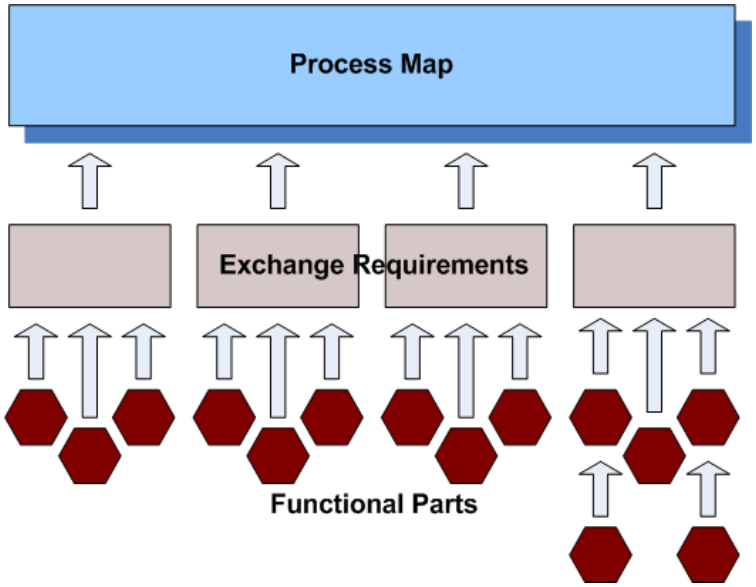


Figure 1. Basic IDM technical architecture (Wix and Karlshøj,2010)

In 2007, a different IDM production model emerged by seeing National Building Information Modeling Standards (NBIMS) IDM as the previous stage of MVD. NBIMS, is the definition of standard steps as a procedure for an MVD procedure as shown in Figure 2. NBIMS is divided into standard logic and parts for building information exchanges that support providing interoperable field connections.[12]

This specified MVD development process consists of three basic steps: first the IDM, second the MVD, and finally the implementation. Stakeholders in the construction industry define an information exchange template that contains functional specifications for each project lifecycle stage. This template is applied to an IDM that defines the change requirements and their attributes. This IDM is translated into an MVD using a subset of the IFC schema.[13]

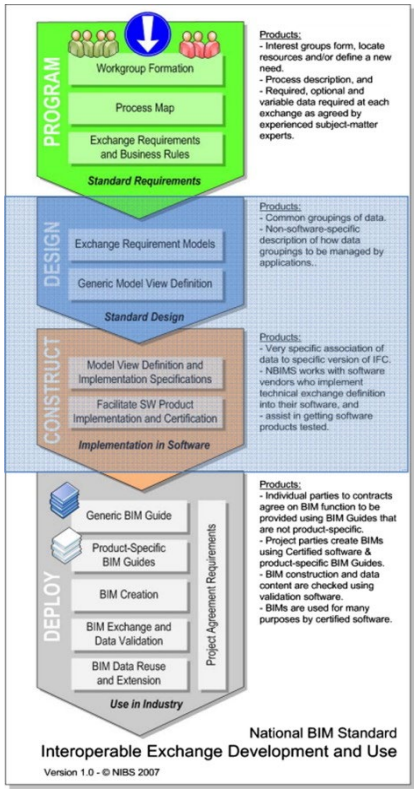


Figure 2. Definition of Information Delivery Manual and Components of IDM (NBIS,2007)

Components related to IDM according to the ISO 294781:2016 standard are as follows.

- Process map (PM): A representation of the relevant characteristics of a process associated with a defined business purpose.
- Exchange requirement (ER): A defined set of information units that must be exchanged to support a particular business requirement at a particular process phase or stage.
- Interaction map (IM): A representation of the roles and transactions relevant to a defined purpose.
- Transaction map (TM): A representation of a set of messages exchanged between participating roles for a particular purpose.
- Information delivery manual (IDM): Documentation that captures business processes and provides detailed specifications about the information that a user fulfilling a particular role would need to provide at a particular point within a project, also known as information delivery specification (IDS).
- IDM components: The basic elements that form an IDM—interaction maps (IMs), transaction maps (TMs), process maps (PMs), and an ER.
- Model view definition (MVD): A computer-interpretable definition of an ER, specifically bound to one or more particular standard information schemas.
- Use case (UC): A description of how, when, why, and by whom a set of information is used 14[14]

When the definitions and IDM components in BuildingSmart, NBIMS and ISO standards are examined, it is seen that the process map and exchange requirements are a common component in creating IDM. According to NBIMS, MVD and IFC standards should definitely be included, while according to ISO standards, IM and TM should be among the IDM components.

METHODOLOGY

Due to the complexity, multi-stakeholder nature of construction projects, and their one-time nature, disruptions in information exchange can occur. Therefore, IDMs are recommended for different construction project types, at different project lifecycle stages, and using different tools. Therefore,

this study examines IDM studies in the literature through a systematic literature review. Following this review, a meta-analysis was completed, focusing on project types, project lifecycle stages, and the tools used in recommending IDMs. Scopus, Web of Science databases were used for searches within the scope of systematic literature review. The search was made with the fields of "title / abstract / keyword". No time period was limited. The keyword "information delivery manual" was used in the search. The publications were required to be in English. Only publications related to project and construction management were included in the scope of the study. And also engineering field is included in the Scopus database. In figure 3 indicate that determination, investigation and scope of the selected publication. In Scopus 74 publication was found and in WOS 61 publication was found. After removing duplicate publication 97 publication was investigated and than 3 of them found that as irrelevant to the construction management. Finally 94 publication was investigated in this study scope.

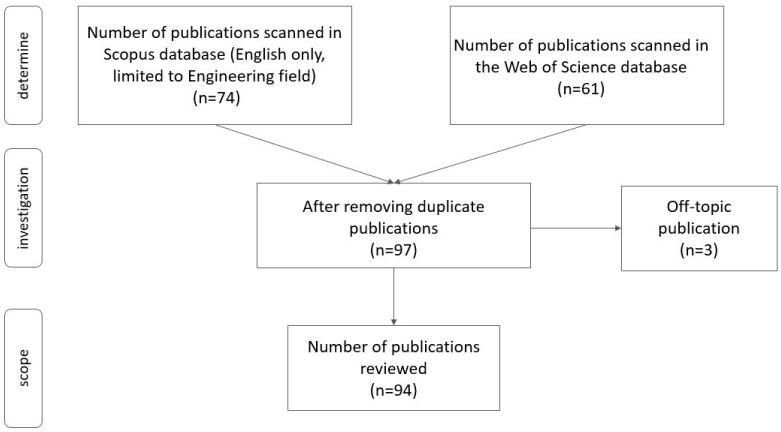


Figure 3. Systematic literature review methodology

RESULTS

This study examined a total of 94 publications related to IDM, obtained from the Scopus and Web of Science databases. Bibliometric analyses were conducted to examine these publications. Subsequently, the review identified that IDM is recommended for different project lifecycle stages and different types of construction projects. A meta-analysis was conducted to identify which project lifecycle stages and project types the 94 publications were recommended for. Finally, literature reviews identified the use of specific tools for creating IDM. These tools include BPMN/BPMNxml, ISO standards, Use_case-based, IFC, MVD/MVDxml, Xppm, NBIMS toolkit, onthology-based, BIM Execution Plan (BEP) guide, and Building Smart Data Dictionary(BSDD). Tables were created for the combined use of these tools, either individually, in pairs, in triplicate, or in quadruples. After these tables were generated, the frequency of combined tools was examined and evaluated. The results will be described in this section.

Bibliometric Analysis Result

In this part of the paper bibliometric analysis data result will be indicated. First of all in figure 4 indicate that number of the publication distribution according to year.

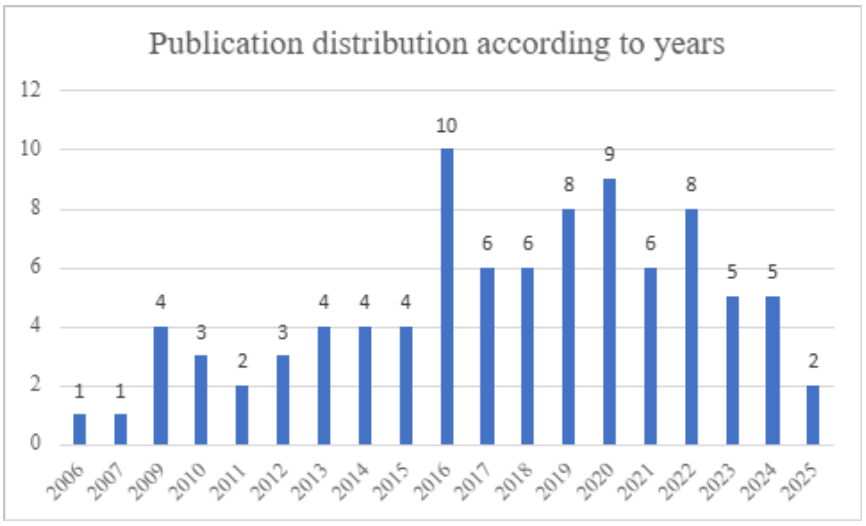


Figure 4. Distribution according to years (Scopus & Web of Science,2025)

Secondly in Figure 5 indicate that distribution of the publications according to country. As seen in Figure 5, 24 of the 94 publications examined regarding the IDM concept were completed in the USA. The UK comes second with 10 publications.

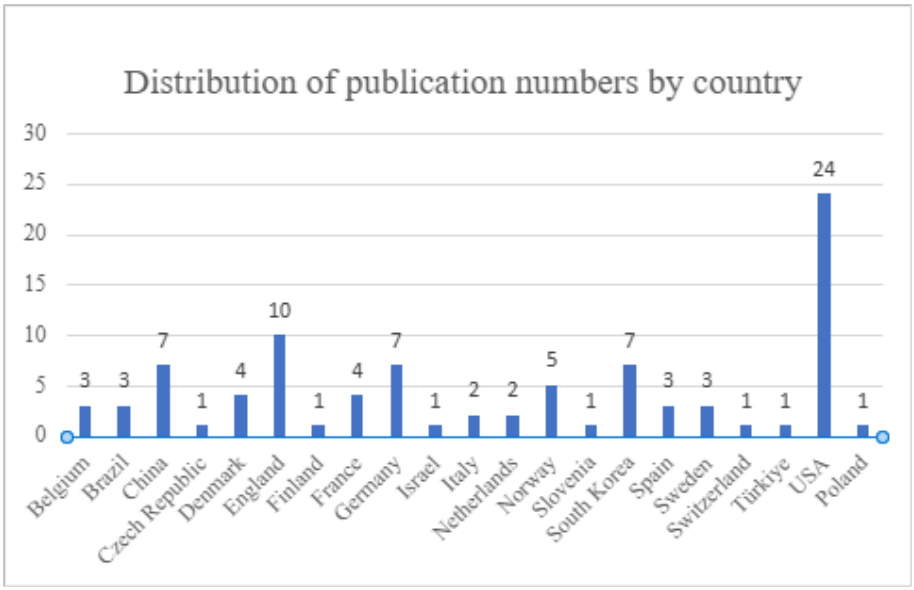


Figure 5. Distribution according to years (Scopus & Web of Science,2025)

Project Life Cycle Result

In the literature analysis when publications on IDM were examined, it was observed that there were studies that were aimed at specific project life cycle stages or that covered all life cycle stages in the construction projects. According to these knowledge meta analysis is conducted and all these publication also examined project life cycle stage. Which these stages are; early design phase, preliminary design phase, design phase, detailed design phase, construction phase, tender phase, facility management and all phases. In Figure 6 indicate that 27 of the 94 publications examined IDM was proposed for the design phase. Secondly IDM proposed in 20 publications for all project life cycle stages and 18 publication proposed for facility management.

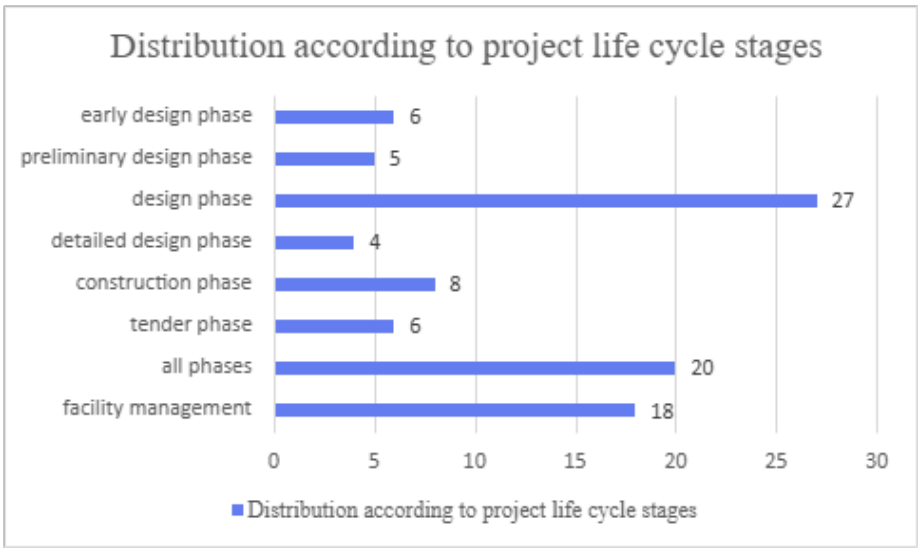


Figure 6. Distribution according to project life cycle stages (Scopus & Web of Science,2025)

Type of Project Result

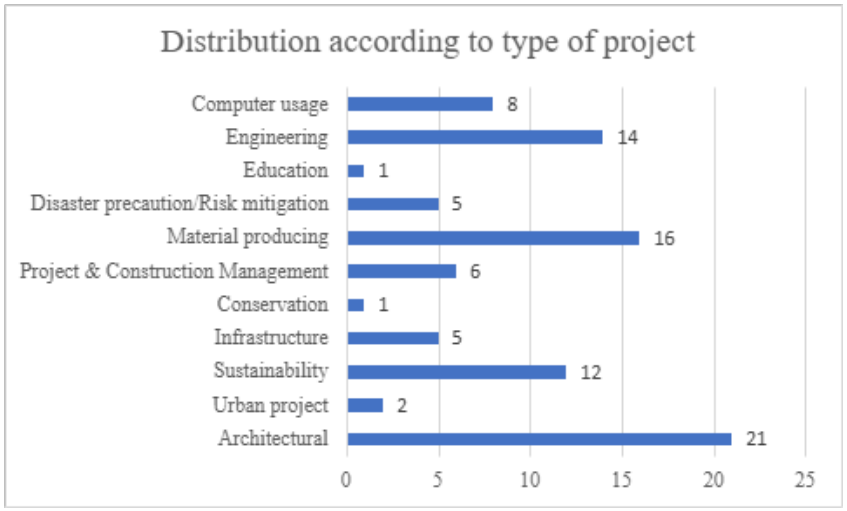


Figure 7. Distribution according to type of project (Scopus & Web of Science,2025)

In Figure 7 indicate that distribution of the type of the project for construction project. IDM can proposed for computer usage, engineering, education about construction management, disaster precaution/risk mitigation, material producing, project and construction management, conservation, infrastructure, sustainability, urban project and architecture. In literature, according to conducted meta analysis in 21 of 94 publication IDM was proposed for architectural construction management project, secondly in 16 of 94 publication related material producing in construction, after that 14 of 94 publication related with the engineering.

Tool Usage Result

Proposing an IDM need the tools, which these are; BPMN/BPMNxml, ISO standards, Use_case-based, IFC, MVD/MVDxml, xPPM, NBIMS toolkit, onthology-based, BEP guide, and bsDD. Figure 8 shows the tool usage combination rate according to individual (one tool), in pairs (two tool together), triplicate (three tools together) and quadruples (four tool together). And also Table 1, Table

2 and Table 3 show the tables of the tools used in publications scanned only in Scopus, scanned only in WOS and scanned in both Scopus and WOS.

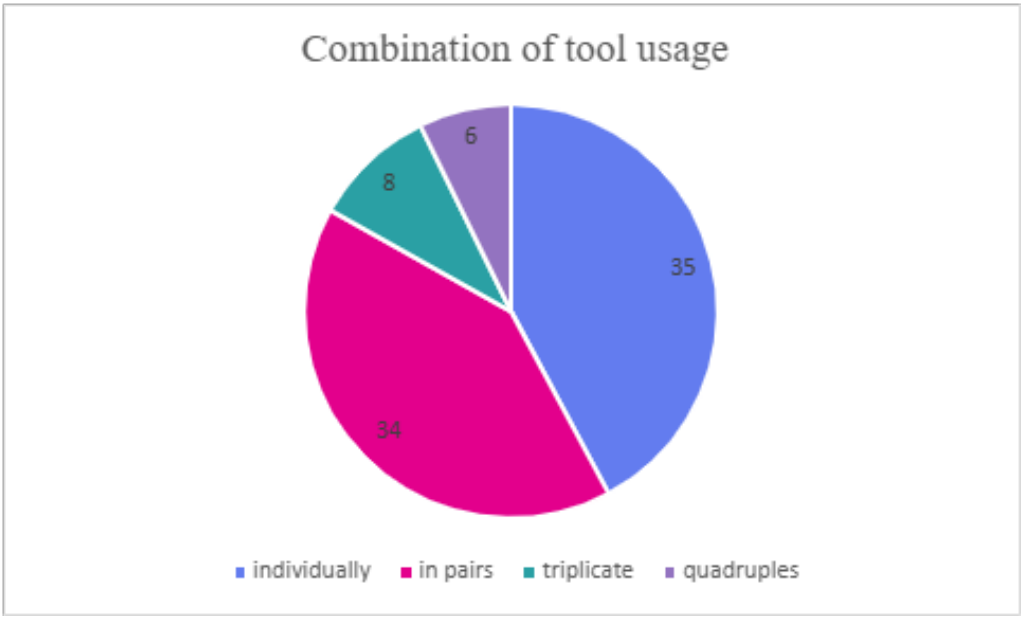


Figure 8. Combination of tool usage (Scopus & Web of Science,2025)

	IDM Tool													
	ISO standards					UC_Based	IFC/IFCdoc	BPMN/BPMNxml	xPPM	MVD/MVDxml	NBIMS/NBStoolkit	onthology based	bsDD	BEP Guide
AUTHOR'S NAME AND YEAR	types of ISO													
	ISO 19650	ISO 222363	ISO 13790	ISO12006-2	ISO 29481									
1, Carmo and Satolino, 2022					X			X						
2, Shariatfar and Lee,2023							X			X				
3, Jin-Kook et all.,2020										X				
4, Ramaji and Memari, 2018										X				
5, Emira et all.,2015							X			X				
6, Hjelseth,2010														
7, Eastman et all., 2010								X			X			
8, Liu et all,2023							X							
9, Shariatfar et. all, 2023							X			X		X		
10, Nascimento et al, 2022						X		X						
11,Klusmann et all, 2020						X	X			X				X
12, Shariatfar and Lee, 2020										X				
13, Breit et all, 2019							X							
14, Lee et all.,2019										X				
15, Robert et all, 2019														
16, Petrova et all, 2017			X				X	X		X				
17, Sacks et all,2016							X	X		X				
18,Afsari and Eastman ,2016							X			X				
19, Kaiser,2016														X
20, Kaiser, 2016							X			X				
21, Nawari, 2014								X		X				
22,Bradley et all., 2014							X			X				
23,Jallow et all, 2013										X				
24,Nawari, 2012							X	X		X	X			
25,McCuen and Bredehoeft, 2012											X			
26,Nawari, 2011										X				
27,Kim et all., 2010							X							
28,Krigsvoll,2007														X
29,Zhou et all.,2024	X							X						
30,Shariatfar and Lee, 2024										X				
31,Liang and Tang, 2024							X			X				
32,Li et all,2024							X			X				

Table 1. Distribution of Tool Usage (Scopus 2025)

	IDM Tool													
	ISO standards					Use Case-based	IFC /ifcDOC	BPMN/BPMN XML	xPPM	MVD /MVDxml	NBIMS/NBStoolkit	onthology based IDM and MVD	bsDD	BEP Guide
AUTHOR'S NAME AND YEAR	types of ISO													
	ISO 19650	ISO 222363	ISO 13790	ISO 12006-2	ISO 29481									
Berard and Karlshoej,2011							X	X						
Rena et. all,2019							X	X						
LAI et. all.,2019							X	X						
Xu et. all,2020								X				X		
Son et. all,2022													X	
Xu et. all,2022							X					X		
Wettling et. ell,2023							X	X						
Arayici et. all,2018								X		X				
Santosa et. all,2019							X							
Tanga et. all, 2020							X	X		X				
Sacksa et. all,2018								X						X
Bradley et all.,2021						X		X						
Liu et all,2021							X	X						
Musella et. all,2020							X	X						
Santosa et. all,2020								X						
CICCONE et. all,2023							X	X		X				
Pinheiroa et. all,2018						X	X	X		X				
Popovic et. all,2021								X						
Khudhair et. all,2022							X	X		X				
do Carmo and Sotelino,2022								X						X
Nawari,2019							X			X				
Le et. all,2018								X				X		
Andriamamonjy et. all,2018							X							
Ramaji et. all,2017							X	X						
Gigante-Barrera et. all,2017								X						X
Patacas et. all,2016														
Hoeber and Alsem,2016					X									
Jeong et. all,2009							X							
Popovic et.all,2020														
Suse et. all,2022														X
Moretti et. all,2021					X		X	X		X				
Collins and Gentry, 2019														X
Gigante-Barrera et. all,2017														X
Carrato and Bruner,2017														X
Ramaji and Memari,2015							X	X		X	X			
Won et. all,2013							X			X				

Hjelseth,2009														x
Wix et. all,2006							x							
Calleja-Rodriguez et. all,2016														
Lindholm et. all,2025				x			x							
Solnosky,2025						x		x						

Table 2. Distribution of Tool Usage (Scopus and WoS 2025

	IDM Tool													
	ISO standards					Use Case-based approach	IFC ıfcDOC	BPMN/BPMN XML	xPPM	MVD /MVDxml	NBIMS/NBStoolkit	onthology based	bsDD	BEP Guide
AUTHOR'S NAME AND YEAR	types of ISO													
	ISO 19650	ISO 222363	ISO 13790	ISO 12006-2	ISO 29481									
1.Mondrup et.all, 2014		x												
2.Jeon et all.,2021					x									
3.Liu et. all,2014							x	x						
4.Iram et. all,2014														
5.Lee et all.,2013									x					
6.Lee et all.,2016							x					x		
7.Horn et. all,2020					x		x	x						
8.Hjelseth, 2015														
9.Klobut et. all,2016								x						
10.Treldal et. all,2016						x								x
11.Hjelseth and Thiis, 2009							x							
12.Oostwegel, 2022					x		x			x				
13.Oldfield et. all,2017					x		x			x				
14.Wix et. all,2009							x							
15.Nawari,2012								x			x			
16.Drzymalla et. all,2021														
17.Won et. all,2013							x							
18.Owerko, 2024														x

Table 3. Distribution of Tool Usage (WoS 2025)

EVALUATION OF THE DATA OBTAINED

The study includes publications from a non-period limit scanned in the Scopus and Web of Science database with the IDM keyword. In total 94 publications were examined. As summary, it can be said that IDM-related subject have developed considerably in the past 17 years. Firstly a systematic literature review was completed and than meta-analysis was conducted. According to meta-analysis it examined that in terms of project life cycle, majority of the IDM proposal belong for the design phase. And in terms of type of the construction project; majority of the IDM proposal belong architectural project. When we examine the tool usage to propose these IDM we investigate that when the usage

frequencies of the tools used to create IDM are examined, it is seen that BPMN/BPMNxml, IFC, MVD/MVDxml and ISO standards are used more than other tools.
As a summary BPMN is the most commonly used tool among IDM creation tools. BPMN is followed by IFC and MVD. This is because, if we divide academic studies related with the IDM into five-year periods; Academic studies on IDM focused mostly on smart object transfers with BIM software in the first 5-year period. Data transfer formats SAT, CIVI etc. The importance of MVD definitions has been emphasized over the years by comparing IFC and NBIMS. The studies completed in the second five year period aimed to create smart object libraries and to provide and standardize information exchange with these smart objects. Later, in the following five year periods, the direction of academic studies turned to the creation of IDM by becoming more specific about building material production, design processes and construction techniques. In the last 5 years, the BIM concept has now been studied together with IFC and MVD concepts. Instead of transferring smart objects through BIM software, the subject of information management is studied by directly defining MVD, using APIs and plug-in software to BIM software. In studies published in recent years, MVD transfers are studied between stakeholders in different use cases and different interfaces. The smart object-based transfers that BPMN and OMG first created are being replaced by ontology-based information transfers with the .OWL format. Therefore, BPMN, MVD, and IFC tools are increasingly used when creating IDMs.

CONCLUSION

Based on these results, it appears that IDM is compatible with technological advancements. While studies completed to date have largely focused on the design phase of the project lifecycle, it is anticipated that more comprehensive IDM proposals compatible with integrated project delivery systems will be developed in the coming years. Furthermore, it is anticipated that more IDM proposals will be published in the literature using the onthology tool, which is compatible with big data. The need for interdisciplinary collaboration, in addition to engineering and architecture disciplines, with material manufacturers, computer scientists, and other disciplines, depending on the project type, is emphasized for the effective and efficient development of these IDM proposals.

NOTES

[1] Jeff Wix and Jan Karlshøj, Information Delivery Manual Guide to Components and Development Method, 2010-11.
[2] Jeff Wix, “Information Delivery Manual (IDM): Enabling information exchange in AEC/FM business processes,”, 2005.
[3] Business Process Model and Notation Specification Version 2.0, OMG, 2011. Available: https://www.omg.org/spec/BPMN/2.0.
[4] Jeff Wix, “Information Delivery Manual (IDM): Enabling information exchange in AEC/FM business processes,”, 2005.
[5] Ghang Lee, Rafael Sacks, Charles Eastman, Product data modeling using GTPPM—A case study, 2007.
[6] Charles. Eastman, Ghang Lee, Rafael Sacks, Deriving a product model from process models, 2002.
[7] NBIS (National Institute of Building Science) Facilities Information Council, 2007.
[8] Jan Karlshøj, Process and building information modelling in the construction industry by using information delivery manuals and model view definitions, 2012, 305–309.
[9] Kahyun Jeon, Ghang Lee, Seoungwoo Kang, Hyunsung Roh, Jeaeun Jung, Kyungha Lee, Mark Baldwin, A relational framework for smart information delivery manual (IDM) specifications, 2021.
[10] Thomas Liebich, IFC4—The new buildingSMART standard, 2013.
[11] Jeff Wix and Jan Karlshøj, Information Delivery Manual Guide to Components and Development Method, 2010-20-21.
[12] NBIMS, National Building Information Modeling Standard, 2007.
[13] Charles Eastman, Yeon-suk Jeong, Rafael Sacks, Israel Kaner, Exchange model and exchange object concepts for implementation of national BIM standards, 2009, 25–34.
[14] Kahyun Jeon, Ghang Lee, Seoungwoo Kang, Hyunsung Roh, Jeaeun Jung, Kyungha Lee, Mark Baldwin, A relational framework for smart information delivery manual (IDM) specifications, 2021.

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Eastman, Charles, Jeong Yeon-suk, Sacks Rafael, Kaner Israel, Exchange model and exchange object concepts for implementation of national BIM standards, 2009.
Jeon, Kahyun, Lee Ghang, Kang Seoungwoo, Roh Hyunsung, Jung Jeaeun, Lee Kyungha, Baldwin Mark, A relational framework for smart information delivery manual (IDM) specifications, 2021.
Karlshøj, Jan, Process and building information modelling in the construction industry by using information delivery manuals and model view definitions, 2012.
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SUPERBLOCK STUDIO: CONTESTING THE CULTURAL HEGEMONY OF THE CAR

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INTRODUCTION

This paper will outline the characteristics, implementation, and assessment of a pedagogical tool developed by the author as an Advanced Design Studio that draws connections between Barcelona and New York City. With the title *SuperBlock Studio: Contesting the Cultural Hegemony of the car*, the class has been running for four years in different Schools of Architecture in New York. Students analyze the superblocks -Superillas[1]- implemented in Barcelona starting in 2016 and investigate potential applications in New York. They establish potential traffic patterns, pedestrian areas, community use, etc.; in order to propose the configuration of a New York Superblock.

During its four iterations students have worked in Hell's Kitchen, the Lower East Side, Central Harlem and East Brooklyn. In the process, students engaged each area's community boards: Manhattan Community Boards 03, 04 and 10, and Brooklyn Community Board 02,[2] working with the community on their proposals.

The paper will present an overview of the four editions of the studio with special emphasis on the urban scale and the current state of the overarching goals of the project through a series of examples that demonstrate the potential of Barcelona as an impactful case study for the future of the architecture education curriculum.

PROJECT BACKGROUND

The work presented in this paper pertains to a series of Advance Design Studios that ran for four consecutive years at Pratt Institute School of Architecture[3] and the City College of New York.[4] The design studio, called '*The SuperBlock Studio: contesting the cultural hegemony of the car'*, looks at the Superblocks in Barcelona as inspiration and speculates with design strategies to liberate public space for pedestrian occupation, removing cars and car traffic from the shared space of the street in different neighborhoods in New York City.

In September 2016 when the city of Barcelona[5] implemented its first Superblock, an urban experiment designed to challenge the mobility of the typical urban road network, based in its 113m x 113m grid where the car, as in most metropolises around the world, is ubiquitous. The first Superblock covered an area of 0.16 km2 in El Poblenou neighborhood, gathering nine blocks of the city grid into a roughly 400m x 400m area. Through the modification of the basic road network and the establishment of differentiated routes for each mode of transportation, the Superblock aims to

reclaim and return the public space to the citizen and pedestrian life, while reducing the environmental impacts of vehicles.

The new configuration forces private vehicles to turn on all interior intersections. This means that they are not able to circulate in a straight line, so it is recommended that they avoid going through the Superblock if it is not strictly necessary to access a specific point in their interior; also, the speed of the vehicles has been limited to 10km/h inside. Bicycles are the only vehicles that can cross the intersections of the interior of the Superblock, as illustrated in Figure 1.

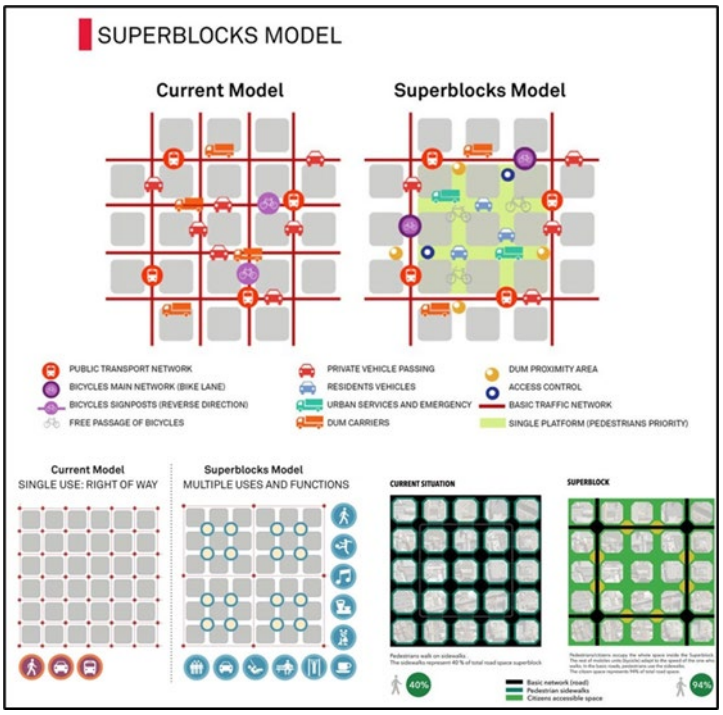


Figure 1. SuperBlocks Model. Ajuntament de Barcelona

This simple operation, that does not require the implementation of major changes in the urban fabric, opens up a discussion, both urgent and necessary, about the future of the urban environment, that the Design Studio takes as its starting point, to speculate with urban and architectural scenarios that can be implemented within the Superblock background in order to actively engage in the social role of architecture and its impact in contemporary cities.

The initial plan was further expanded in the area of Sant Antoni, where a second SuperBlock was opened surrounding an existing market building. In 2020 and 2021, the city unveiled a new stage in the process that involves the transformation of several of the city's main roads into green axes, turning the intersections of these new green axes into public squares. A competition announced its winners for 4 of these streets and 4 of these squares in March 2021.[6]

The studio starts from the analyses of these multiple existing proposals, to investigate their impact in current neighborhoods, and to question ideas of use of public space, temporality, and the potential of architecture to generate long term impact structures envisioning the future of the superblock model. Learning from Barcelona, students are exposed to models of urbanism that can inspire radical solutions in other parts of the world, as, in this case, New York.

METHODOLOGY

The Studio starts by investigating the impact of these proposals in the city, and questioning ideas of use of public space, temporality, and the potential of architecture to generate long term impact structures envisioning the future of the Superblock model. Learning from Barcelona, students are exposed to models of urbanism that can inspire radical solutions in other cities. We organize this work through three scales: City Scale / Superblock Scale / Architectural Scale. The initial large-scale steps are performed in groups, to then work in pairs, having the last portion negotiable in terms of how to proceed, either maintaining the pairs or working individually. This is something that can be adapted to the program in which the studio is taught and the goals of the curriculum. Students, working in groups, analyze the Superblocks implemented in Barcelona and look for potential applications in a defined area of their choice in New York, that has a large boundary determined by the syllabus and connected to the boundaries of different Community Board Organizations in the city. This boundary is different in each of the editions of the studio, prompting students to factor local conditions and speculate with what could happen in the liberated space, both through temporal and permanent solutions.

We start with an analytical and speculative exercise looking at the context of the entire city, that helps us understand the larger impact of an operation of these characteristics at the city scale and to develop a proposal for a NYC Superblock. They establish potential traffic patterns, limits, pedestrian areas, bike paths, etc.; in order to propose the configuration, number of blocks and functioning of their Superblocks. In the process, we also study the area's community boards, the theoretical stakeholders of the project, and look for a collective definition of the term 'Public', in Public Space.

Once the Superblock site is established, the studio speculates within the newly created car-free boundaries, and define the programmatic approach to the area, by proposing the traffic systems for cars, bikes and pedestrians, and envision potential uses for the public space.

Each student analyzes a series of architectural typologies and their relationship with the city (for example: cultural, shelter, commercial, playgrounds…), in order to argue for the selection of typologies to be developed in the second half of the semester through what the syllabus defines a Community Center '+'. Along these exercises, we reflect as well on the impact of Public Health measurements by reading and discussing current literature on the topic and argue for potential impacts on their designs. Based on a basic program for a Community Center, given in the syllabus, each student identifies a potential additive program that addresses the opportunities offered by the Superblock and proposes a permanent structure on the site, developing a Community Center "+", the "plus" being based on the typological study done in the previous exercises. Some Examples include Community Center + Arts Residency / Community Center + Shelter / Community Center + Farming or Community Center + Production. The final presentation focuses on the impact of the architectural building on the city scale, and the discussion on the Superblock as an urban strategy to face the future of our big metropolises.

EXAMPLES

This work was produced within the frame of an Advanced Design Studio that has been running for four editions, both at Pratt Institute School of Architecture and at the City College of New York. In every edition the goals and interest shift depending on the site chosen, the students' interests and the inevitable state of the world at the time of the class.

As Figure 2 shows, the first edition happened at Pratt Institute during the summer of 2018, working with Manhattan Community Board 03 – Lower Manhattan. The second and third edition were developed during the summer of 2019 and 2020 at the City College of New York, meeting and discussing student proposals with Manhattan Community Board 04 – Midtown Manhattan and Manhattan Community Board 10 – Central Harlem. For the last edition, during the summer of 2021,

the studio came back to Pratt Institute, where we work with Brooklyn Community Board 02, that encompasses Downtown Brooklyn, Boerum Hill, Brooklyn Heights, Clinton Hill, DUMBO, Fort Greene, Fulton Ferry, Navy Yard, and Vinegar Hill.

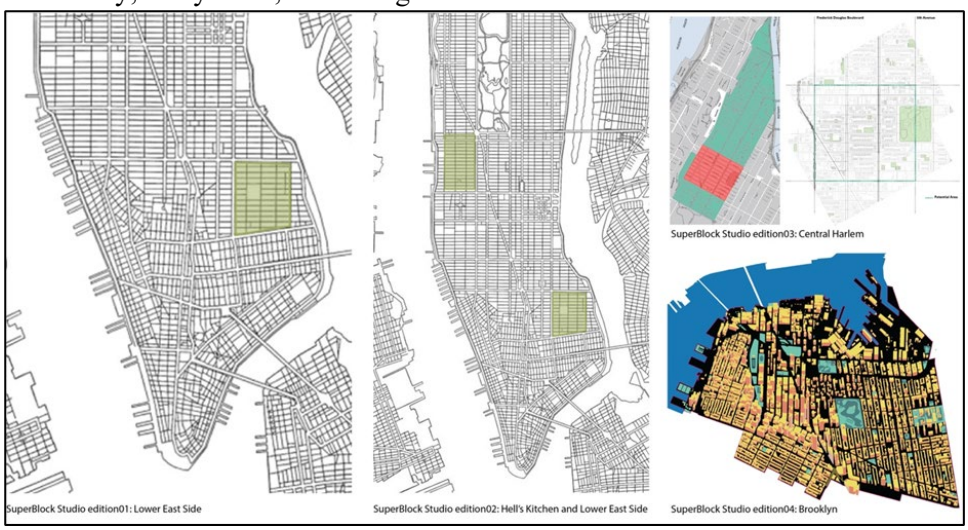


Figure 2. Maps of the four editions of the studio.

Common Assignments

As a start to the semester, students work on a series of initial assignments to help them explore the precedents and initial ideas through different formats.

For the first assignment, they work on urban analyses, starting with Barcelona and moving into New York City. These analyses are approached through an 'Argumentative Analytical Drawing'[7], a method of drawing that teaches architecture students how to use analyses to construct an argument that becomes the generator of design decisions. Through this document, students already set a series of specific interests and goals they intend to pursue through their projects. Some examples focused on human rights, as Figure 3, demographic and income data, or food production and access.



Figure 3. Argumentative Analytical Drawing. Mai Do & Nica Esquivel.

The Second Assignment consists in a 'Speculative Collage', where students translate the initial set of interests explored in the analyses of Barcelona into a quick image visualizing those interests in the place in New York City where they will work. Some Speculative Collages are inspired by precedents, like the Situationists Map of Paris[8] shown in in Figure 4 or Willam Bunge's Radical Cartography,[9] with others working with mixed media to visualize potential changes in the built environment.



Figure 4. Speculative Collage. Anabel Vaquerizo.

The third of these initial assignments is a series of Speculative Models, where students get to explore in a low-resolution format a series of concepts through material experiments. These models do not have site or scale but are rather conceptual and material explorations of the set of interests of each group or student in a format that allows them to work quickly in three dimensions and with some notions of materiality as shown in Figure 5.

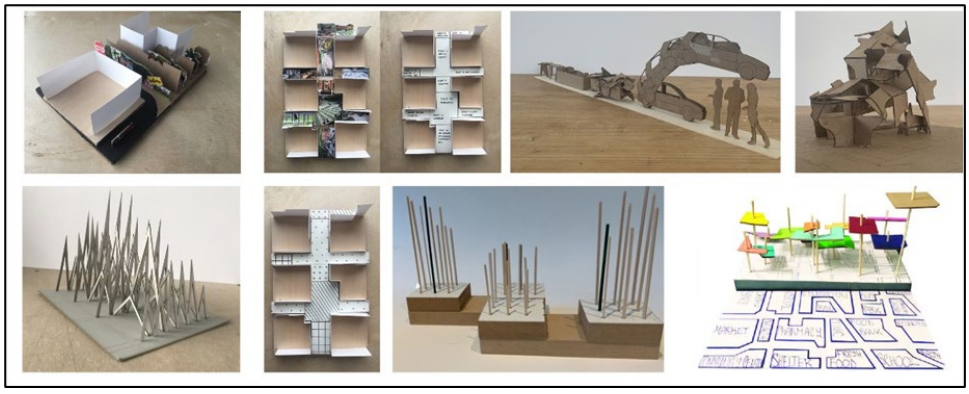


Figure 5. Speculative Models. Various students.

Specific Examples of each edition (2018 – 2021)

To demonstrate different outcomes of the studio in its different iterations, I have selected four examples developed by students. They are:

- "THE PEOPLE'S SUPERBLOCK" [Figure 6]

Students: Mai Do & Nica Esquivel.
Class: SuperBlock Studio. Pratt Institute. Summer ’18.
The site for the studio was the East Village, and these students were highly interested in the history of the neighborhood as a hub for artists and counterculture, aspects that have mostly disappeared throughout the last few decades. In their work, the students explored the right to public space in the East Village, through the re-incorporation of spaces for art as a catalyst for collective life. In the large scale, they proposed a series of devices as workshops, stands or studios that come together in the community center, mixing spaces for the community board with an art residency program, and speculating with the Right for Shelter for every human living in New York, with a series of spaces of shelter that hide under plazas and boulevards.

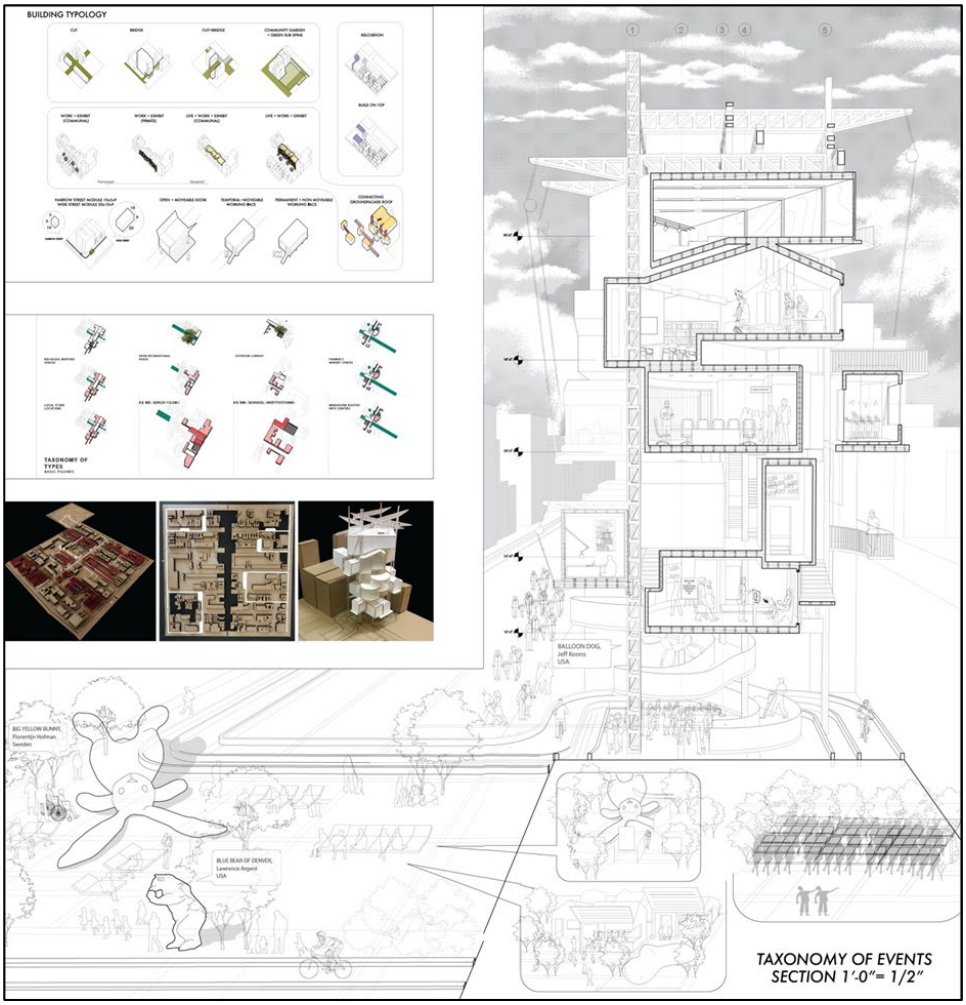


Figure 6. The People’s SuperBlock. Mai Do & Nica Esquivel.

The project was developed in connection with Manhattan Community Board 03 and was highly commended for its proposition towards contesting public space and the engagement with the local community, both aspects triggered by the syllabus and their understanding of the radical proposition of the Superblocks in Barcelona.

- “INTEGRATION OF [S]PACES” [Figure 7]
Students: Jiaying Li & Jiajun Liu.
Class: SuperBlock Studio. City College of New York. Summer ’19.

The students tested in this project the notion of a community center hybridized with domestic programs. Their project emerged from the criticism to the idea of 'modern life' and its distribution of time based on the division of 8 hours of sleep, 8 hours of work and 8 hours of leisure. Their argument defends this temporal distribution does not reflect many members of the community and seeks ways in which an urban intervention based on fragmenting time through architectural typologies might combine chunks of time and activity in devices that challenge domestic, working and leisure programs and combines them in the space of the street.

In this case, we extensively discussed how design might address restorative social justice and inclusive strategies, as well as challenge notions of property and public space, with the background of Tompkins Square Park[10] and its rich history of protest, contestation movements and space for liberation.

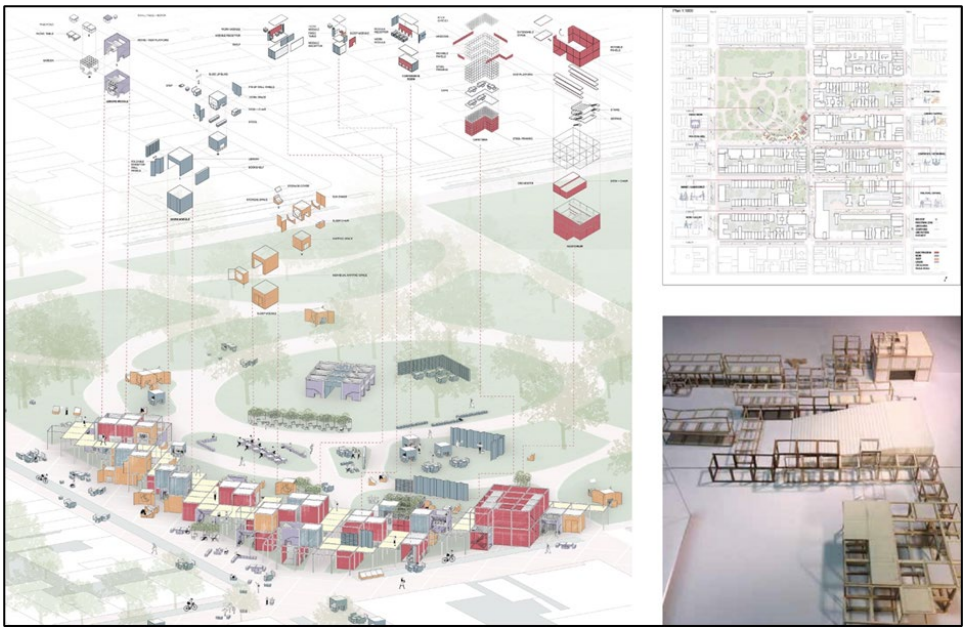


Figure 7. Integration of [S]paces. Jiaying Li & Jiajun Liu.

- "COMMUNITY IN TIMES OF SOCIAL UNCERTAINTY" [Figure 8]

Students: Tania Jaquez, Gloria Hwang, Carry Pak & Mario Joya.

Class: SuperBlock Studio. City College of New York. Summer '20.

In 2020, and for the second time at City College, we carried the first fully remote edition of the studio, due to the pandemic. We worked with Manhattan Community Board 10, in Central Harlem, where most of the students resided at that time.

We also experimented with larger partnerships for the urban scale interventions that then evolved into individual proposals for community centers. Students Tania Jaquez, Gloria Hwang, Carry Pak and Mario Joya worked on the project "Community in times of social uncertainty".

The project was highly influenced by the impacts of the pandemic on local resources and investigated Public Space usage in conditions of uncertainty[11]. Their project aims to adjust to the social or economic state the community is in, with clinics, classrooms, or counseling units as part of the program.

The studio had very strong positions towards Urban Crises and Citizen's Right to public space, resonating both with the Covid-19 pandemic as well as with urban crises such as shrinkage,

disinvestment, and oppression, resonating with my own doctoral research, that was being developed at that time.

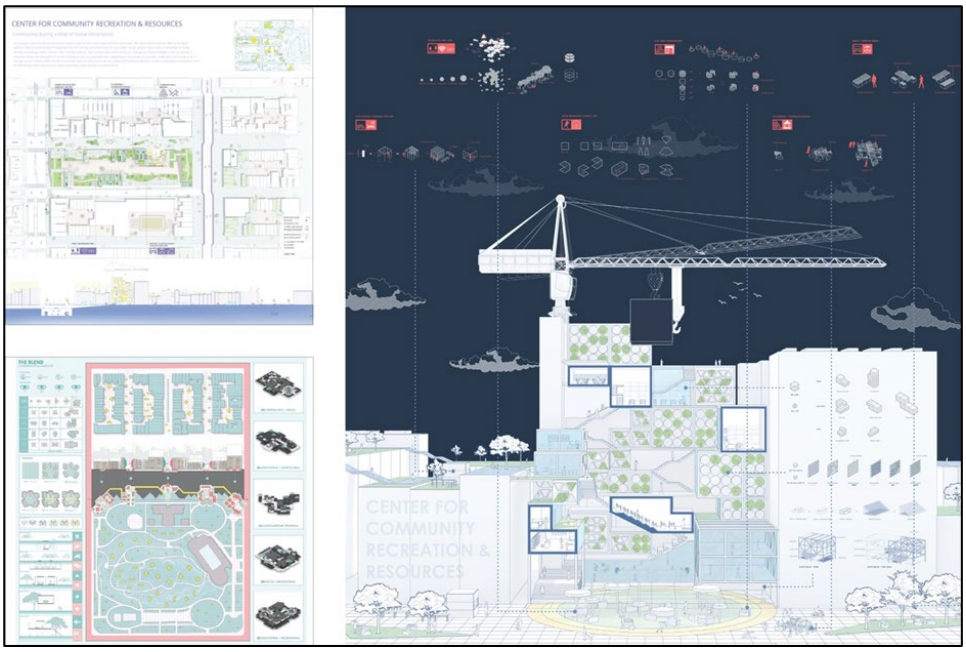


Figure 8. Community in times of social uncertainty. Tania Jaquez, Gloria Hwang, Carrie Pak & Mario Joya.

- “FROM CAR TO CARE” [Figure 9]

Students: Hannah Kim.

Class: SuperBlock Studio. Pratt Institute. Summer ’22.

The last instance of the studio happened during the summer of 2021 at Pratt Institute School of Architecture. Fully remote once again, we took the chance to engage with the community board where pratt institute is located, Brooklyn Community Board 02.

This time we continued expanding on collaborative methods and the whole class worked together on a plan oblique of the community board’s boundaries, where students tested their urban scale strategies in relationship to each other’s and the neighbourhood. This drawing kept evolving throughout the semester as students developed their proposals and week by week inserted their progress, demonstrating them the relationship between scales in an architectural project. Projects emerged with propositions towards establishing infrastructures of care and mutual aid, as well as addressing an urban space of the commons.

As shown in Figure 9, Hannah Kim, a student from the group, proposed in her project “Transparency of craft and shelter: from car to care” a reappropriation of the ubiquitous materiality of scaffolding in New York to establish an infrastructure of mutual aid to transport medicine, food and cultural objects as books or music, connecting the residents with the healthcare commuters that work in the area.

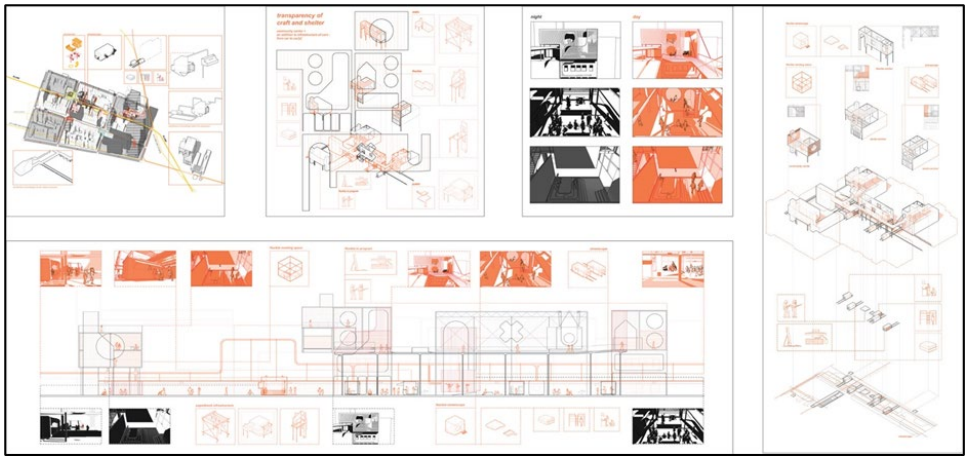


Figure 9. From Car to Care. Hannah Kim.

CONCLUSION

The studio encourages and guides students towards formulation of ideas through argumentative drawing, exploring how representation conventions, as well as inventions, can articulate their claims, inspired by historical precedents of radical mapping as well as other disciplines such as social sciences, geography, or biology.

During the course of the different editions of the Studio, students have been involved in enacting a way of drawing as a tool for community engagement that reinforces architecture and urbanism as fields deeply connected to their context and the people they serve.

A fundamental part of the pedagogy is the way students engage with several community driven institutions and organize participatory workshops with them. This usually happens twice or three times during the semester, after the set of initial assignments, for the midterm review, and the final review.

Over the years, we have collaborated with Manhattan and Brooklyn Community Boards 02, 03, 05 and 10, in multiple workshops with interviews, design charettes, planning committee presentations and discussions, both in person and remotely, as seen in Figure 10. We have also organized several collective workshops where students from different years are invited to physically engage with large scale maps and drawings of the places they are designing with, as well as participated and visited exhibitions and events each semester that allow students to expand the limits of the bounded classroom.

Through this studio and its pedagogical methodology, students get exposed to an academic context that has the potential to go engage large scale questions for the city and small-scale interactions with its neighbors, adding a complex layer of social understanding to the discipline or architecture and urbanism.



Figure 10. Community Board meetings.

As an architect trained in Barcelona and working as an educator in the United States, I have found the city where I studied to be a consistent source of inspiration and an example of good practice. The work here shown is grounded in a connection between Barcelona and New York, but it has the potential to be expanded to other metropolises in the world. As a next step, a new edition of the Studio will take place in the Fall of 2026 in San Francisco, California, to continue the speculation on the effects of Barcelona's exemplary urbanism.

NOTES

[1] From Barcelona's City Council site: "The Barcelona City Council aspires to build a city model that has a public space that is safer and healthier, favors social relationships, promotes local commerce, puts the needs of children and the elderly of this city at the center. SuperIllas is the formula to achieve this goal." Ajuntament de Barcelona: https://ajuntament.barcelona.cat/superilles/en/superilla/eixample

[2] Although coordinated through the Mayor's Community Affairs Unit, each Community Board has independent sites: Manhattan Community Board 03 - https://www.nyc.gov/site/manhattancb3/index.page
Manhattan Community Board 04 - https://cbmanhattan.cityofnewyork.us/cb4/
Manhattan Community Board 10 - https://cbmanhattan.cityofnewyork.us/cb10/
Brooklyn Community Board 02 - https://cbbrooklyn.cityofnewyork.us/cb2/

[3] Pratt Institute School of Architecture, available at https://www.pratt.edu/architecture/

[4] The Bernard and Anne Spitzer School of Architecture, City College of New York, available at https://ssa.ccny.cuny.edu/

[5] The SuperBlock intervention was proposed and implemented by Ada Colau, Barcelona's Mayor from 2015 to 2023 with the political party 'Barcelona en Comú'. First woman to hold that office, she worked as a housing rights activist before becoming mayor.

[6] Barcelona's City Council held two public competitions for selecting architect and engineer teams to define the calmed-street model for the 21st century and the squares that were to be created at the crossroads. Results available at https://ajuntament.barcelona.cat/superilles/en/content/en-resoluci-dels-concursos-d-idees-de-superilla-barcelona

[7] Gonzalo José Garrido. "Argumentative Analytical Drawing. A Pedagogical Tool for Architectural Repair." *ACSA Annual Meeting 113th, 2025, 418–26*. https://doi.org/10.35483/acsa.am.113.54

[8] Guy Debord, "*The Naked City, A Psychogeographical Guide to Paris"*, 1955.

[9] William Wheeler Bunge, Jr. (born 1928, La Cross, Wisconsin). Founder of the Society for Human Exploration and the Detroit Geographic Expedition and Institute. One of the most influential Geographers of his generation.

[10] Tompkins Square Park has a long history as a center for activism, from the 19th-century labor movement to the 1988 riot protesting a curfew imposed on a large homeless encampment in the park. The park has been a site of protests for various causes, including workers' rights, housing justice, and against gentrification, drawing figures from punk and the counterculture scene.

[11] Streets for Pandemic – Response and Recovery. Available at https://nacto.org/wp-content/uploads/2020/05/NACTO_Streets-for-Pandemic-Response-and-Recovery_2020-05-21.pdf?utm_medium=website&utm_source=archdaily.com

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SOME OBSERVATIONS ON DIGITAL PLACEMAKING-LED URBAN HERITAGE REVITALIZATION: A CASE STUDY OF MACAO

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INTRODUCTION

Digital technology is widely employed in the design of built environment and closely integrating the physical space, which significantly merges and blurs the borders between digital and physical space. The hybrid physical-digital space thus arises and becomes a major force in people's everyday lives. As McQuire states that 'we are all "thrown" into an age of digital urbanism, whether we use particular devices or services or not'.[1] Through digital transformations of built environment and potential changes of spatial uses in ordinary everyday life, the technologically mediated spaces function at various scales of individual's daily actions, local community's initiatives, and up to citywide projects, which are digitally enabled by a wide range of technologies. As Harrison and Dourish argue that the digitally enhanced space is 'comprised of both physical and virtual space, and in action is framed simultaneously by the physical space, the virtual space and the relationship between the two'.[2] Moreover, Dourish further investigates the role of technology in spatial transformation and indicates that 'The technologically mediated world…provides a new set of ways for that physical world to be understand and appropriated…by opening up new forms of practice within the everyday world…to re-encounter and re-imagine everyday space'.[3]

In a context of a heritage city like Macau, where urban development and building constructions are normally considered as a potential threat to the heritage site and are strictly restricted by the local heritage protection law, digital technologies have profoundly reshaped the way individuals live and perceive historic urban environments. Urban heritage sites have been digitally mediated and associated with new meanings. Focusing on investigating how "the actually existing technologically enhanced city" is produced, this study provides a detailed examination of the mechanism for digital placemaking-led urban heritage revitalization. This study adopts a place-centric perspective and employs it as an analytical framework to examine and elaborate digitally mediated urban heritage in ordinary individuals' everyday life.

LITERATURE REVIEW

Focusing on the 'rich and complicated interplay between people and the environment',[4] place is a means of understanding the people, space and the relationship between the two. Its conceptualizations have been examined by scholars from various disciplines such as human geography, architecture, and

urban planning and design. It combines location, locale, and identity and is endowed with meaning.[5] As a way of being the world, place is also a qualitative phenomenon,[6] and a conjunction of built environment, culture and people.[7] Relph indicates that space and place were dialectically structured in people's everyday activities and their experiences.[8] Tuan points out a place's four dimensions that were physical, personal, social, and cultural aspects and indicates that "the ideas 'space' and 'place' require each other for definition … if we think of space as that which allows movement, then place is pause; each pause in movement makes it possible for location to be transformed into place".[9] Canter proposes a theoretical model for the constitution of place. He explains that place was a juxtaposition with three major constituent elements that were physical attributes, individual's activities, and his conception, which is adopted as the analytical framework of this study (Figure 1).[10]

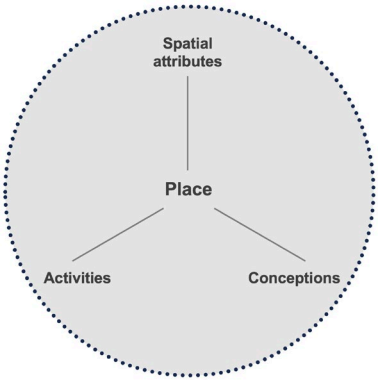


Figure 1. Canter's model of place.
Source: The author

In the contemporary context and with the development of digital technology, place is now extremely hybrid. As de Souza e Silva indicates, widely used mobile communication technologies merge the borders between physical and digital space.[11] In digital environments that "translate all inputs and outputs into binary structures of 0s and 1s",[12] people encounter and engage with various digital technologies and conduct embodied practices through their daily adaptations and appropriations. Furthermore, digital placemaking is the use of technology in placemaking practices.[13] It reshapes traditional notions of placemaking by merging physical and virtual elements.[14] It can occur through location-based technology, augmented and virtual reality, and even pop-up artefacts.[15] Digital placemaking create a hybrid reality and affect community engagement and sense of belonging. Amid the ongoing convergence of physical and digital environments, this research puts itself in a research context of centrally located heritage sites and employs place-based approach as an analytical framework to examine the mechanism of digital placemaking-led lived-in urban heritage and to draw on the evidence of this study to inform planning and policymaking of urban development in heritage sites.

METHODOLOGY

With a land area of 32 square kilometres and a population of 682,500, Macau Special Administrative Region (SAR) of the People's Republic of China comprises the Macau Peninsula and the two islands of Taipa and Coloane linked by the Cotai reclamation area, which makes the city one of the most densely populated areas in the world. To 'investigate a contemporary phenomenon within its real-life context',[16] this research adopted a case study approach and selected Macau's Historic Centre and its buffer zones as the research object (Figure 2). Inscribed on the United Nations Educational, Scientific and Cultural Organization (UNESCO) World Heritage List in 2005, the Historic Centre and its buffer

zones are collections of architectural legacies of the city's cultural heritage, which comprise more than twenty ancient monuments, various historic streets, residential and religious buildings, and public spaces interwoven in the heart of the mixed used city. It is a representative and lively case site for investigating digital placemaking-led urban heritage revitalization. It is this kind of study which is the core of this research project.



Figure 2. The Historic Centre of Macau (shown in blue) and its buffer zones (shown in red). Source: The figure is edited based on a screenshot from Google Earth and an online map from https://www.wh.mo/cn/about/#

With the use of Canter's theorical place model comprised of spatial attributes, people's activities and conceptions as the analytical framework, this study employed a combination of a spatial survey, walk-by observations, and semi-structured interviews. To have an initial enquiry into currently existing digitalized built environment, several narrative city walks were firstly conducted in 2022, which allowed a close look at material space of the case site. Moreover, walk-by observations were employed to capture and record how individuals interact with the hybrid physical-digital environment. In addition, employing the convenience sampling, the research team conducted twelve semi-structured in-depth interviews with residents, these inhabitants' responses provided insights into exploring and speculating ways of digital placemaking-led urban revitalization of heritage sites. In the meantime, data from various types of documents were also collected as supplement.

FINDINGS AND DISCUSSION

The transformation from purely physical attributes to physical-digital attributes in varying degrees to afford new experience and everyday use.

Digital technology is extensively applied at the case site to form a digitally integrated historic urban area to primarily conserve heritage space. When integrating information and communication technology with urban built environment, the heritage site gets digitalized and gains technical capacities to become potentially interactive and responsive. Through spatial survey, it is found that spatial environment of historic urban area is digitally optimized and transformed into a hybrid physical-digital setting in varying degrees (Figure 3). Moreover, it is also shown that the currently existing digital transformation of the area dominantly results from top-down planning and design.

Digital terminals such as diverse forms of QR codes contained either in heritage signs or digital kiosks are some of the most common hybrid properties, which provide a digital layer to the existing environment and generate digitally enhanced space to potentially accommodate new ways of people-heritage interacting rather than being constrained by merely preserving the material properties. Furthermore, the increasing pervasiveness of visible and invisible digital artefacts such as digital screens installed either in urban open space or commercial shops, closed-circuit television cameras, and various sensors, connectors, and transmitters together make the heritage site capable of affording a great potential to various adaptive uses, actively or passively. It thus provides individuals new possibilities to re-experience and to reuse the designated historic urban area, which potentially enables and facilitates their temporary or long-lasting practices of digital placemaking.

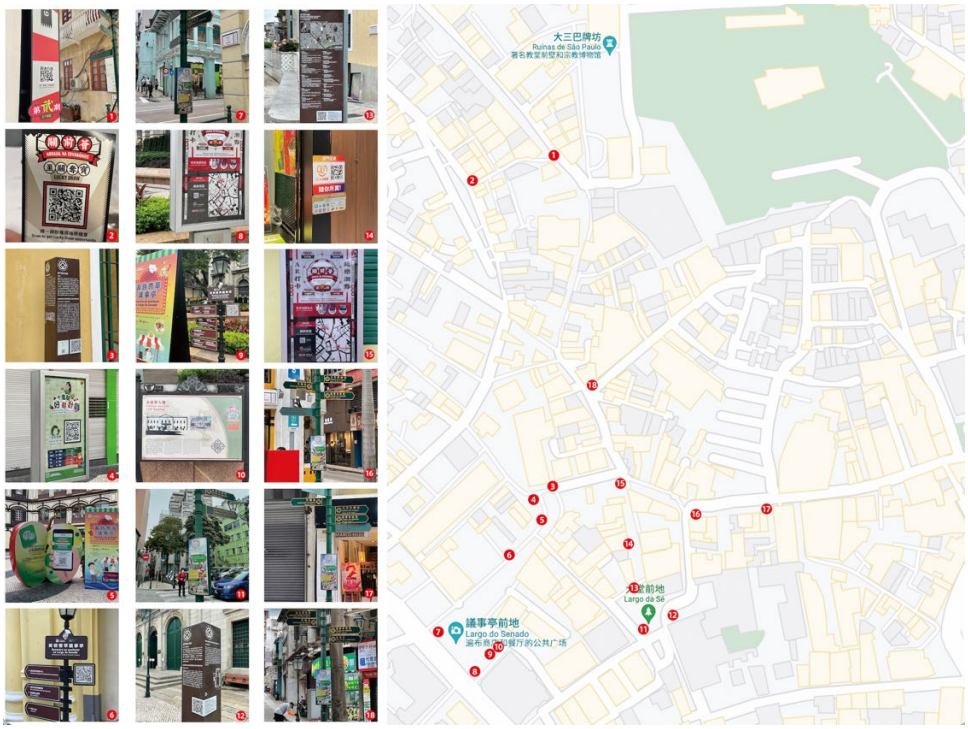


Figure 3. The varying degrees of physical-digital spatial attributes and their distribution. Source: The author

The transformation from static and specific to dynamic and everyday

Simultaneously, placemaking is a generative process through continuous people-place interactions. Empowered by hybrid physical-digital urban artefacts, city users can generate narratives to meet their diverse purposes such as getting extraordinary heritage experience through playing or passively receiving public notification in a real-time manner. People's spatial uses are thus not necessarily constrained by merely conserving built form of the heritage and the historic environment. To extend the range of historic preservation and to purposefully broaden the notion of heritage especially beyond the tourism and its commercial value, technologically empowered individuals obtain the ability and the power to use and appropriate the heritage to enrich their lived-in experience. In this sense, heritage site's digitally enabled capacity is not only for recognizing its primary conservation but also for creatively accommodating people's diverse recreational and social activities, for instance, people enjoyed playing augmented reality (AR) interactive installations set up in the district of Rua dos

Ervanários through scanning the QR codes to take photos with nostalgic filters or to get the purely stunning flower bloom AR backdrops to later share it online (Figure 4).



Figure 4. The on-site people-heritage interactions with AR.
Source: The figure is edited based on screenshots from online video of Macao Daily News. https://www.youtube.com/watch?v=TgO-gLE3p1c&ab_channel=%E6%BE%B3%E9%96%80%E6%97%A5%E5%A0%B1-MacaoDailyNews

The digitally mediated flow of everyday place and the threat of technologically fragmented heritage

The urban heritage is digitally transformed, which affords both residents and tourists diverse new ways to use, interact, and even play. The technologically contextualized heritage site becomes everyday landscapes of the city when it is routinely used by dwellers and visitors through their mundane and repetitively occurred activities. However, in the process of digitally empowered heritage-led placemaking, different groups of individuals' daily movement are highly regarded and mostly concerned by several interviewees. To various extent, five of the twelve respondents all pointed out that the technologically optimized spatial navigation mattered most when retrofitting the historic urban site, which have special significance in reconciling urban demands of inhabitants and visitors. To make urban heritage smart and inclusive, conflicts caused by the residents' and tourists' intersected travel routes could and should be firstly alleviated through the intervention of digital technology. Interviewee NO.1 particularly mentioned that "Residents don't want to be interrupted by the tourists' visiting. Although we really welcome the visitors, we do hope the digital technology can help tourists better navigate themselves. Moreover, we expect that our daily routine and visitors' movement can be digitally mediated and coordinated in a real-time and dynamic means".

Besides the digitally navigated and coordinated daily flows of historic urban area, when responding to the question of how to digitally make urban heritage smart, Interviewee NO.8 especially indicated that "The digital approach causes problems when retrofitting historic urban district. The heritage site will

not be experienced authentically in a digitally enforced mode, which likely makes people neglect the historical background and cultural deposits of the heritage. Instead, individuals will heavily focus on the technologically stimulated effects rather than knowing the whole process of historical transformation. In this sense, what people perceived are fragmented heritage".

CONCLUSION

This study shed light on how a centrally located smart urban heritage can be achieved through individuals' digital placemaking, which contributes to the broader notion of heritage-led urban regeneration. It reviewed the concept of place and employed it as the analytical framework. With the used of methods of a spatial survey, observations, a document-based analysis, and in-depth interview, the Macau's Historic Centre and its buffer zones are examined, through which it demonstrates the mechanism of digital placemaking-led urban heritage transformation and revitalization.

To expand heritage's designated qualities, to recognize the importance of the site's situated urban neighbourhood, and, at the same time, to appreciate individuals' lived-in experiences, the digital placemaking approach is an ongoing and constantly changing action to move beyond heritage's material reality. Rather than merely restoring historic site, it centres on providing new possibilities and occasions for common individuals to experience the heritage in their mundane daily life, which reveals and unfolds new forms of person-heritage relations. The diverse physical-digital spatial attributes afford to mediate and influence both residents' and visitors'' lived-in activities. Utilizations of urban heritage thus become dynamic, which forms a unity between the conserved quality and the perceived reality. More importantly, integrating with the city's daily activities, the digitalized historical site obtains new place bonding and narratives. The historical and contemporary urban environment together evolves. With a digital and technological context means, contested meanings between residents and tourists diffuse the primary value for preservation. The contemporary interpretations of digitally empowered placemaking can act as catalysts in heritage-led urban regenerations, which can carry infinite urban stories and may be a highly feasible approach for the sustainable development of heritage-led urban regeneration.

IMPLEMENTATIONS

Examining and reflecting the mechanism of placemaking-led urban heritage revitalization in the context of densely populated Macao, this study further suggests that when planning and designing a digitalized urban heritage site to provide ordinary people with new interactive experiences, a variety of digital terminals could be employed at different scales, ranging from on-site personal uses to online public sharing. These hybrid physical-digital environmental artifacts, when combined, could potentially form a relatively holistic system that blends and integrates specific historical qualities with everyday realities. Consequently, the threat of technologically fragmented heritage may be greatly relieved. Moreover, in return, the digitally mediated ordinary individuals' daily life in their lived historic urban areas likely provides government administrators, policy makers, planners, and designers new insights for leveraging heritage's conservation and city's future development. The technologically advanced practices of contemporary urban life within a heritage context contribute to the comprehension of a specific form of digital urbanism. As digital technologies are significantly advancing and increasingly pervading everyday space, a place-led approach of responding to the changing urban dynamics and technological advancements for a heritage city could not only enhance heritage values but also empower common individuals, which potentially leads to the sustainable development of a smart heritage city.

ACKNOWLEDGEMENT

The author would like to thank the "Subsidy Scheme for Macao Higher Education Teaching and Research Staff Professional Development" (NO. M24-0005833277) from the Education and Youth Development Bureau of the Government of the Macau Special Administrative Region for the support of this study.

NOTES

[1] Scoot McQuire, *Geomedia: Networked Cities and the Future of Public Space* (Cambridge, MA: Polity, 2016), 60.
[2] Steve Harrison and Paul Dourish, "Re-Place-Ing Space: The Roles of Place and Space in Collaborative Systems" (paper presented at the 1996 ACM Conference on Computer Supported Cooperative Work, New York, NY, USA: ACM, 1996, 72).
[3] Paul Dourish, "Re-Space-Ing Place: 'Place' and 'Space' Ten Years On" (paper presented at the 20th Anniversary Conference on Computer Supported Cooperative Work. New York, NY, USA: ACM, 2006, 304).
[4] Tim Cresswell, *Place: A Short Introduction* (Oxford, UK: Blackwell Publishing, 2004), 11.
[5] John A. Agnew, *Place and Politics: The Geographical Mediation of State and Society* (Boston, MA: Allen and Unwin, 1987), 26-28.
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[7] David Harvey, *Social Justice and the City* (London: Arnold, 1973).
[8] Edward Relph, *Place and Placelessness* (London: Pion, 1976), 8-42.
[9] Yi-Fu Tuan, *Space and Place: The Perspective of Experience* (Minneapolis, MN: University of Minnesota Press, 1977), 6.
[10] David Canter, *The Psychology of Place* (London: Architectural Press, 1977), 105-127.
[11] Adriana de Souza e Silva, "From Cyber to Hybrid: Mobile Technologies as Interfaces of Hybrid Spaces," *Space and Culture* 9, no 3 (2006): 261-278.
[12] Peter Lunenfeld, "Screen grabs: The digital dialectic and new media," in *The Digital Dialectic: New Essays on New Media*, ed. Peter Lunenfeld. (Cambridge, MA: MIT Press, 1999), xiv–xxi.
[13] Germaine Halegoua, *The Digital City: Media and the Social Production of Place* (New York: NYU Press, 2020).
[14] Patricia Canelas and Jan Hoehnk, "Practices of Digital Placemaking: Accelerating Place Attachment," *Urban Research and Practice* 18, no 3 (2025): 392.
[15] Joel Fredericks, Hespanhol Luke, Callum Parker, Dawei Zhou and Martin Tomitsch, "Blending Pop-Up Urbanism and Participatory Technologies: Challenges and Opportunities for Inclusive City Making," *City, Culture and Society* 12 (2018): 44-53.
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URBAN EXPANSION DYNAMICS: EXPONENTIAL GROWTH AND IRREGULAR LAND USE IN CHILE'S CENTRAL COASTAL REGION

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INTRODUCTION

In Latin America, informal urban expansion associated with housing shortages and real estate speculation intersects with the risks linked to climate change,[1] intensifying the spatial inequalities and structural inequalities experienced by the Global South.[2] In this context, Chile represents a paradigmatic case for tracing these dynamics, especially in the central coastal zone of the country, where informal settlements or *campamentos* spread towards Urban-Forest Interfaces (UFI) characterized by deep ravines, where there are forest plantations and soils of high ecological value are subject to degradation.

Informal Urban Expansion, Risk, and Vulnerability in Valparaíso

In February 2024, a mega-wildfire occurred in this peri-urban territory of the Metropolitan Area of Valparaiso (MAV), devastating 9,216 hectares and damaging nearly 10,000 buildings across five municipalities. This event highlighted the socioecological vulnerability that represents the informal inhabitation of the UFI, representing a significant risk for this informal environment[3] (Figure 1).

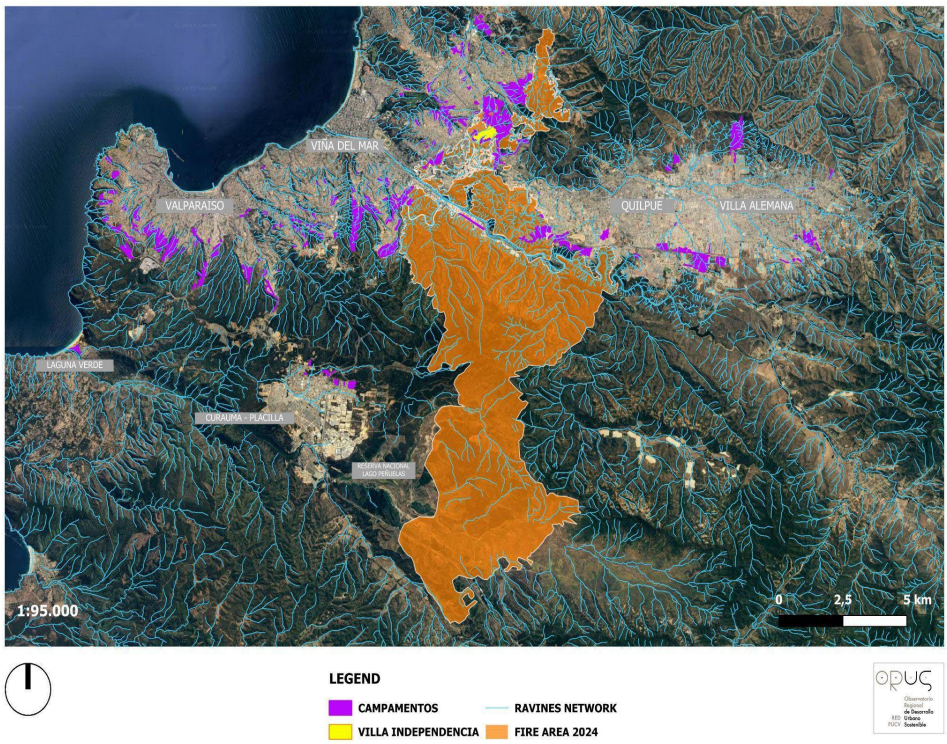


Figure 1. Geographical link between the 2024 wildfire, the urban areas, and the location of campamentos in the MAV.

The Ministry of Housing and Urbanism (MINVU) defines *campamentos* as settlements of eight or more households that occupy land irregularly, with precarious dwellings and lacking at least one of the three basic urban services: electricity, drinking water, or sewerage.[4] Since 2019, with the social revolt and the pandemic, the *campamentos* expanded meaningfully. Between 2019 and 2022, 355 more *campamentos* were added, and between 2022 and 2024, a further 341, reaching 1,432 settlements in total. This 51.4% increase over five years affects 120,584 families.[5]The rise of rents, income precarity, unemployment, and migration drove this growth.[6] The Valparaíso Region concentrates 41.8% of the *campamentos* in the country (374 in 2024). Here, the expansion has entailed the occupation of ravines –territories highly exposed to wildfires, landslides, and floods.[7]

In this context, the research question focuses on how to address the accelerated growth of *campamentos* in the ecologically fragile and socially vulnerable coastal region of Valparaíso, where hybrid risks from climate change and territorial inequality converge. The objective is to examine, visualize, and develop exploratory design projects that envision sustainable transitions for the UFI of Viña del Mar and San Antonio, which have been severely affected by informal urban expansion and the extractive use of soils. In both cases, housing pressures intersect with risks of wildfires and debris flows, compromising soils that currently provide significant yet increasingly degraded ecosystem services. Recent pilot programs for resilient urbanism promoted by MINVU aim to restore ravines as green spaces. Thus, this study contributes to these initiatives by undertaking a situated analysis and developing exploratory design proposals to advance care-centered urbanism in such liminal territories.

On one hand, the study examined the growth of *campamentos* in Viña del Mar and San Antonio, together with the identification of the vulnerabilities, risks, and hazards experienced by communities established in liminal UFI in both municipalities. Vulnerability is understood as a multidimensional phenomenon encompassing not only physical exposure to risks (wildfires, floods, landslides) exacerbated by climate risks but also socioeconomic precarity linked to lack of regular access to basic

services and institutional marginalization.[8] The combination of these factors increases exposure of communities and thus makes it necessary for disaster risk reduction efforts to prioritize vulnerability reduction.[9] As Moreira-Muñoz points out,[10] in the peri-urban territories of Valparaíso, the abandoned forest of eucalyptus and pines represents a permanent risk to wildfire spread in territories inhabited by *campamentos*.

On the other hand, the research incorporates a projective approach aimed at envisioning future scenarios for urban–forest interfaces in Viña del Mar. The second phase focused on developing design proposals in one of the macro-zones of this municipality affected by wildfire. The work was produced by students of architecture of the Pontificia Universidad Católica de Valparaíso (PUCV), as a part of the collaboration with the Secretariat of Planning (SECPLA) of the Municipality of Viña del Mar and the Regional Observatory of Sustainable Urban Development (ORUS) of the PUCV.

The design proposal is inspired by the principles of transition design,[11] which advances an epistemological and practical approach to developing long-term, place-based urban design, addressing structural drivers of systemic vulnerability and fostering socio-ecological resilience. This phase also builds on the urban metabolism approach, a conceptual framework that recognizes relational dynamics among ecological systems, infrastructural flows, and socio-spatial practices.[12] Urban metabolism is defined as the sum of material and energy exchanges between the city, the biosphere, and the surrounding territory.[13] For the design studio, metabolism enables understanding how UFI material energies flow can evolve from an extractive perspective towards a more sustainable place-based urbanism that integrates ecosystem services.[14]

These proposals are aligned with the Law on Climate Change[15] and urban policies developed by CIGIDEN and MINVU,[16] which identify the need for ecological restoration of the UFI, together with preventing habitation in high-risk areas due to recurrent disasters—such as wildfires and debris flows—in these abyssal and liminal spaces.

METHODOLOGY

This research adopts an interdisciplinary approach that combines geography, architecture, and urbanism, integrating spatial analysis, planning regulations, and exploratory design. Thus, the methodology was organized into two interconnected phases: (1) spatial and regulatory analysis using GIS; and (2) design of situated interventions based on the notion of territorial metabolism and the principles of transition design.

Spatial Analysis Using GIS

The first phase unfolded in three stages. First, we examined the geolocated spatial extent of *campamentos* recorded by MINVU,[17] distinguishing between those established before and after 2019. This data was then intersected with the urban boundaries defined in the *Plan Regulador Comunal* (PRC) of Viña del Mar and San Antonio. Second, we georeferenced satellite images from before and after 2019, overlaying them with the footprints of *campamentos* identified in the MINVU cadaster.

Additionally, we incorporated a vector layer indicating the locations of rooftops in new *campamentos*. We gathered information on land tenure to determine whether these informal settlements are in geographically hazardous areas, such as ravines, hillsides, and forest edges. Third, A wildfire risk layer proposal was explicitly developed for UFI, based on the methodology outlined in *Caractérisation et cartographie des interfaces habitat-forêt.*[18] Unlike broader regional approaches, this zoning focuses on a local scale, considering the detailed spatial arrangement of the built environment in relation to its surroundings.[19] Two critical components were identified: (i) the mass of combustible vegetation and (ii) human settlements, represented by rooftops, within the study area, using high-resolution satellite imagery. For mapping purposes, four distinct zones were established:

(i) Forest Influence Radius (study area): a 500-meter distance applied between forest mass and human settlements (rooftops). (ii) No-Build Area: a 25-meter belt measured from the last remnant of continuous, permanent vegetation, where siting dwellings should not be permitted. (iii) Buffer Area: a 75-meter belt adjoining the No-Build Area where all feasible measures should be applied to prevent and mitigate wildfire risk. (iv) UFI: the sum of the No-Build Area (25 m) and the Buffer Area (75 m) produces a 100-meter protection belt that delineates the UFI.

In this proposal, the mass-wasting hazard areas were systematically incorporated. For Viña del Mar, the *Mass-Wasting Hazard Map for the cities of Valparaíso, Viña del Mar, and Concón* report[20] was employed to assess hazard levels related to landslides, mudflows, debris flows, creep, rockfalls, and the potential collapse of unstable materials. In the case of San Antonio, data from the PRC (2015) was utilized, which identifies zones vulnerable to avalanches, rockfalls, debris flows, and intensified erosion. Both datasets were georeferenced to delineate the associated hazard zones accurately.

Design Interventions Oriented to Transition

The second phase of this research employed an exploratory approach for design transitions in the UFI, focusing on three key components: multi-scalar territorial diagnosis, project formulation, and architectural-territorial prototyping for socio-ecological transitions. Thus, the design process initiated a thorough GIS-based diagnosis by ORUS, concentrating on the 2024 mega-wildfire in the MAV. This multilayer mapping integrates three critical layers, including geomorphological features, slope gradients, hydrological networks, wildfire footprints, and mass-wasting areas. The biotic components: Remnants of native vegetation, active and abandoned plantations, post-fire conditions, and ecological continuities. And the anthropic components: Formal and informal settlement patterns, infrastructure, informal land uses, and land tenure contexts.

The analysis combined advanced cartographic techniques, photo interpretation, spatial overlays, and field verification. The second step focused on developing masterplans for the Villa Independencia sector in Viña del Mar, advocating for a watershed-driven design that aligns runoff management with active mobility and emergency routes. The proposal included critical green-blue infrastructure, such as ecological corridors, and the restoration of vegetative surfaces, while also proposing community facilities such as greenhouses for locally based productive centers.

In collaboration with ORUS, the students assessed the proposal based on the UFI plan produced during the first stage of this research, prioritizing proactive strategies to mitigate or relocate dwellings in high-risk areas and to give more autonomy to this community, as urban facilities are scarce or virtually non-existent.

RESULTS

Spatio-temporal and Regulatory Analysis

The spatio-temporal analysis revealed that until 2019, the study area contained no housing, functioning instead as a peripheral landscape of ravines, which was dominated by forest vegetation and grasslands. From 2019 onward, this territory had a rapid informal urban expansion, with 3,200 roofs spreading across 120 hectares and consolidating 13 *campamentos* on this liminal space of the city. This process has contributed to a total of 400 hectares of Viña del Mar now occupied by informal settlements, representing about 5% of the urban territory. The new *campamentos* have been established on steep slopes contiguous to combustible forest vegetation and rainfall-activated ravines, creating conditions of aggravated socioecological vulnerability (Figure 2).

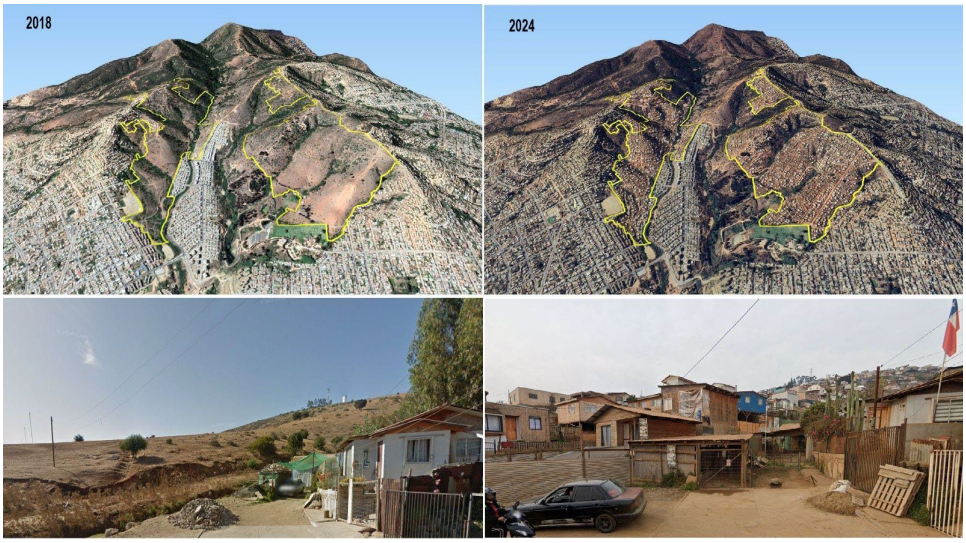


Figure 2. The evolution of the land occupied by new campamentos in Viña del Mar from 2018 to 2024

In San Antonio, spatio-temporal analysis indicates that before 2019, the study area contained no housing. Although this extensive lot of land lies within the city boundaries, it is privately rather than state-owned and, as in Viña del Mar, was characterized by forest vegetation, grasslands, and ravines. From 2019 onward, the territory experienced rapid informal urban expansion, with 6,200 roofs spreading across 232 hectares and consolidating 12 *campamentos*. Today, this informal expansion occupies 309 hectares, representing 7.3% of the urban territory. As in Viña del Mar, these settlements are located next to combustible forest vegetation and rainfall-activated ravines, creating conditions of heightened socioecological vulnerability. (Figure 3).

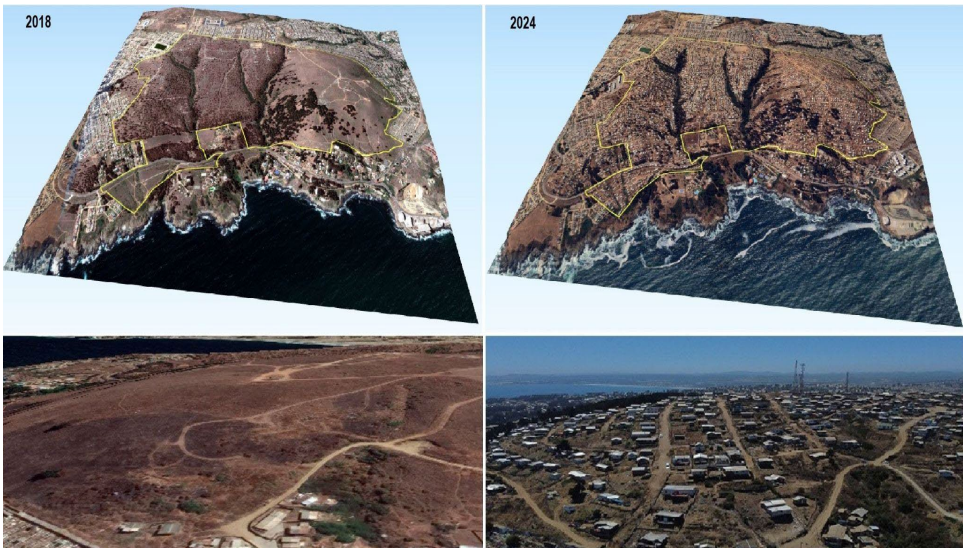


Figure 3. The evolution of the land occupied by new campamentos in San Antonio from 2018 to 2024

Fire Risk According UFI Zoning

In Viña del Mar, the methodology applied to assess fire risk through UFI zoning revealed critical gaps, as this risk is not currently addressed in the communal regulatory plan. (Figure 4). The major wildfire of 2024 (represented by the gray polygon) underscored the urgency of identifying the areas most likely to be affected again. Results indicate that within the 13 new informal settlements, 590

roofs (marked in yellow) are located in non-buildable zones (red) and should not remain in their current sites. In addition, at least 1,370 roofs (blue) fall within the buffer zone (light blue), where mitigation measures need to be concentrated. The surrounding active forest mass (green) further amplifies the level of risk.

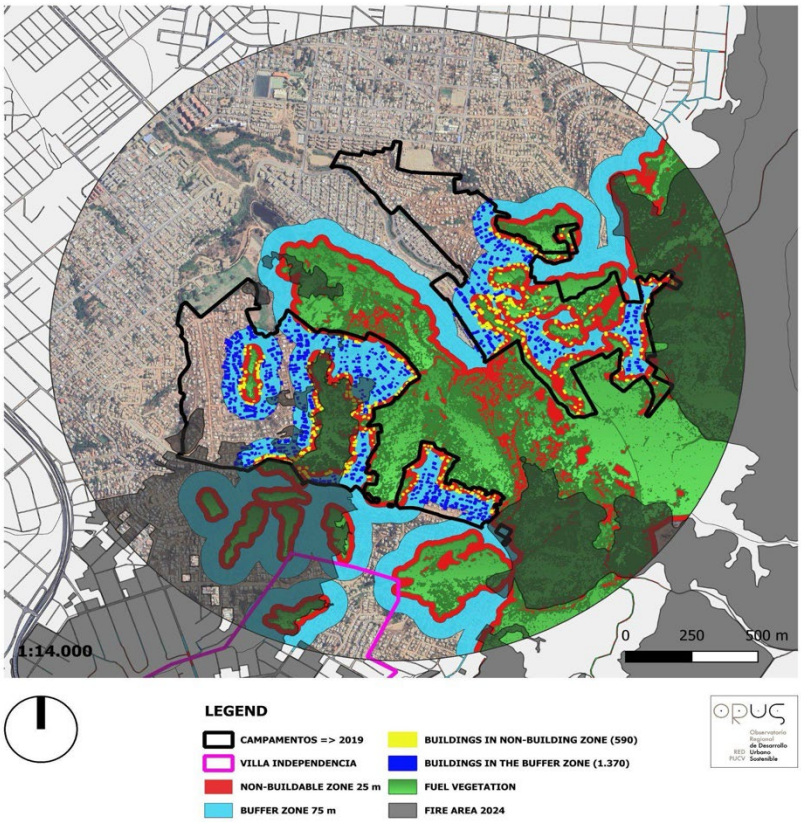


Figure 4. UFI zoning obtained for the new campamentos in Viña del Mar

In San Antonio, the methodology applied revealed that fire risk—also absent from the regulatory plan—poses critical challenges (Figure 5). The results show that within the 12 new *campamentos*, 860 roofs (yellow) are in non-buildable zones (red) and should not remain in their current sites. In addition, at least 1,800 roofs (blue) lie within the buffer zone (light blue), where mitigation measures should be prioritized. The presence of active forest cover (green) surrounding these areas further intensifies the risk.

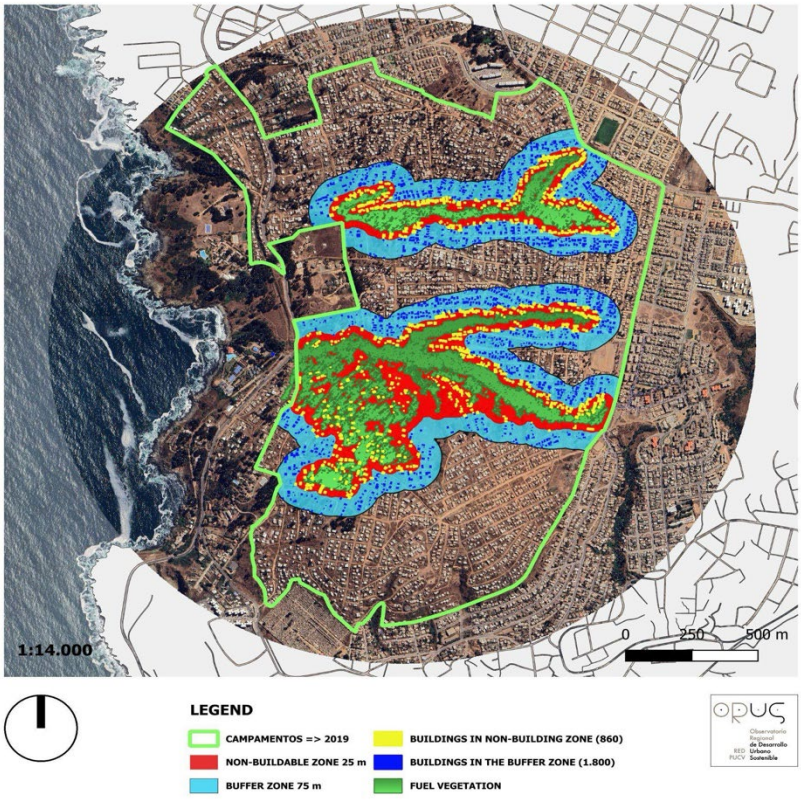


Figure 5. UFI zoning affecting the new campamentos in San Antonio

Landslide Risk Zone

In Viña del Mar, landslide risk has been officially mapped since 2005, yet this information has never been integrated into the communal regulatory plan (Figure 6). When the landslide risk layer is compared with the 13 new *campamentos*, a critical scenario emerges: 380 roofs (yellow) are already located in areas classified as high risk (red), while another 2,400 (blue) lie within zones of moderate risk (orange). These findings underscore the extent to which housing has expanded into unstable terrain, where the absence of regulatory consideration leaves communities highly exposed to future landslides.

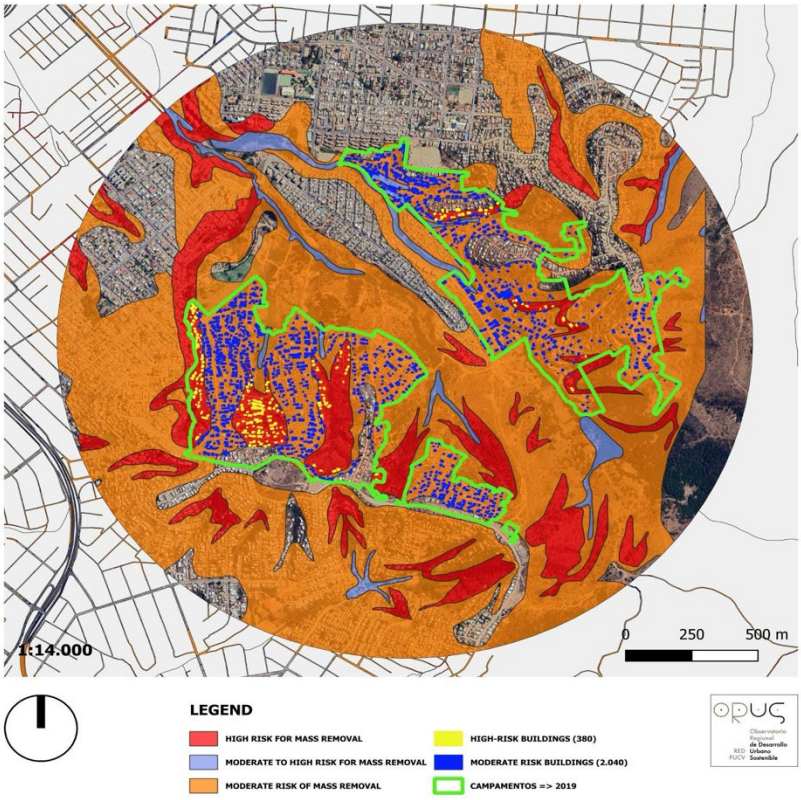


Figure 6. Landslide risk zone affecting new campamentos in Viña del Mar

In San Antonio, the updated regulatory plan does account for landslide risk, yet the reality on the ground reveals persistent vulnerabilities (Figure 7). When the landslide layer (brown) is overlaid with the 12 *campamentos*, the analysis shows that 1,600 roofs (yellow) are located within risk zones. Despite this evident vulnerability, this scenario highlights the gap between regulatory frameworks and everyday practices.

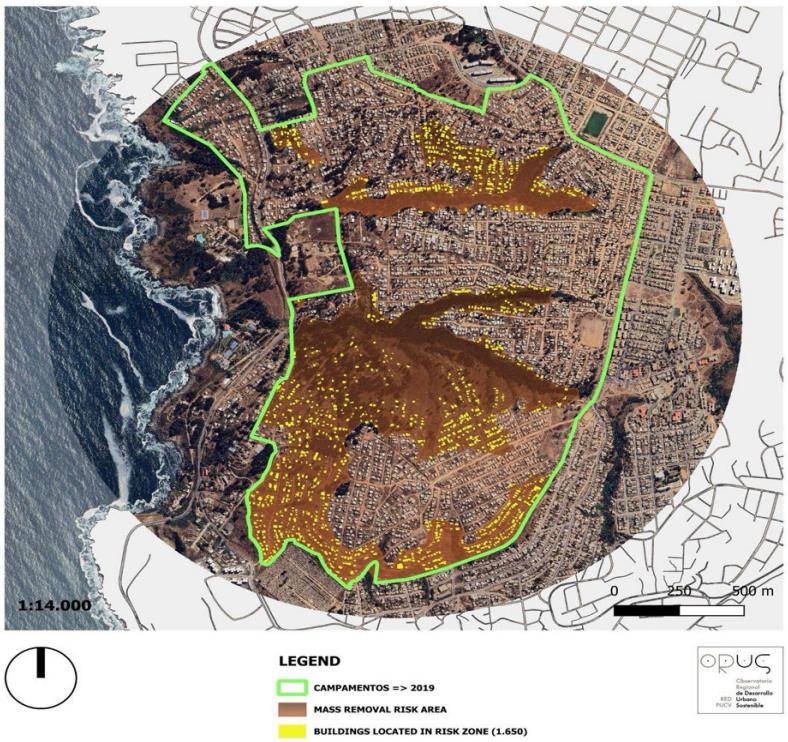


Figure 7. Landslide risk zone affecting new campamentos in San Antonio

Transition Design in UFI

The territorial analysis and proposal of the UFI in Viña Del Mar revealed that ravines feature the study area, creating a high risk of wildfires where dense forests are limited by informal housing. CONAF data showed that highly flammable monoculture plantations overlap with scrubland and native trees of varying flammability: low (boldo, colliguay), high (litre, quillay, espino, romerillo), and very high (peumo). Their proximity to dwellings indicates the need for detailed vegetation management to reduce fire risks – see video in link.[21]

In general terms, two UFI scenarios were defined. First, 50-meter buffer zones were established around forest perimeters with high and very high flammability. Second, the morphology of ravines was considered, given their Venturi effect that accelerates the spread of fire. The risk increased with altitude, so buffer zones of 50, 100, and 150 meters were applied at average elevations: low (214-274 m), high (274-334 m), and very high (334-394 m). The overlapping buffer zones identified the most vulnerable areas, concentrated on the highest slopes.

Based on this assessment, the masterplan recognized ravines as critical hydrological design elements. Accordingly, green and blue infrastructure connected to urban tributaries and water collectors was introduced (Figure 8). The proposals included artificial wetlands and ponds designed for small-scale community use. By analyzing solar exposure across ravine slopes, the plan integrated differentiated endemic vegetation adapted to each orientation, together with architectural interventions for energy capture, such as solar panels incorporated into shading structures within community facilities, and devices for capturing coastal fog to recover water (Figure 9). In addition, active mobility and emergency routes were established, including the designation of safe zones within the ravine, supplemented by educational, recreational, and productive facilities such as vegetable gardens and urban nurseries on degraded slopes. This program builds on activities already undertaken spontaneously and informally by the community.

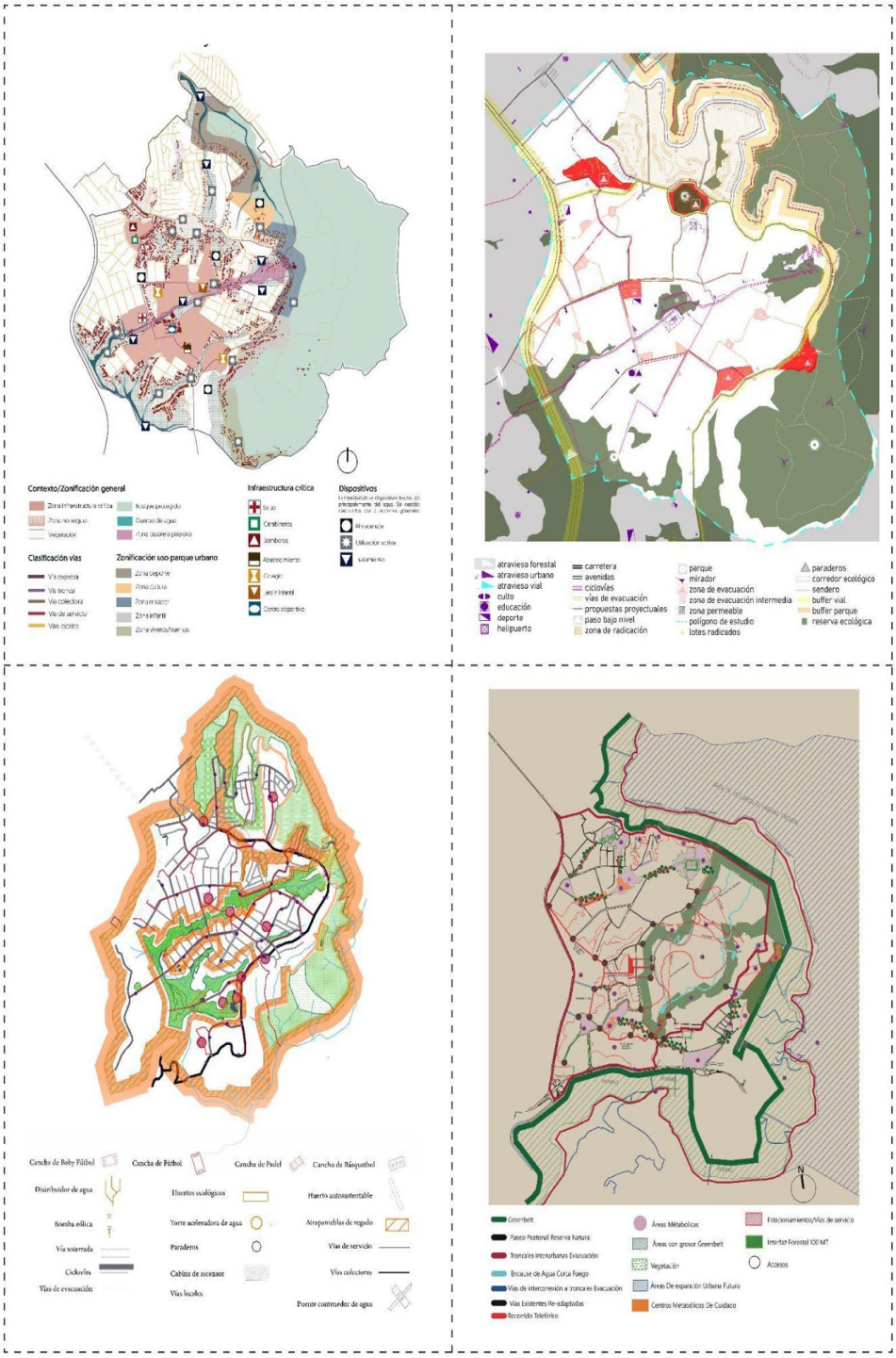


Figure 8. Masterplan proposals for the Villa Independencia sector of Viña Del Mar



Figure 9. Models of infrastructure and devices (fog catchers) in ravines

DISCUSSION

The informal urban expansion of *campamentos* in Chile's central coastal region highlights the complex issue of social inequality, environmental fragility, and governance gaps that affect Latin America.[22] As Cutter et al.[23] and Otto et al.[24] argue, vulnerability must be understood as multidimensional, combining exposure to wildfires, floods, and landslides with socioeconomic precarity, lack of services, and institutional marginalization.

The mega-wildfire in Valparaíso exposed these dynamics. As Moreira-Muñoz[25] notes, abandoned pine and eucalyptus monocultures act as structural vectors for fire spread, intersecting with informal occupation and exposing contradictions in peri-urban planning. Here, ecological degradation and social precariousness converge, pushing vulnerable populations into collapsing ecosystems.

In this line, it is arguable that current planning instruments fail to integrate UFI and landslide hazards, creating mismatches between hazard cartographies and zoning scales. As Lampin-Maillet et al.[26] suggest for Europe, local methodologies for interface characterization are needed to translate risk gradients into enforceable planning criteria. Without such updates, informal dwellings continue to proliferate in no-build and buffer zones, perpetuating cycles of risk.

At the same time, this research emphasizes that a prospective methodological approach is essential. Transition design[27] provides a framework to envision long-term strategies that address structural drivers of vulnerability. Connected with territorial and urban metabolism,[28] transition design allows us to rethink UFI as socio-ecological systems where material flows, infrastructures, and community practices must be integrated.

The urban expansion of *campamentos* in the central coastal region of Chile demonstrates the wicked problem of social inequality, environmental fragility, and governance gaps that characterize many Latin American cities. As Cutter et al. and Otto et al. argue, vulnerability must be understood as a multidimensional issue linked, for instance, to exposure to wildfires, floods, and landslides compounded by socioeconomic precarity, lack of access to services, and institutional marginalization. Inspired by critical care architecture and urbanism,[29] the proposals for watershed-based planning, ecological corridors, and community facilities align with institutional initiatives to recover ravines and

the UFI.[30] These explorations show how post-disaster recovery can be linked to long-term strategies of resilience, moving beyond emergency responses toward sustained territorial care.

CONCLUSIONS

This research highlights the challenges of reimagining UFI as territories for sustainable transition, where risk reduction, ecological restoration, and social equity must converge. In the abyssal coastal landscapes of peri-urban territories of central Chile, urban and territorial planning instruments remain insufficient, as they fail to incorporate wildfire and landslide risks in ravines—risks that have become critical for informal urban expansion into these liminal spaces. Continuous integration of updated GIS data and situated information could strengthen monitoring and enable place-based design interventions to break this cycle of vulnerability. In these territories, ecological restoration should prioritize replacing monocultures with resilient native ecosystems and incorporating green–blue infrastructures within watershed corridors, thereby reducing fuel loads and reinforcing ecosystem services.

The findings also underline that communities inhabiting these vulnerable territories should not be considered as merely passive victims but as active agents for alternative models of socio-ecological urban transition. Finally, rather than limiting responses to emergency shelter or post-disaster reconstruction, the evidence points to the need for systemic transformations that entrench care, restoration, and resilience into the very peri-urban tissue.

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EXPLORING THE IMPACT OF POPULATION DENSITY ON WALKING BEHAVIOR

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INTRODUCTION

Walking is widely recognized as an accessible form of physical activity that provides multiple health benefits, such as preventing lifestyle-related diseases and promoting mental well-being.[1] Governments worldwide are increasingly focusing on improving walkability as a priority for urban planning and public health. Efforts typically involve developing built environments that encourage walking both for transportation and recreation, thereby generating benefits for individuals and communities.[2] Previous studies have demonstrated that the physical characteristics of residential areas influence physical activity. Walking behavior, in particular, depends on environmental factors, such as land-use diversity, availability of public transportation, quality of pedestrian infrastructure, and safety. Among these, population density plays a central role, as it is closely related to these factors. Higher density typically increases the proximity of residential and commercial facilities, promotes the development of public transportation, and creates a safer and more walkable environment.[3] Therefore, population density is considered an important determinant of walking behavior.

Low-density regions generally rely more on private vehicles, reducing walking and lowering step counts. Increasing population density improves public transportation convenience, encouraging walking, for instance, when accessing bus stops and train stations, which results in higher step counts.[4]

However, extremely high population density may shorten travel distances, potentially reducing daily steps. Based on these considerations, this study hypothesizes that the relationship between population density and walking is nonlinear, with an optimal density level that maximizes walking.

Several studies have examined this relationship. Paydar et al. reported a positive correlation between walking frequency and population density in Temuco, Chile.[5] Kutsuzawa et al. showed that walking time increased with higher population density, even after adjusting for urban compactness.[6] Using individual-level data, Rodríguez et al. demonstrated that residential density in several U.S. states was positively associated with both utilitarian and recreational walking.[7] Despite differences in locations and methodology, numerous studies consistently demonstrate a positive association between population density and walking.[8]

However, these studies generally assume a linear relationship between walking and population density, without fully capturing the potential negative impacts of excessively high density. Wu et al. provided an exception, identifying a nonlinear relationship in Zhongshan, China, where walking time among adults aged 60 and above peaked at approximately 300 persons/ha.[9] Other studies have also

assumed nonlinear relationships and identified optimal population density levels.[10] Nevertheless, these studies were limited to specific cities or elderly populations, and nationwide analyses remain scarce. Furthermore, although many studies control for individual attributes such as gender, age, and employment status, limited attention has been devoted to health conditions and lifestyle factors, which also influence walking behavior.[11]

In Japan, Tanishita and Wee analyzed step counts using individual-level data from the 2016 National Health and Nutrition Survey (NHNS), which covered 164 regions nationwide.[12] Their analysis incorporated individual attributes such as age, gender, Body Mass Index (BMI) and sleep duration. The peak step counts at a population density of approximately 110 persons/ha. However, this result was based on cross-sectional data at a single point in time. Moreover, while the optimal model according to the Bayesian Information Criterion (BIC) was monotonic, the result did not conclusively demonstrate the existence of a true peak. In addition, the study estimated population density from average values within five broad prefectural categories. As these spatial units are large, they may not accurately reflect the actual residential environments, raising potential concerns about measurement precision.

Considering these limitations, this study aims to clarify the relationship between population density and step count using a nonlinear model while accounting for individual attributes. Specifically, we employ individual-level data from the 2017–2019 NHNS, pooling data across these to increase the sample size. We also define the population density using two approaches:

1) the mean habitable land population density of municipalities within the relevant classification; and
2) the habitable land population density of the municipality assigned by the simulation.

METHODOLOGY

We modeled the relationship between step count (y) and population density (x) using a cubic polynomial function (see Appendix A for the functional form). This approach assumes that the effect of population density can be described by a polynomial relationship up to the third degree, as shown in Equation (1).

$$y_i = \beta_3 x_i^3 + \beta_2 x_i^2 + \beta_1 x_i + \sum_j \alpha_j z_{ji} + \epsilon_i \quad (1)$$

The analysis also included personal attributes such as BMI, age, occupation, sleep duration, frequency of alcohol consumption, and smoking status as explanatory variables. In addition, regional environmental factors, such as distance to the nearest station or park and monthly average precipitation, were also incorporated. The model comprised polynomial terms for population density, linear terms for variables such as gender and drinking frequency, and nonlinear terms for age and BMI to analyze the predicted number of steps.

A quadratic or cubic polynomial model that minimizes the BIC and yields a negative second- or third-order coefficient indicates the existence of an optimal population density at which the number of steps is maximized. Conversely, non-negative higher-order coefficients imply the absence of such a peak.

The NHNS used in this study classifies residential areas by prefecture into the following five categories:

(1) designated cities and the 23 wards of Tokyo, (2) cities with a population of 150,000 or more,
(3) cities with a population of 50,000–150,000, (4) cities with a population of less than 50,000, and
(5) towns and villages.

Although information is available regarding each participant's prefecture and residential population size category, the exact municipality of residence is not identified. Substantial variation in population density exists even within the same classification—for example, Tokyo's 23 wards exhibit considerable heterogeneity in population density (see Figure 1).

Analyzing the relationship between step counts and population density using only the mean population density for each classification risks overlooking this heterogeneity. To address this, a Monte Carlo simulation was conducted. For each participant, a municipality within the applicable classification was randomly selected, and the habitable land population density of that municipality was assigned to the participant. Repeating this process 5,000 times enabled the modeling of potential variation and facilitated examination of the range of population densities at which step counts are maximized, as compared to estimates based on mean values alone.
Therefore, population density for the 164 regions included in this study was calculated using two approaches:
1) the mean habitable land population density of municipalities within the relevant classification; and
2) the habitable land population density of the municipality assigned by the simulation.

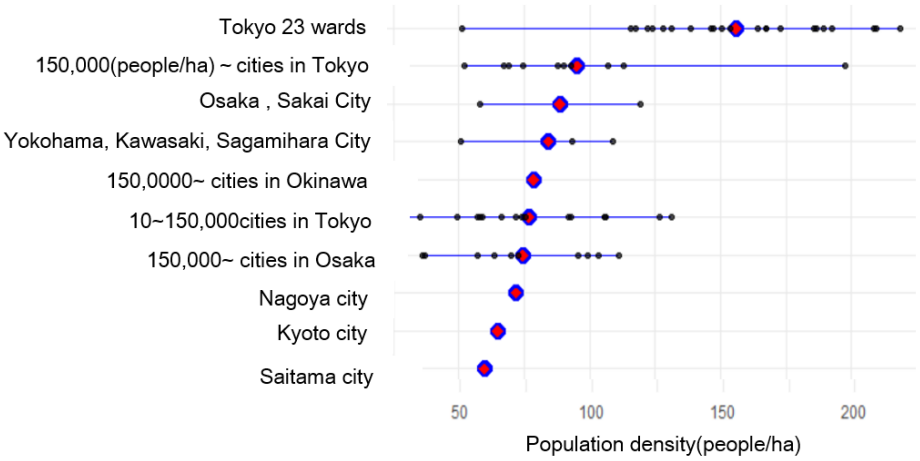


Figure 1. Distribution of population density in municipalities with the 20 highest average population densities in habitable areas (2017)

Data

Number of steps

Step count data were obtained from the physical condition component of the NHNS conducted between 2017 and 2019. The NHNS, an annual survey, assesses physical health, nutrient intake, and lifestyle habits, serving as a primary resource for public health policy. Each year, approximately 6,000 households and 18,000 household members (aged one year or older as of November 1 of the survey year) are selected using stratified random sampling from 300 designated survey units.
This study utilized responses from the physical condition questionnaire, which collects information on basic health status, exercise habits, and daily step counts during November. Valid step count records from 7,150 men and 8,207 women were included in the analysis.

Population density

Population density data were obtained from the Centre for Statistics and Data Analysis, which provides information on habitable land area and population density (persons/ha) based on municipal population data from the Basic Resident Register (2017–2019). Figure 1 displays the top 20 regions with the highest average habitable land population density in 2017. As expected, Tokyo's 23 wards exhibited the highest densities, although substantial variation was observed within the wards, with values ranging from a minimum of 51.3 to a maximum of 219 persons per hectare. The Tokyo

metropolitan area cities with populations over 150,000 residents formed the second-highest category and also showed considerable variability.

Other regional variables

Several additional regional variables were included. Distances to the nearest park and railway station were determined based on data from the 2020 Housing and Land Statistics Survey. Rail usage rates and day–night population ratios were calculated from the 2020 National Census. Given that local weather conditions likely affect activity levels, the average temperature and precipitation for each municipality during November 2017–2019 were obtained from the Japan Meteorological Agency.

Sociodemographic variables

Sociodemographic information was extracted from the NHNS. In addition to basic characteristics such as gender and age, the survey also collects data on health-related factors influencing walking behavior, including sleep duration, smoking status, and drinking frequency.

Previous studies have demonstrated walking's nonlinear association with age and BMI, and significant correlation with gender and occupation. Therefore, this study included BMI (calculated from participants' height and weight), age, gender, occupation, sleep duration, smoking status, and drinking frequency as individual-level covariates in the model.Table 1presents the correlations between regional variables. Distance to the nearest park and station, as well as railway usage rates, exhibited high correlations with population density, and therefore, were excluded from the model. Monthly average temperature, monthly average precipitation, and day–night population ratio were also excluded because they did not show significant associations with step counts. Table 2 summarizes the variables employed in the analysis.

	Population density	Railway usage rate	Distance to the nearest station	Distance to the niearest park
Population density	1	0.91	-0.81	-0.69
Railway usage rate	0.91	1	-0.82	-0.66
Distance to the nearest station	-0.81	-0.82	1	0.72
Distance from nearest Park	-0.69	-0.66	0.72	1

Table 1. Correlation between regional variables

Variables		Min	Mean	Max	SD
Number of steps		1,000	6,052	13,998	3,034
Independent variable		Min	Mean	Max	Std
Population density		0.86	32.01	159.8	31.76
BMI		14.1	23.04	34.94	3.39
Age		20	57.75	98	16.57
Socio-demograghic variables		Sample size		Proportion (%)	
Gender	Men	5,109		44.6	
	Women	6,346		55.4	
Occupation	Specialized technical	1,463		12.8	
	Management	509		4.4	
	Clerical	1,257		11.0	
	Service	1,022		8.9	
	Household	2,731		23.9	
	Not employed	1,933		16.9	
	Others	2,526		22.1	
Sleep duration	-6h	4,057		35.6	
	6-7h	2,211		19.4	
	7-8h	584		5.1	
	8-9h	141		1.2	
	9h-	4,416		38.7	
Smoking status	Daily	1,669		14.6	
	Occationally	129		1.1	
	Stopped	879		7.7	
	Non-Smoker	8,728		76.5	
Drinking frequency	Daily	1,990		19.3	
	5-6days/week	748		7.3	
	4-5days/week	679		6.6	
	3-4days/week	907		8.8	
	Non-Drinker	5,986		58.1	

Table 2. Descriptive Statistics

RESULTS

Mean population density

Table 3 presents the results of the cubic polynomial model describing the relationship between the number of steps and the explanatory variables (see Appendix A for the functional form). In this model, the coefficient of the cubic term of population density was significantly negative. The relationship between population density and daily step counts increased monotonically up to approximately 100 persons/ha; beyond this point, the slope flattened and step counts began to decline, with a threshold identified at 148 persons/ha (Figure 2).

Monte Carlo simulation-based population density

Among the 5,000 models generated by the Monte Carlo simulation, 63.8% exhibited a statistically significant negative cubic coefficient for population density. Thus, 63.8% of the models identified a peak in the relationship between population density and walking, whereas 36.2% indicated a monotonic increase. Figure 3 displays a violin plot of the estimated population densities at which step counts reached their maximum for the 63.8% of the models showing a peak. The estimated peak values ranged from 60 to 220 people/ha, with most models indicating a maximum around 120 people/ha.

Dependent variable: Number of steps (logarithmic)		Cubic function model	
Variables		Estimate	t-value
Population density		8.78E-03	6.88
(Population density)^3		-2.86E-08	-1.92
Gender (Men)	Women	-0.07	-4.84
Occupation (Hosuehold)	Specialised technical	0.12	6.29
	Management	0.05	1.73
	Clerical	0.05	2.42
	Service	0.01	6.95
Sleeping duration (6-7h)	7-8h	-0.01	-0.88
	8-9h	-0.07	-2.90
	9h-	-0.02	-4.67
Smoking status (Non-smoker)	Daily	-0.08	-5.08
	Occasionally	-0.22	-2.34
Drinking frequency (Non-drinker)	Daily	0.05	3.11
	5-6 days/week	0.12	5.27
	3-4 days/week	0.07	2.90
Intercept		8.48	416
Nonlinear term		edf	F
Age		2.96	142
BMI		2.6	34
Sample size		11386	
BIC(0)		20115	
BIC		18870	
Coefficient of determination		0.11	
Peak population density		148	

Table 3. Analysis results for the cubic polynomial model

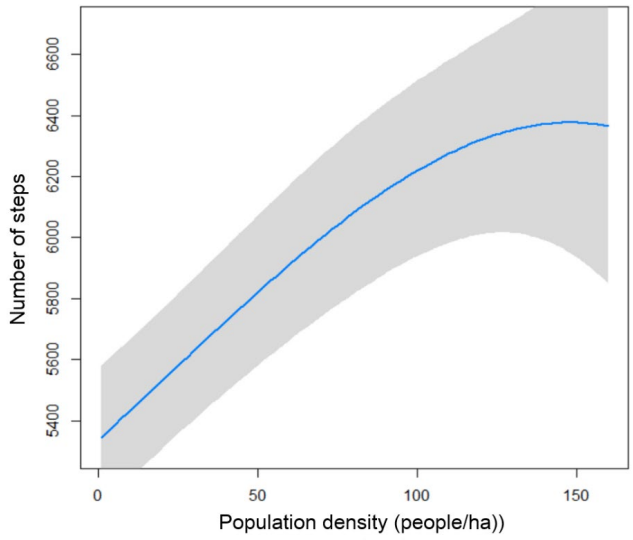


Figure 2. Relationship between population density and number of steps
Grey areas represent the 95% confidence interval of the estimated curve.

These results suggest that the peak population density of 148 persons/ha obtained from the mean-value model may not accurately reflect the true peak at the municipal level. They also indicate that walking behavior is most promoted at population densities lower than those recorded in Tokyo's 23

wards. The higher estimated peak in the mean-value model may be attributable to the inclusion of municipalities with extremely high population densities within the same classification.
Appendix B provides details on the effects of personal attributes.

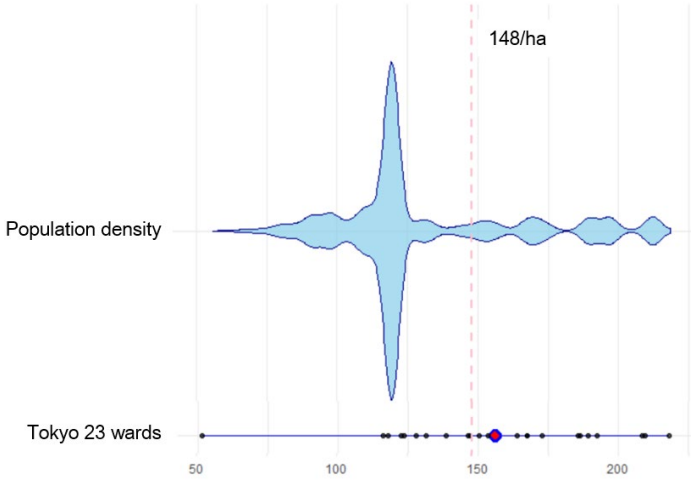


Figure 3. Distribution of population density at which the number of steps was highest

DISCUSSION AND CONCLUSIONS

In this study, we analyzed the relationship between step count and population density using individual-level data from 11,386 participants collected over 3 years. Population density in habitable areas across 164 regions in Japan was calculated using two approaches: (1) the mean municipal population density within each region, and (2) individual assignments to municipalities through Monte Carlo simulation for more precise estimates.
Analysis based on average values identified a peak population density of 148 persons/ha. By contrast, the simulation results indicated that approximately 64% of the models exhibited a peak, with the most common peak occurring near 120 persons/ha. These findings suggest a nonlinear relationship between population density and step count, supporting the existence of an optimal population density. This result aligns with those in previous studies, including Wu et al. (focused on Zhongshan, China[13]) and Lu et al. (focused on Hong Kong[14]). The variation in estimated optimal densities across studies may be attributed to several factors. First, unlike previous studies, this study used habitable population density rather than broad administrative averages. Second, by encompassing all of Japan, including low-density rural areas, our findings reflect a broader range of settlement patterns than prior investigations that often exclude such regions. Third, differences in population density distributions across countries could further explain the observed variation. In this study, the nationwide identification of an activity peak suggests that, in extremely high-density areas such as Tokyo's 23 wards, the proximity of commercial facilities and public transportation hubs may reduce the need for long-distance walking. Moreover, factors such as noise and overcrowding could diminish the appeal of walking, collectively resulting in lower daily step counts. Therefore, this study suggests that while increasing population density generally promotes walking, its positive effect plateaus and eventually reverses at extremely high-density levels.
Nevertheless, these findings must be interpreted in the context of several limitations. First, this study did not employ panel data or a difference-in-differences approach, which would strengthen causal inference. Future research should incorporate these methods to more robustly address causality. Additionally, although the "5Ds" framework— density, diversity of land use, pedestrian-friendly

design, accessibility to destinations, and distance to public transportation—is recognized as integral to promoting walkability,[15] it was not fully included in this study due to the broad spatial scale covering multiple municipalities and limitations in capturing detailed local characteristics. Employing finer spatial units than those used here and explicitly incorporating environmental variables related to the "5Ds" framework could improve future modeling accuracy. Furthermore, this study did not consider bicycle use. In areas with moderate population density, bicycles may serve as a major mode of transport alongside walking.[16] Future research that integrates walking and bicycle usage data could provide a more nuanced understanding of the nonlinear relationship between population density and active transport modes.

Despite these limitations, this study is notable for its comprehensive analysis of population density effects on walking across diverse settings, ranging from rural to urban areas. In particular, clarifying the nonlinear relationship between population density and walking behavior offers valuable insights that can inform urban planning and policymaking efforts aimed at promoting public health.

APPENDIX A. Functional form

In addition to the cubic polynomial model discussed in the main text, we estimated a generalized additive model (GAM) as a supplementary analysis. The model combines the effects of population density (x) and other covariates (z) additively (Equation 2), allowing for a nonlinear relationship between population density and the number of steps without assuming a specific functional form. It assumes that the effects of population density and other covariates can be represented by smooth functions and combined additively, thereby enabling a more flexible assessment of potential nonlinearities.

$$y_i = \sum_j f(x_{ji}) + \sum_k \alpha_k z_{ki} + \epsilon_i \quad (2)$$

In this supplementary analysis, three specifications of the GAM were considered: 1) a pooled model using all survey years, 2) a model including an interaction effect between occupation and survey year, and 3) a random effects model allowing the slope and intercept of the population density–step count relationship to vary by region. The results are summarized in Table A1.

APPENDIX B. Results regarding personal variables

Focusing on individual-level attributes, all variables—gender, occupation, sleep duration, smoking status, and drinking frequency—were statistically significant. In addition, both age and BMI exhibited significant nonlinear relationships with step count (Figure A1). However, based on model selection criteria such as the BIC, coefficient of determination, and residual analysis, the cubic polynomial model outperformed all GAM specifications. Therefore, the cubic polynomial model was ultimately adopted as the preferred model.

The observed relationships between individual attributes and the step count are discussed below.

Gender and occupation: Men and employed individuals had higher step counts. This may be attributed to differences in daily activity levels and attitudes toward physical activity.

		Cubic function model		Pooling model		Occupation and year cross-sectional model		Random effect model	
Variables		Estimate	t-value	Estimate	t-value	Estimate	t-value	Estimate	t-value
Population density		8.78E-03	6.88						
(Population density)^3		-2.86E-08	-1.92						
Gender (Men)	Women	-0.07	-4.84	-0.07	-4.86	-0.07	-4.85	-0.07	-4.84
Occupation (Hosuehold)	Specialised technical	0.12	6.29	0.12	6.28			0.12	6.27
	Management	0.05	1.73	0.05	1.72			0.05	1.77
	Clerical	0.05	2.42	0.05	2.40			0.05	2.42
	Service	0.01	6.95	0.15	6.93			0.14	6.86
Sleeping hours (6-7h)	7-8h	-0.01	-0.88	-0.01	-0.89	-0.01	-0.86	-0.01	-0.95
	8-9h	-0.07	-2.90	-0.07	-2.92	-0.07	-2.93	-0.07	-2.95
	9h-	-0.02	-4.67	-0.22	-4.69	-0.22	-4.71	-0.22	-4.72
Smoking status (Non-smoker)	Daily	-0.08	-5.08	-0.08	-5.09	-0.08	-5.09	-0.08	-5.11
	Occasionally	-0.22	-2.34	-0.11	-2.35	-0.11	-2.36	-0.11	-2.31
Drinking frequency (Non-drinker)	Daily	0.05	3.11	0.05	3.11	0.05	3.13	0.05	3.20
	5-6 days/week	0.12	5.27	0.12	5.28	0.11	5.22	0.12	5.28
	3-4 days/week	0.07	2.90	0.07	2.90	0.07	2.92	0.06	2.91
Interaction term	Specialised technical × 2017					0.44	18		
(Occupation ×Year)	・・・								
	Service × 2019					0.45	15		
Intercept		8.48	416	8.53	447	8.21	605	8.53	
Nonlinear term		edf	F	edf	F	edf	F	edf	F
Population density				2.18	30.4	2.22	29.1	1	32
Age		2.96	142	2.96	142	2.96	140	2.96	144
BMI		2.6	34	2.6	34	2.89	34.1	2.6	39
Sample size		11386							
BIC(0)		20115							
BIC		18870		18872		18989		18878	
Coefficient of determination		0.11		0.11		0.11		0.11	
Peak population density		148							

Table A1. Analysis results for each model

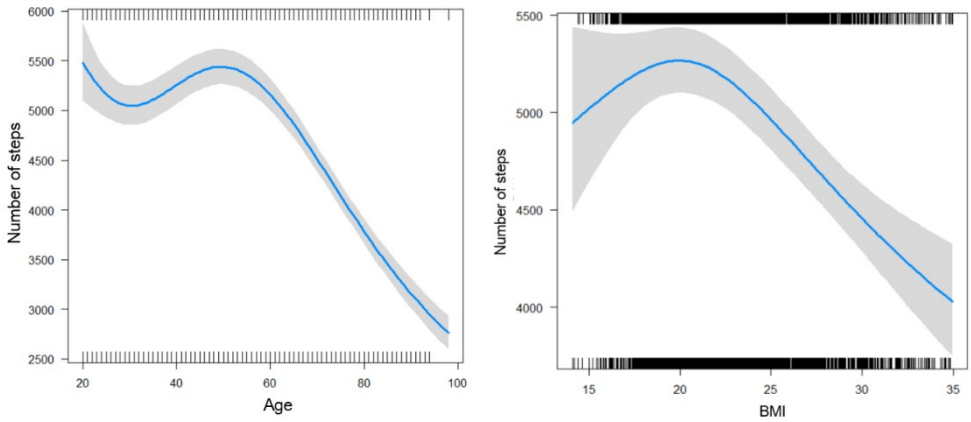


Figure A1. Association of step count with age (left) and BMI (right)

BMI: Step counts peaked at a BMI of 20, suggesting that individuals with normal body weight may have higher health awareness and physical activity levels. Conversely, overweight or underweight individuals may have lower physical activity levels.

Sleep duration: Participants with longer sleep duration tended to have lower step counts, possibly due to reduced time available for outdoor activities and daily movement. Differences in lifestyle patterns may also contribute to this result.

Alcohol consumption frequency: Higher step counts were observed among individuals who reported frequent alcohol consumption. This may reflect increased opportunities for social activities involving drinking, which could lead to more frequent movements or outings.

FUNDING

This study was supported by JSPS KAKENHI Grant Number JP24K07705.

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RETHINKING URBANITY THROUGH HYBRIDIZATION: DISSOLVING BOUNDARIES BETWEEN INSTITUTIONAL ARCHITECTURE AND PUBLIC PLAZAS IN BARCELONA

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INTRODUCTION

While the typical plaza is defined by adjacent monuments and landmark buildings, Barcelona's plazas serve as stages for the patterns of daily life. A myriad of spontaneous encounters between skaters, street performers, artists, and elders that define this unique urban typology. These plazas support a mix of social, commercial, and reflective activities, they often remain physically and programmatically disconnected from adjacent cultural, civic and academic institutions. While inverting conventional figure-field relationships, the spatial void of the plaza, rather than the figural object of any, one building, is formally and experientially primary.

Distributed throughout the city, Barcelona's public spaces create a matrix of accessible and walkable nodes that enable collective life and foster social interaction. However, despite their importance in the social, urban life of the city, plazas remain peripheral in terms of formal, cultural and educational institutions such as museums, galleries, and schools. The segregation between social life and institutional infrastructure, and between public experience and formal learning, shrouds opportunities for alternative hybrid urbanisms that blur proprietary binaries: inside/outside, formal/informal, and controlled/spontaneous.

Operating in the margins, beyond the proper realm of the museum or gallery, street art, also known as graffiti, provides a boundary blurring precedent for an alternative urbanism. Rather than functioning purely as an aesthetic intervention, graffiti exemplifies a form of public authorship - a deep resonance in Barcelona's underground culture. In response, under the city's "Cuidem Barcelona" plan, 300,345 m² of graffiti are cleaned annually- about half of which reappears within weeks.[1] Street art speaks to a desire for public, urban life that parallels the myriads of social activities accommodated in the plaza. The act of making art in public, even when deemed illicit, is not merely aesthetic; it represents a population's resistance to imposed norms, explicit boundaries and institutional segregation from the lived city.

This research challenges conventional programmatic segregation in contemporary public space by disrupting normative boundary conditions. Inspired by the heterogeneous, multifunctional capacity exemplified by the overlapping of discrete activities in plazas, as well as the subversive tactics embodied by the street artist, the work subverts binary relationships in search of new institutional and urban typologies. Blurred boundaries between high and low art, formal and informal education and institutional versus urban exhibition are examined for their capacity to foster more inclusive,

interactive spaces that merge education, art, and civic life. In doing so, it reframes architecture as a field of interaction rather than a container of knowledge, seeking to consider what learning looks like, where it happens, and who participates.

HYBRID SPACE AND INFORMAL URBAN PRACTICES

In most contemporary cities, the boundary between formally programmed institutions and informal street activity is fixed and visibly enforced. In contrast, hybrid urban spaces are not defined by a single use but evolve through multiple and simultaneous functions, accommodating both planned programming and spontaneous activity. In Barcelona spatial hybridization relies on layered, overlapping programs defined by blurred boundaries. Street artists and skateboarders perform alongside informal gatherings on park, benches, and the more structured cafe seating variations across the day and season, reshaping how the space is occupied and experienced.

The distinction between curated exhibitions and spontaneous public expression becomes particularly visible at the margin between formal institutions and everyday street life as culture is not limited to the museum interior but also occupies the exterior building walls in adjacent plazas. Graffiti activates overlooked areas of the built environment, claiming space that eludes singular programmatic designation. Hybrid zones are defined by their capacity to accommodate reinterpretation, allowing informal practices to intervene in and reshape the intended use of space *(Figure 1).* Unsanctioned inscriptions operate as participatory spatial interventions that challenge institutional control. In a paper titled "Creativity and Territory," Ricardo Klein argues that for many graffiti writers and street artists, the city functions as a street-wide canvas - one that becomes a way through which spatial claims are made, and cultural identities are constructed through acts of inscription and occupation.[2] In this sense, graffiti becomes both a territorial act and a form of civic participation, inscribing new narratives onto institutional surfaces.

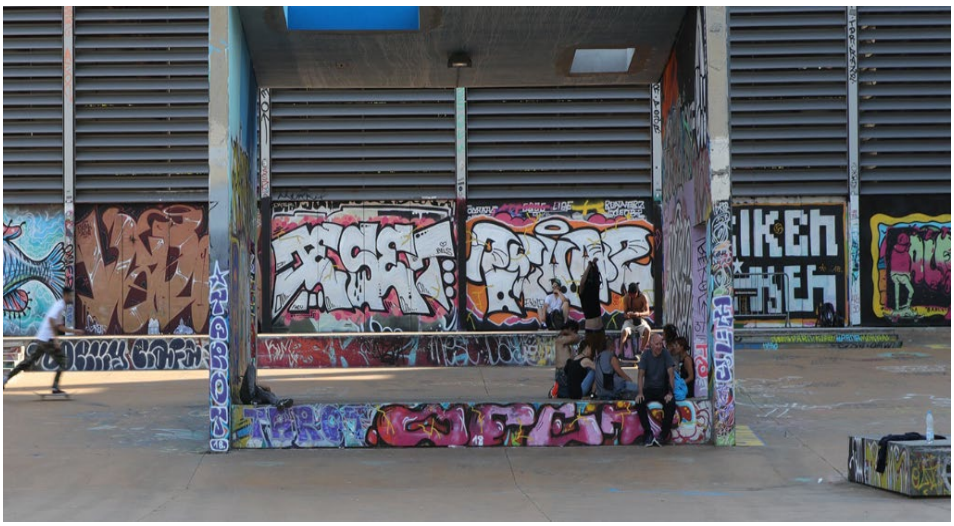


Figure 1. Tres Chimeneas in Barcelona showing a space primarily used and occupied by street artists.[3]

While museums and cultural centers in Barcelona offer structured access to the arts through curated exhibitions, fixed hours, and clear boundaries, their relationship to the surrounding public realm is often separated. Gallery walls function as filters, selecting which voices and works are permitted to participate in official narratives of culture *(Figure 2).* In contrast, the public plaza- particularly in neighborhoods like El Raval and Poblenou - functions as a democratic canvas where expression is less policed and open to reinterpretation.



Figure 2. ADN Galeria in Barcelona, a platform inviting artists to performances and talks about art and society.[4]

The city's municipal efforts to regulate aesthetics clash with spontaneous cultural authorship. In the first half of 2025, 242 fines were issued for graffiti-related offenses, and fines for vandalizing heritage buildings rose by 66.6% - reflecting an effort to reclaim space through civic order and erasure.[5] Even though authorities clear graffiti, it returns fast, proving that urban spaces are always being renegotiated by users. This interaction between institutions and informality produces a hybrid urban condition. Rather than being separate realms, formal places like museums and informal places like graffiti-covered streets converge in transitional spaces. Building walls and surfaces are used as art boards and scaffolds, becoming open-air galleries. Evans highlights this contradiction, noting that graffiti and street art met with conflicting reactions, as they can both celebrated but also criminalized.[6] However, this response can shift depending on where the work appears, how it's framed, and whether institutions choose to support or criminalize it.

The interaction between formal and informal can be understood as a generative condition leveraging a productive tension that redefines the role of architecture in the contemporary city by focusing on the provision of social, public space instead of object building. Graffiti, performance, and informal gatherings utilize formal infrastructure, to accommodate reinterpretation. Municipal recognition and acceptance of informal practices like graffiti and street art expands the conventional limits of urban design. Rethinking architecture as a framework for coexistence and ongoing transformation invites designers to reconsider how surfaces, edges, and thresholds operate as formal elements, that can be reprogrammed over time. Walls no longer function only as boundaries but as potential stages, canvases, or forums. Hybrid spaces do not just support cultural production but instead invite it, accommodating voices that often go unheard in institutional settings. In doing so, they become sites of informal authorship and public contribution. Importantly, these acts of expression layered onto public architecture carry the potential to teach in subtle, indirect way. In this sense, spaces begin to operate as a civic space, but as an educational environment in disguise.

RETHINKING PEDAGOGY THROUGH HYBRID URBAN CONDITIONS

Hybrid urban spaces function as pedagogical environments of civic expression. Extending this perspective, such spaces may also be understood as pedagogical sites that are expressive, reactive, and actively generative. Within the context of Barcelona, learning extends into and adheres to the surfaces, thresholds, and interstitial spaces of the city, rather than being confined to formal educational settings. In corridors, students would occupy benches for sketching, cafés for

collaborative workspaces, and alleyways for graffiti. These spaces lack formal timetables, hierarchical structures, and demarcated roles between "teacher and student". The informal, participatory character of learning beyond the walls of the school resonates with alternative pedagogical models, including the Montessori philosophy, which prioritizes learner-led exploration in spatially responsive environments. As Montessori asserts, "education is a natural process spontaneously carried out by the human individual. It is acquired not by listening to words, but by experiences upon the environment".[7] Although developed for children, this principle equally applies to post-secondary education, when situated within the city, where knowledge emerges through encounter, exposure, and unstructured access to place.

By contrast, formal pedagogical structures are predominantly top-down and static, privileging instruction over exploration and separating content from its lived context. Such models, frequently reinforced within institutes, remain bound to silos, rigid timetables, and hierarchical organization. Ivan Illich critiques these arrangements as mechanisms of social control, imposing dependency and limiting autonomy rather than enabling transformation.[8] He argues against this spatial and institutional confinement, suggesting that an open city can function as a parallel, and often more transformative, site of learning.[9] Informal pedagogies are therefore a deliberate openness that acknowledges the capacity for individuals to learn most effectively when immersed in the environments they seek to understand.

In Barcelona's *Plaça dels Àngels*, skateboarders inscribe architectural surfaces in real time; in El Raval, murals layer and fade before documentation can occur (*Figure 3*); in public squares, architectural critiques draw the attention of passersby who become unplanned participants.

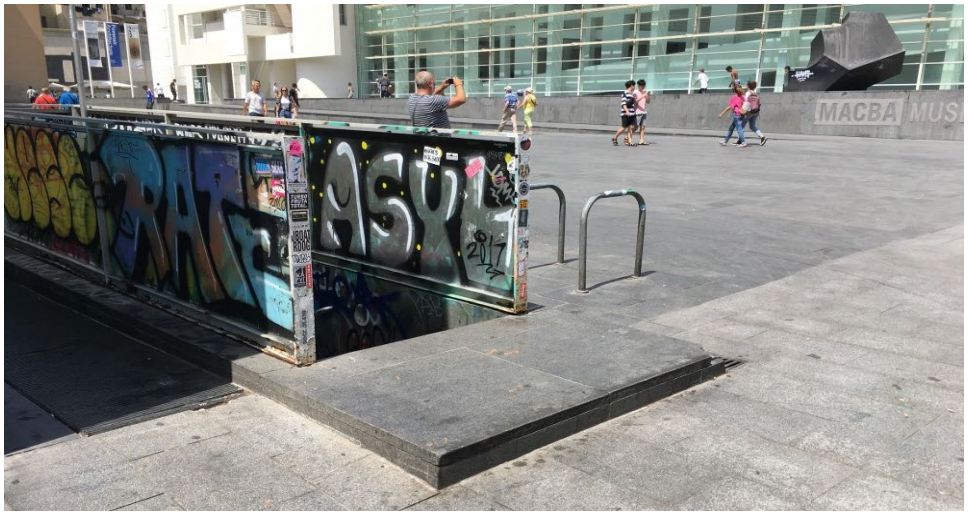


Figure 3. Plaça dels Àngels, Barcelona. Informal graffiti art curated by locals in the public plaza, parallel to the MACBA.[10]

These non-curated intersections broaden the conception of education as a process of shared experience rather than a one-way transmission of information. Such conditions highlight the necessary role of this pedagogy. If significant learning transpires beyond institutional boundaries, how might architecture facilitate civic learning rather than merely contain it? Jacobs (1961) observes that "Cities have the capability of providing something for everybody, only because, and only when, they are created by everybody," a participatory principle that extends to educational environments; a learning space embedded within the public realm that invites multiplicity, of participants, narratives, and interpretations, transforming education into a co-authored process.[11]

DESIGN CHALLENGE

The project responds to a condition we observed in Barcelona's public spaces, in which plazas operate as adaptive environments. Our objective was to translate the qualities that make these plazas vibrant into an architectural intervention that functions as a study abroad center for art and architecture students. The challenge was to learn from the social and spatial conditions evident in the plaza to integrate new academic and cultural functions. The proposed intervention transforms this plaza into a new urban typology- a learning landscape embedded into the public realm- by relocating cultural and academic programs into the plaza itself, creating a space where education and civic life intertwine.

The chosen site is a campus plaza associated with the *Facultat de Comunicació i Relacions Internacionals* located behind the CCCB, lacks the activity and variety of uses common in Barcelona's more popular plazas (*Figure 4*). Despite its adjacency to a university, the plaza is underused during both weekdays and weekends. The lack of activity presented an opportunity to energize the space by introducing formal and informal spaces of art, learning and discussion that encourage public life and academic involvement.

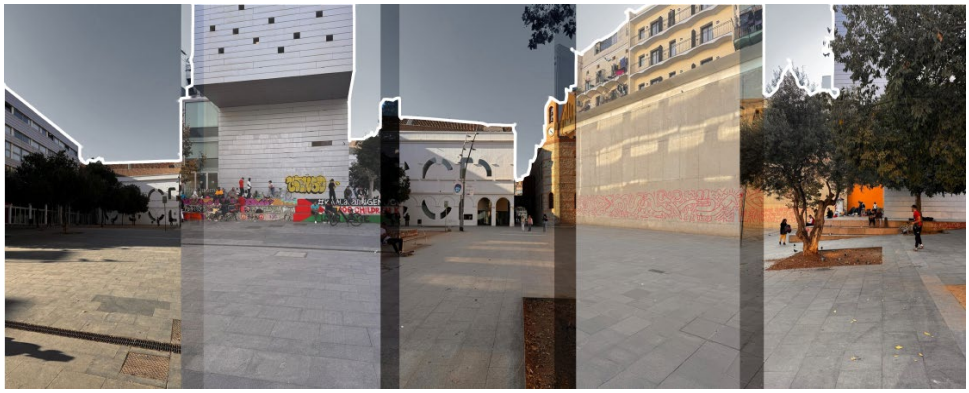


Figure 4. Collage of the calm campus plaza environment behind the CCCB courtyard. (by the author)

DESIGN METHODOLOGY

The design proposal leverages an "inside-out" design strategy that inverts conventional expectations. Programs typically confined within schools or museums are brought into this public space, transforming the plaza into an active space of learning, experimentation, and artistic expression. By integrating informal art practices like graffiti and public installations, and by relocating institutional functions such as learning, exhibition, and discussion into the open, the plaza becomes a porous civic space where art, education, and public life overlap.



Figure 5. Render of an ariel shot of the proposed urban model showing a space where boundaries dissolve and art, education, and public life collide. (by the author)

URBAN AND ARCHITECTURAL STRATEGIES

The design process begins with the decision to preserve and enhance the openness of the plaza, resist enclosure and instead layering activity across multiple ground levels. The intervention avoids monumental form-making in favor of subtle urban manipulations - carving into the ground plane, extending walls outward, and blurring distinctions between circulation, seating, and exhibition surfaces.



Figure 6. Rendering of the plaza's hybrid spaces, linking subterranean studios with sunken courtyards, where circulation serves as gallery and vertical walls form continuous exhibition surfaces. (by the author)

The project features vertical elements - scaffolding structures, pin-up walls, and thickened partitions - that serve as connectors between subterranean and ground-level spaces. These elements become exhibition surfaces, circulation routes, and social condensers. Figure 7. reveals how the panels extend, and the same pin-up surfaces below stretch above ground. The ground level becomes an open studio while the graffiti-covered walls create a natural invitation for people to gather and observe.

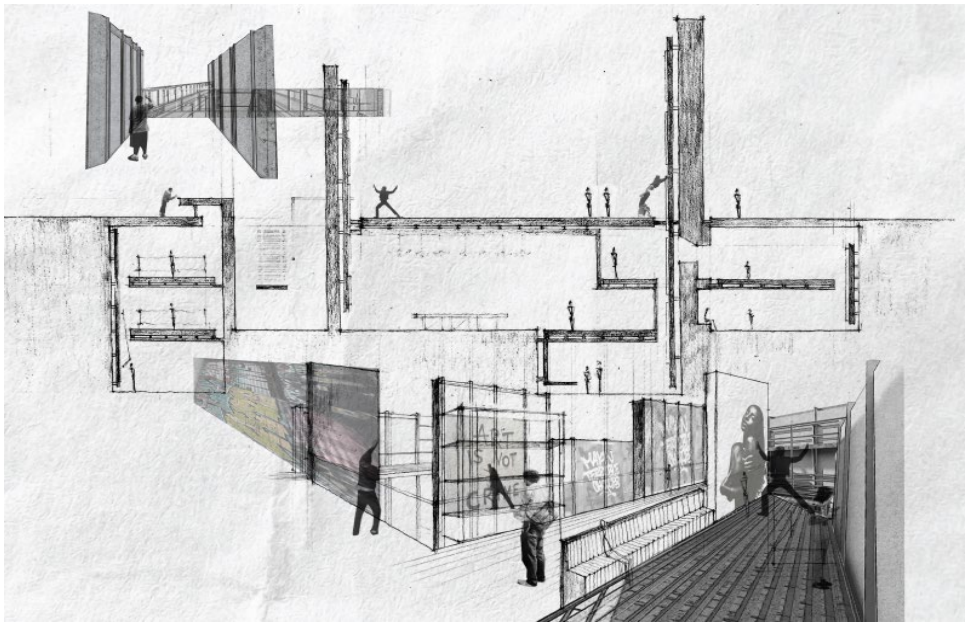


Figure 7. Collage of continuous vertical panels serving as connectors between subterranean and ground-level spaces. (by the author)

Murals produced by local artists share the same surfaces as students' academic pin-ups, producing an evolving visual field that oscillates between formal presentation and spontaneous expression. (*Figure 8*). shows possibilities for interaction- whether in the form of collaborative work or public engagement- are continually anchored by the vertical exhibition elements that rise to ground level. These surfaces act as a shared canvas, binding together the activities below and above, and allowing the outputs of the subterranean studios to re-enter the public realm. Figure 9 further demonstrates the project's emphasis on transparency and spatial layering. The subterranean studios are not enclosed, isolated interiors; rather, they maintain active visual and programmatic connections with adjacent spaces. This arrangement facilitates the exchange of ideas between different functions, enabling movement, visibility, and dialogue across multiple levels. The result is a continuous interplay between making, exhibiting, and public interaction, reinforcing the project's core aim of dissolving the boundaries between institutional production and the life of the plaza.

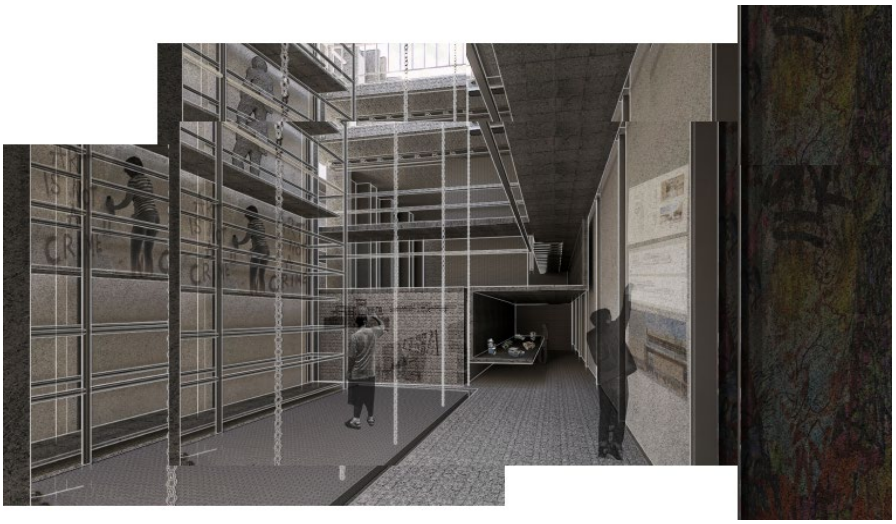


Figure 8. A collage which shows a view from the artist's studio, capturing the dialogue between formal and informal modes of artmaking. (by the author)

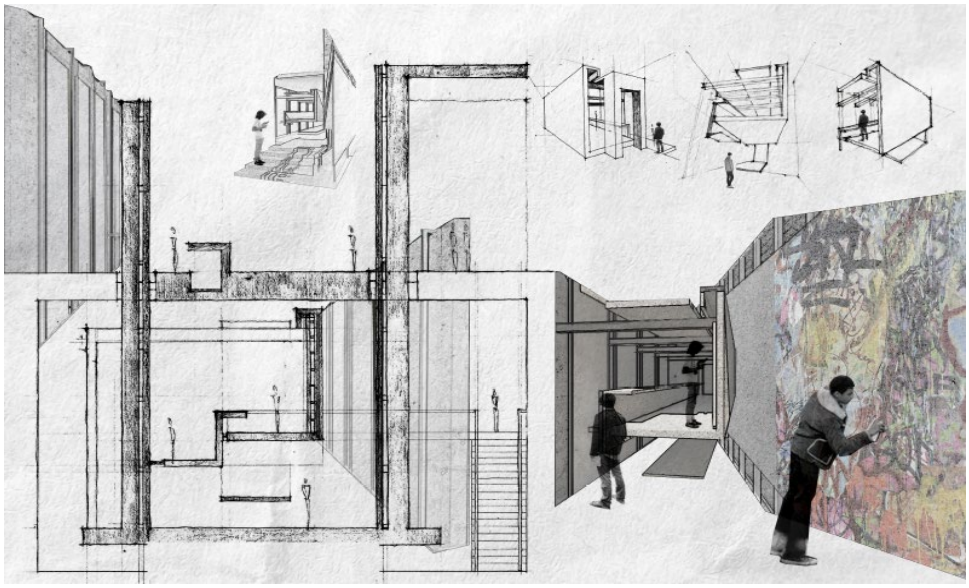


Figure 9. A collage which shows a view from the artist's studio, capturing the dialogue between formal and informal modes of artmaking. (by the author)



Figure 10. A subterranean view of the main studio, where students pin up, work and engage in discussion. Its visually connected to the gallery space on left and adjacent to the atrium space. (by the author)

The proposed plaza operates as an evolving palimpsest, and the approach provides a model for application throughout the city. Over time, layers of artistic intervention - murals, posters, temporary installations - accumulate across the surfaces, embedding the history of student and community engagement directly into the fabric of architecture. The spatial arrangement encourages permeability from highly public zones into more intimate workspaces through a series of increasingly private layers. The coexistence of formal exhibition spaces and informal graffiti surfaces celebrates the full spectrum of artistic expression. This spectrum fosters a full educational environment combining formal, structured critique with the unpredictable dialogues that occur in shared public space.

CONCLUSION

The layered urbanism of Barcelona's Plaza reveals the city that operates as both background setting and proactive agent. The ongoing interplay between formal institutions and informal expressions, between gallery and graffiti, building and bench, exemplifies a dynamic relationship in which hybrid spaces are continually reshaped by their users. These complex spaces contain pedagogical potential in which teaching is woven into encounter, interaction, and participation.

Designing within this context involves dissolving boundaries between civic life and formal learning such that the rigor of the educational act is retained within and beyond conventional enclosure, without losing clarity or intentionality. The proposal therefore balances these forces, positioning the plaza as a public, porous learning ground that is simultaneously structured to support reflection, critique, and making. The investigation demonstrates the value of informal pedagogies does not lie in rejecting structure entirely, but in embedding it lightly, enabling adaptation and reinterpretation by users. Programs are layered rather than segregated, surfaces are purposefully left unfinished, and circulation merges with gathering. This intentional ambiguity fosters contribution and participation, while relying on the engagement of the community to activate the space.

Finally, rather than proposing a new building type, the project advances a shift in a pedagogical attitude, one that understands education not as a discrete activity confined to specialized spaces, but as a practice that can be experienced, observed, and shaped across the urban fabric. It suggests a "pedagogy of the public", inscribed onto walls and unfolding across thresholds, continually re-authored by those who inhabit and traverse the city.

NOTES

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NEIGHBOURHOOD LIVEABILITY FROM THE PERSPECTIVE OF RESIDENTS: CASE STUDIES ACROSS NEIGHBOURHOODS IN GOLD COAST, AUSTRALIA; WELLINGTON, NEW ZEALAND; AND QUEZON CITY, PHILIPPINES

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INTRODUCTION

A liveable neighbourhood is a dynamic zone of fit between people's residential aspirations and the environment they live in.[1] This statement sums up the lessons on neighbourhood liveability from the neighbourhoods in this study. This paper aims to demonstrate that as social practice, the creation of neighbourhoods go beyond the realm of urban design but also encompass governance and social behaviours; and that even if there may be universal principles to neighbourhood liveability, they should be applied in the milieu of cities and cultures.

LIVEABILITY AND SUSTAINABILITY

In 2014, the Union Internationale des Architectes (UIA), put forth the "Declaration 2050 Imperative", engaging architects to "advocate and promote socially responsible architecture for the community", as well as "reduce carbon emissions to zero by 2050 and provide equal access to shelter".[2]

UIA's declarations echo the notions of what sustainable architecture really is, which is ultimately "a response to a myriad of contemporary concerns about the effects of human activity" or simply "the way good design must be".[3] This definition of sustainable architecture resonates with the definitions of sustainable development:

- An integration of economic, social and environmental objectives of human processes.[4]
- A societal process of mediating society's impact on the environment to ensure a better future for succeeding generations.[5]

The definitions above point to the importance of the oft-mentioned but understudied aspect of sustainability – social sustainability, as well as the Nested Circles model,[6] comprised of three circles representing "environment" as the outer circle, a middle circle representing "society" and the inner circle representing "economy" (Figure 1, below).

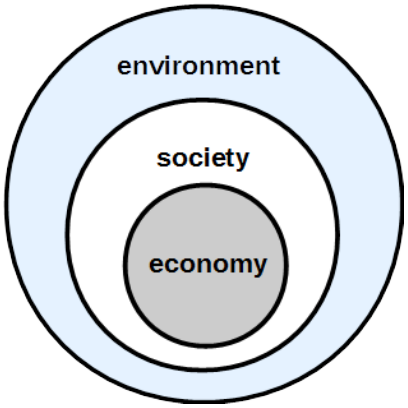


Figure 1. Nested Circles Model of Sustainability

This model implies that the economy is part of society and society is contained within the environment from which it draws sustenance. This implies that the core of sustainability is social sustainability, of which buildings, neighbourhoods and cities are but means to the ends of a sustainable life.

Social sustainability

The literature on social sustainability mostly deal with the social implications of environmental policies "rather than as an equally constitutive component of sustainable development".[7] Vallance, Perkins and Dixon,[8] also report that the various definitions and notions about the social aspects of sustainable development leave a lot of uncertainty about its meaning and applications.

However, the various definitions of social sustainability show intersections and commonalities in concerns and expected outcomes. To marry the descriptions with the simplicity of the Bruntdltand Report's definition of sustainable development-- "development that meets the needs of the present without compromising the ability of future generations to meet their own needs",[9] we can define social sustainability as:

the process of meeting a group's needs in consonance with that group's desired quality of life, sustained through succeeding generations.

Societal Needs

A global study conducted by Tay & Deinier[10] across 123 countries examining the association between human needs and subjective well-being (SWB). Tay & Deiner emphasized the relationship of societal needs to SWB, where the latter is dependent on the fulfillment of the former. In the literature on social sustainability, the terms quality of life and subjective well-being are used almost interchangeably.[11] Camfield & Skevington[12] threshed out these terms' conceptual differences and convergences in the health sciences literature and concluded that SWB and subjective QoL are synonymous.

Social sustainability and liveability

The dictionary definition for "liveability" is: "suitability for human living".[13] In connection with sustainability assessments, "liveability" is conceived along the lines of quality of life factors.[14] Ruth & Franklin[15] describe the concept of liveability as having two elements: (1) the fulfillment of human needs and aspirations, and (2) the quality of the built and natural environment supporting the intended population. The empirical study done by Howley, Scott, & Redmond[16] equates liveability to satisfaction with the house or apartment and satisfaction with the neighbourhood. Thus, in relation to social sustainability, liveability can be defined as: *meeting people's needs according to the quality of environment they want.*

NEIGHBOURHOOD LIVEABILITY

Social sustainability, and ultimately sustainable development, puts humanity at the core of its aims – meeting basic needs that are in accord with the desired quality of life, which includes liveability. These needs and quality of the built environment, particularly the neighbourhood, are tackled in this section.

Liveable neighbourhoods and their assessments

The UN Conference on Environment and Development in 1992 produced an action plan called "Agenda 21",[17] which anchors sustainable development at the local level. Mawhinney[18] suggests that it is at the community (neighbourhood) level where "all the competing interests meet", which makes it a proper level of analysis for sustainability. Ellen & Turner[19] cited empirical bases for the significance of neighbourhood effects on individual outcomes, although lamented the fact that these studies offer no guidance for policy on how to improve neighbourhoods.

Attaining sustainability at the neighbourhood level has been a contentious issue of measurement.

A number of neighbourhood assessment tools have been studied for their reliability and validity and were found wanting. These evaluations[20] demonstrate how Neighbourhood Sustainability Assessments (NSAs) have been heavily reliant on technology use, and to drive neighbourhood design and development. Such flawed assessment tools have resulted in neighbourhood sustainability standards that are not in consonance with residents' values and desires.

Understanding sustainable neighbourhoods

Given the unresponsiveness of current NSAs to reflect residents' needs and environmental aspirations, a model that reflects the complexity and wholeness of living in a neighbourhood is in order. The conceptual model below (Figure 2) is inspired by the works of Capra & Luisi,[21] Gert Spaargaren[22] and Del Castillo & Mendoza.[23] This model aims to address the gap between current neighbourhood liveability indicators and what liveability ought to capture.

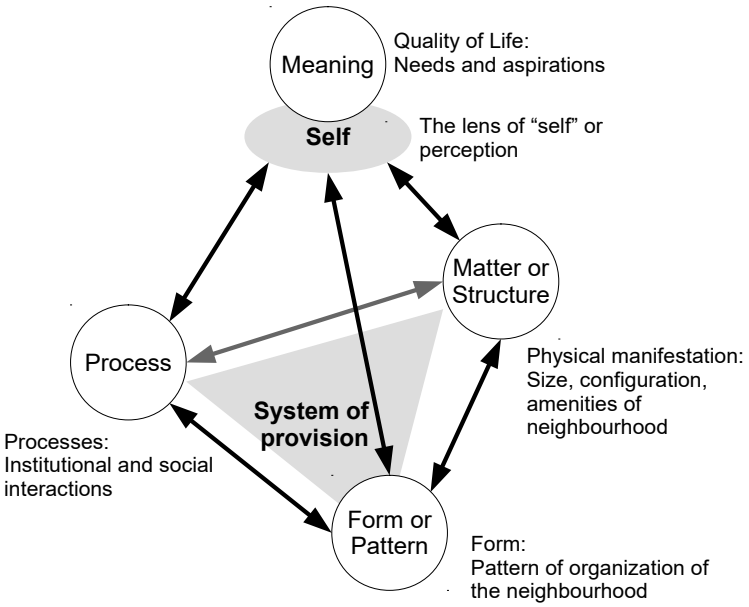


Figure 2. Neighbourhood as Living System

Spaargaren's Social Practices model[24] differentiates and articulates residents' perceived needs and aspirations into the relevant indicators for use at a policy-making level. The Four Perspectives on Life of Capra & Luisi[25] may also be seen as enhancing the social practices model by breaking down the system of provision into the process of provision, the patterns of organization (form) and the actualization of the pattern (structure). All three perspectives are mediated by the meanings people have about their life. And, as the themes of the meanings of houses[26] portray, neighbourhood may actually be viewed through the lens of "self" of residents.

The underlying questions in this study are: How do residents perceive their neighbourhood? What aspects do they value in their neighbourhood, and how do these aspects of neighbourhood affect their aspired quality of life?

RESEARCH DESIGN

To find out people's needs and wants, a qualitative, grounded theory approach, using case studies of existing neighbourhoods was employed. Two neighbourhoods each from three cities in three countries were selected. This selection allowed the comparison of neighbourhood liveability perceptions where the differences in culture and, perhaps, climate were expected to reveal differences in the way residents of these cities view their respective neighbourhoods. Gold Coast, a sub-tropical city that is emerging as a multi-cultural city. Southport and Varsity Hills are the neighbourhoods studied in Gold Coast. Wellington is also a multi-cultural city located in the temperate region of the southern hemisphere. Karori and Te Aro were selected as case studies for Wellington. Quezon City is in a tropical country with a relatively homogeneous ethnic population. Project 6 and Filinvest 1 were the neighbourhoods selected for Quezon City.

Neighbourhood meanings reveal people's needs and values. These meanings were culled through a semi-structured interview and a neighbourhood satisfaction rating scale. Each neighbourhood was analyzed in terms of their form, structure and processes. The interview questions were intentionally open-ended to allow the respondents to freely express themselves. This was meant to derive categories of neighbourhood life that may not have been known or uncovered in previous studies. Figure 3 below illustrates the Conceptual Framework of this study and how the data and analysis was conducted.

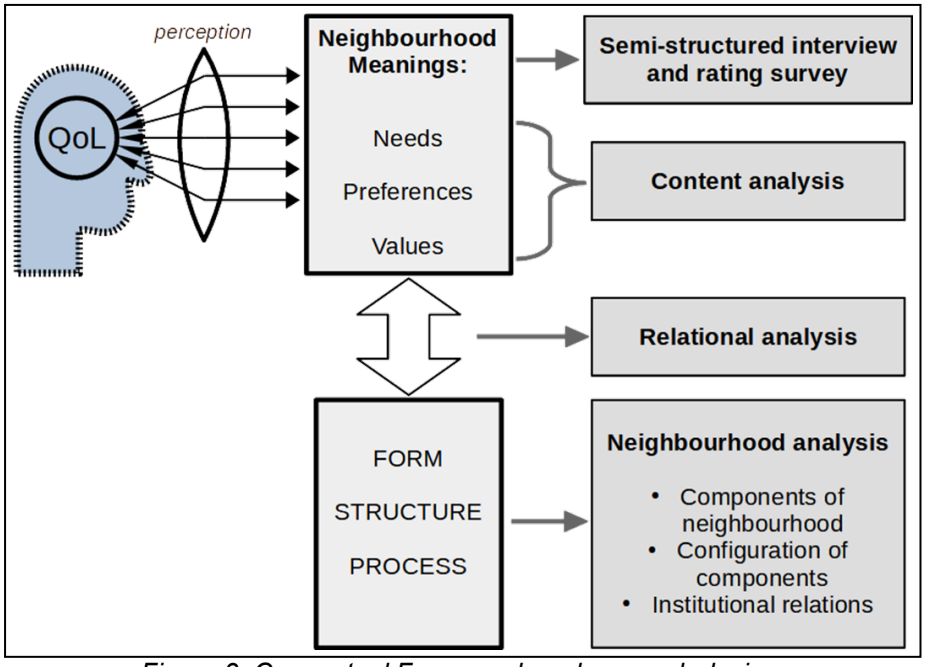


Figure 3. Conceptual Framework and research design.

RESIDENTS' PERCEPTION OF NEIGHBOURHOOD

The residents' descriptions of their neighbourhood yielded a total of 28 dimensions of neighbourhood, which were organized into 4 themes – the Personal theme which is about their feelings and memories about their place; The Physical theme, dealt with the physical aspects of neighbourhood; The Social theme, the theme with the most responses, is about people – who they are, their activities and behaviors; and lastly, the Political theme which groups the dimensions of safety, crime, local governance, transport and traffic. (See Table 1)

Personal (14%)	Physical (26%)	Social (49%)	Political (11%)
how they feel about their place	physical aspects of neighborhood	people, their activities, interactions with people	Governance, crime and safety issues
• Feelings • History • This place	• Built features • Natural features • Accessibility • Location • Amenities • Leisure • Walkability • Crowding • Street condition	• Neighbors • Neighbors' behavior • Friendliness • Quiet / noisy • Lifestyle • Peaceful / calm • People on streets • Privacy	• Safety • Council • Crime / drugs • Clean / dirty • Economics • Transport • Traffic • Police response

Table 1. Dimensions and themes of neighbourhood

The respondents across the cities are almost all in agreement in what they appreciate about their neighbourhoods, practically across all dimensions, with some minor differences such as "lifestyle/atmosphere", which are absent Gold Coast responses, and "walkability" for QC residents. (See Figure 4 below)

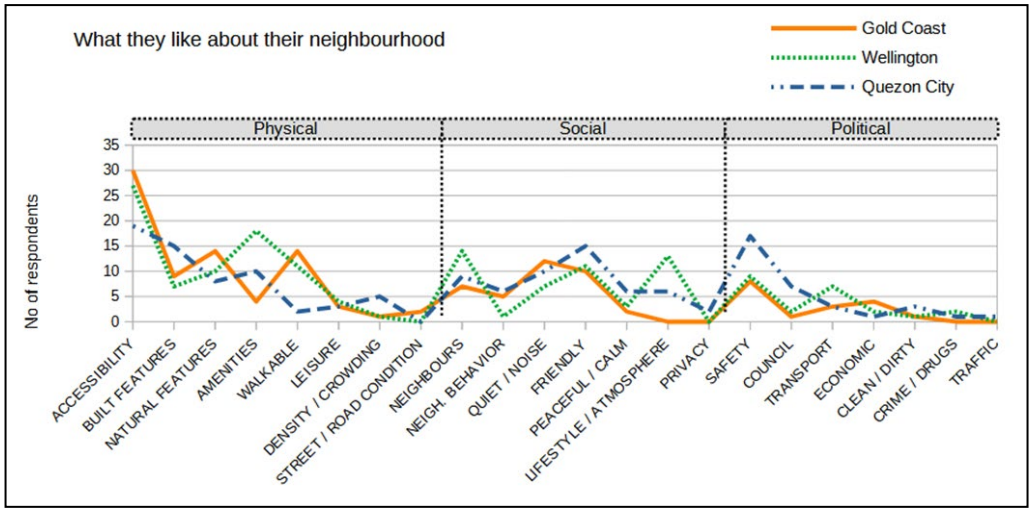


Figure 4. What they like about their neighbourhood

Divergence occurs in what they dislike in their neighbourhoods (Figure 5, below). Wellington respondents had two basic issues: the natural features (Karori's often cold, windy climate; and Te Aro's lack of parks and greenery), and the noise experienced by Te Aro's residents. Gold Coast respondents decry three aspects: the dilapidated houses, lack of amenities, and the annoying or worrisome neighbors in Southport; the narrowness of streets in Varsity Lakes. For Quezon City respondents, it was the uncooperative neighbors, and their concern for their safety due to the perceived intensity of crime in their areas.

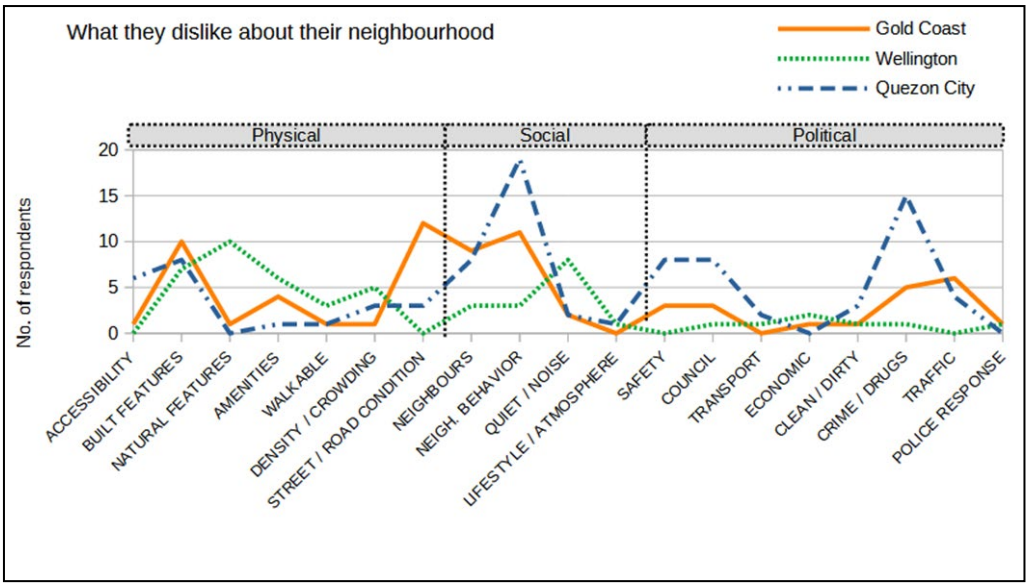


Figure 5. What they dislike about their neighbourhood

As for the desired and despised neighbourhoods (Figures 6 & 7 below), the overall responses in the three cities expressed various intensities of almost the same neighbourhood aspects that they would want to have and not have in a neighbourhood. The varied intensities reflect the particular concerns they have with, and the features they want repaired, in their current neighbourhood's.

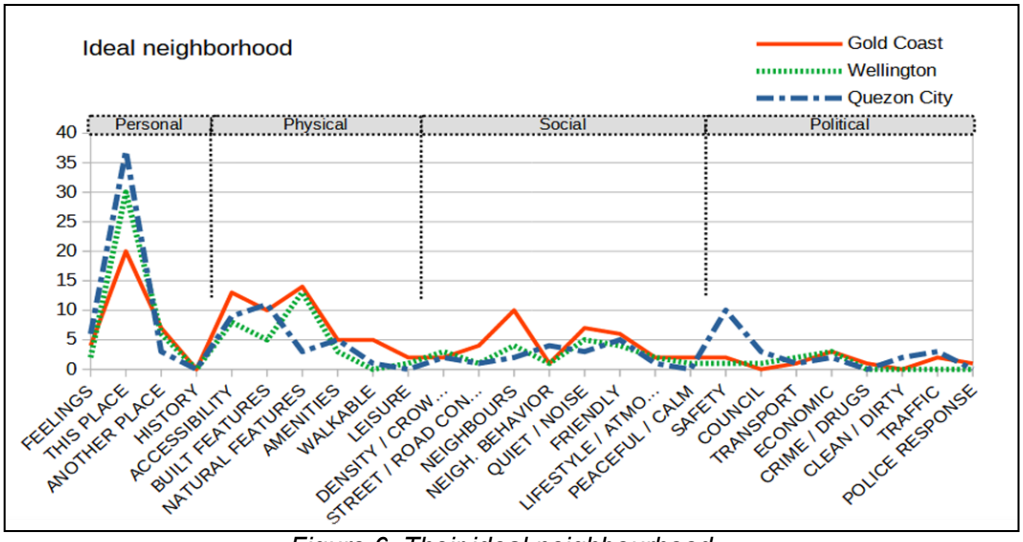


Figure 6. Their ideal neighbourhood

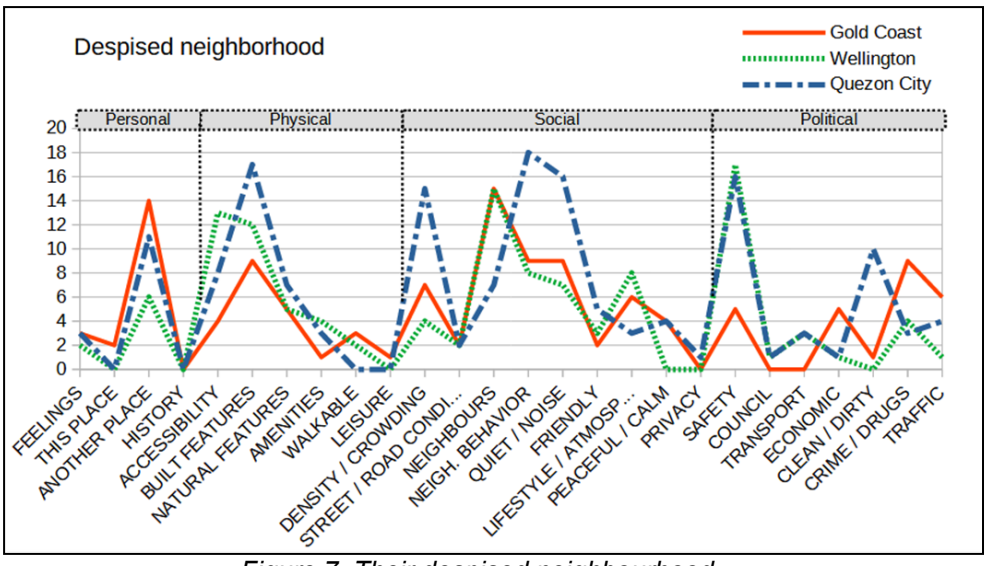


Figure 7. Their despised neighbourhood

It must be highlighted that two-thirds of the total respondents named their neighbourhood (This Place) as their ideal neighbourhood. Setting the personal dimensions aside, the respondents tended to have more to say about their desired physical aspects in a neighbourhood. The physical dimensions make up 36% of all responses.

For the despised neighbourhood, the social dimensions: Neighbors, Neighbors' Behavior and Noise are the aspects that are most important to all respondents. This is followed by the Physical dimensions of the Built Features, Accessibility, and Natural Features. The rest of the abhorred aspects of neighbourhood life diverge depending on the study area's context – especially in the political dimensions of safety and cleanliness (for QC), and safety and crime in Gold Coast.

THE ELYSIANS

The two-thirds of respondents who named their neighbourhoods their Ideal Neighbourhood became the focus of analysis. These respondents may be called – Elysians – from Greek mythology, the residents of Elysium, who think their neighbourhoods to be the ideal neighbourhood.

That there are Elysians hint that these people are living in a place where their needs are met according to the quality of the environment that they want – the definition of "liveability". The Elysians vary in each study area, with Southport having the least number of Elysians; while the Elysians of Karori, Project 6 and Filinvest comprise more than 75% of the total respondents in each study area.

	Neighborhood Satisfaction Ratings						
Elysians	5	4.5	4	3.5	3	2.5	Ave
Gold Coast	9	2	9	0	0	0	4.5
Wellington	20	5	5	0	0	0	4.75
Quezon City	10	4	21	1	1	0	4.28
Non-Elysians	5	4.5	4	3.5	3	2.5	Ave
Gold Coast	4	2	10	2	4	0	4.00
Wellington	1	3	7	0	1	1	4.00
Quezon City	0	0	4	0	3	0	3.57

Table 2. NSRs of Elysians and Non-Elysians

Analyzing the Neighbourhood Satisfaction Ratings (NSRs) of Elysians and Non-Elysians (Table 2) reveals the subjectivity of ratings and the degrees of tolerance people have about their ideal neighbourhood. (The Likert scale had "5" as "very satisfactory", "3" as "neither satisfied nor dissatisfied", and "1" as very dissatisfied".) Even as most of Elysians rate their neighbourhoods with at least a 4, there were 2 respondents in Quezon City who gave their neighbourhood a rating below 4. Conversely, there are Non-Elysians who rate their neighbourhoods high yet still not find their places ideal places to live in.

Grouping the Elysians and Non-Elysians also allows the analysis of the factors that affect neighbourhood satisfaction. In Table 3 (below), the physical attributes of neighbourhood are given more weight when respondents talk about what they like in a neighbourhood; while the non-physical aspects become more salient when they talk about aspects that they would not like about their neighbourhood.

Across all study areas, there seems to be separate sets of indicators for neighbourhood satisfaction and for dissatisfaction. The respondents tended to have more to like about their physical environment than the social or political aspects. Based on the frequency of liked dimensions in each theme, there is an indication that the physical dimensions have a greater effect on how neighbourhood experience is highly rated.

SOUTHPORT	No. and % of responses							NSR	Neigh. Type	Pop. Density
ELYSIANS	PHYSICAL		SOCIAL		POLITICAL		TOTAL	4.02		
LIKES	17	68%	5	20%	3	12%	25	4.36	Old/ central	67/ha.
DISLIKES	0	0%	5	50%	5	50%	10			
NON-ELYSIANS										
LIKES	24	59%	12	29%	5	12%	41	3.86		
DISLIKES	7	23%	11	37%	12	40%	30			

VARSITY LAKES	No. and % of responses							NSR	Neigh. Type	Pop. Density
ELYSIANS	PHYSICAL		SOCIAL		POLITICAL		TOTAL	4.45		
LIKES	26	60%	11	26%	6	14%	43	4.58	New / periph'l	44/ha.
DISLIKES	14	78%	2	11%	2	11%	18			
NON-ELYSIANS										
LIKES	12	52%	8	35%	3	13%	23	4.25		
DISLIKES	9	64%	4	29%	1	7%	14			

TE ARO	No. and % of responses							NSR	Neigh. Type	Pop. Density
ELYSIANS	PHYSICAL		SOCIAL		POLITICAL		TOTAL	4.32		
LIKES	23	49%	17	36%	7	15%	47	4.58	New / central	78/ha.
DISLIKES	5	29%	8	47%	4	24%	17			
NON-ELYSIANS										
LIKES	17	71%	5	21%	2	8%	24	3.94		
DISLIKES	9	56%	6	38%	1	6%	16			

KARORI	No. and % of responses							NSR	Neigh. Type	Pop. Density
ELYSIANS	PHYSICAL		SOCIAL		POLITICAL		TOTAL	4.74		
LIKES	32	48%	23	34%	12	18%	67	4.88	Old/ periph'l	21/ha.
DISLIKES	10	84%	1	8%	1	8%	12			
NON-ELYSIANS										
LIKES	6	46%	5	39%	2	15%	13	4.13		
DISLIKES	6	100%	0	0%	0	0%	6			

PROJECT 6	No. and % of responses							NSR	Neigh. Type	Pop. Density
ELYSIANS	PHYSICAL		SOCIAL		POLITICAL		TOTAL	4.07		
LIKES	24	41%	21	35%	14	24%	59	4.25	Old/ central	277/ha.
DISLIKES	6	15%	8	21%	25	64%	39			
NON-ELYSIANS										
LIKES	5	42%	6	50%	1	8%	12	3.40		
DISLIKES	2	13%	6	40%	7	47%	15			

FILINVEST 1	No. and % of responses							NSR	Neigh. Type	Pop. Density
ELYSIANS	PHYSICAL		SOCIAL		POLITICAL		TOTAL	4.29		
LIKES	31	41%	27	36%	17	23%	75	4.32	New / periph'l	67/ha.
DISLIKES	11	35%	15	48%	5	16%	31			
NON-ELYSIANS										
LIKES	2	33%	2	33%	2	33%	6	4.00		
DISLIKES	3	33%	3	33%	3	33%	9			

Table 3. The multi-dimensional nature of neighbourhood satisfaction

On the other hand, the same data set shows that certain non-physical aspects of neighbourhood may lead to dissatisfaction, as demonstrated by the non-Elysians' average NSRs in Southport, Te Aro and Project 6 -- all below "4". For Southport, these are the dimensions of neighbors, neighbor's behavior (social aspects) and crime (political aspect); For Te Aro, these would be noise and neighbor's behavior (social); and for Project 6, the dimensions neighbor's behavior (social), crime and feeling unsafe (political).

Relating the neighbourhood evaluations to the type of neighbourhood and population density, on a per city basis, the data suggests lower neighbourhood satisfaction ratings associated with higher density and proximity to the city center. Southport of Gold Coast, Te Aro of Wellington and Project 6 of Quezon City, all show lower average neighbourhood satisfaction ratings with respect to their peripheral and lower-density counterparts, -- Varsity Lakes, Karori and Filinvest 1, respectively. This finds affinity with the empirical study of five British cities[27] where it was found "residential satisfaction, stability, neighbourhood environment, and safety... (are) lower in high density/central places".

The aspirations for neighbourhood

The lessons offered by the Elysians responses from the six study areas allow a derivation of common neighbourhood aspirations:

- Accessible to and from places of work, school, shopping and leisure
- An aesthetically-pleasing built environment that satisfies residential needs and mobility needs;
- Surrounded by pleasing natural features;
- Preferably with neighbours of the same socioeconomic status;
- A safe place, crime-free and illegal drugs-free;

CONCLUSION

What are the lessons on neighbourhood livability from Gold Coast, Wellington and Quezon City? Consequent to the derivation of common indicators of livability from the residents' perspective, several insights were gained:

1. Neighbourhood livability is an experienced overall quality of environment

◦ Livability is closely tied to definition Quality of Life (QoL), which stresses the importance of the perception of each citizen in the evaluation of society's development.

2. Neighbourhood livability is a gestalt

◦ As manifested by the Elysians and non-Elysians, liveability is a combination of aspects that interact, interrelate, and vary in value or priority among individuals. The Elysians have shown that an "ideal neighbourhood" is one that they "love" or "enjoy" despite the presence of unwanted aspects.

3. Neighbourhood livability a measure of residents' satisfaction.

◦ The degree of satisfaction indicates a resident's personal experience of living in the neighbourhood. Hence, it cannot be simply broken down into distinctly quantifiable terms.

4. Neighbourhood livability is a dynamic state.

◦ This implies that a livable neighbourhood must also be a resilient neighbourhood – capable of adapting to the changes in and around its boundaries, most especially the changes in composition, lifestyle and values of its residents. Livability has to be assessed over time.

5. Neighbourhood livability is contextual.

◦ Different environmental, social and economic conditions call for context-specific indicators. Measurement is dependent on geographic, socio-cultural and personal contexts.

6. Measuring livability requires a reflexive process.

◦ The real measure of livability is arrived at when the neighbourhood is lived in, and its residents are engaged in a reflexive process of assessing its livability according to their expectations,

7. Livable is not necessarily sustainable

◦ If one of the goals of sustainable cities is lesser dependence on cars as a means of travel, this study revealed that a car-dependent neighbourhood can be deemed livable by its residents, as in the cases of Southport, Varsity Lakes, Karori and Filinvest 1; People choose to live in places that meet their needs, and their needs and choices, are not necessarily sustainable.

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TWO DECADES OF URBAN RENEWAL SPECIAL ZONE IN TOKYO: EVALUATING GROUND-LEVEL LAND USE TRANSFORMATIONS

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INTRODUCTION

In Japan, two decades have passed since the enactment of the Special Measures Law for Urban Renaissance,[1] which was introduced in the aftermath of economic stagnation and a decline in international competitiveness following the collapse of the economic bubble. Among its measures, the Special Urban Renaissance District (Special District) system has facilitated large-scale redevelopment by exchanging the relaxation of land-use and floor-area ratio (FAR) regulations for public contributions such as plazas and pedestrian pathways, thereby strengthening international business and exchange hubs and enhancing the attractiveness of major cities.

At the same time, in response to issues such as urban population growth and global warming, the importance of creating internationally "livable" cities—as emphasized in Sustainable Development Goal (SDG) 11—has gained global attention.[2] Around the same period in the United Kingdom, the Urban Task Force[3] and researchers such as Newman et al.[4] demonstrated that in areas with high-rise residential towers, residents tend to experience social alienation, while in uniformly low-rise housing estates, the absence of open spaces hinders social interaction, leading to similar feelings of isolation. As a result, districts that incorporate both vertical and functional diversity have been regarded as more desirable.

In practice, this principle has been reflected in policies abroad. For example, in Portland, Oregon, United States, the concept of the "20-minute city"[5] was proposed, aiming to create residential areas where essential amenities can be accessed within 20 minutes. Likewise, in Paris, France, the "15-minute city"[6] initiative was introduced to ensure access to daily necessities within a 15-minute bicycle ride. In this way, European urban regeneration has increasingly emphasized a human-centered, walkable city design. From these discussions, it can be inferred that the diversity of ground-level land use is a crucial element of livability. However, the trend in Japan's special districts to increase floor area ratios, while remaining unaffordable for diverse businesses and residents, raises concerns about a decline in land-use diversity.

OBJECTIVE

This research aims to visualize the cumulative impacts under schemes such as Tokyo's special districts by focusing on the transformation of ground-level land use. We reassess these districts by quantifying the extent of their influence on land use within walking distance. For this objective, The

Paris ZAC districts, which have been systematically introduced under public leadership as part of the recent "15-minute city" concept, serve as a comparative reference.

EXISTING STUDIES

There have been several studies on Japan's Special Urban Regeneration Districts. For example, Kitazaki et al.[7] clarified the realization and actual conditions of the system itself, such as deregulation of the FAR and public financial support, but they did not address the impacts of the system on cities. Ban et al.[8] analyzed the external effects of Special Urban Regeneration Districts and other urban planning systems by using the hedonic approach. However, their work is essentially a policy evaluation, and they used land price as a variable to measure the value of a city.

Although there has been growing attention regarding the concept of the walking distance（living sphere）, there are very few indicators that are available to evaluate it. There has been some analysis of the actual conditions of the living sphere: Guzman et al.[9] examined Bogotá in the context of the 15-minute city, and Shimizu et al.[10] studied part of the Kanto region. However, neither research proposed indicators for evaluating cities. Moreover, Guzman et al.[11] used point data of facilities, while Shimizu et al.[12] relied on Public Transport (PT) survey data survey data, meaning that they did not consider the influence of facility size. Asano et al.[13] did consider facility size in their research. They analyzed the relationship between designated urban function inducement areas and the locational trends of large-scale retail stores in Utsunomiya City. However, this research was limited to large-scale retail establishments. Currently, one of the widely used indices is the Walk Score,[14] which evaluates walkability based on the number of facilities within walking distance, using point data. However, this score does not consider the influence of facility size or spatial configuration, but only the quantity of facilities.

TARGET

In Tokyo, high-rise development has been promoted at the scale of individual blocks by utilizing special exemptions such as the relaxation of height and floor-area ratio (FAR) regulations. However, ground-level spaces tend to be enclosed within on-site commercial facilities or atria, leaving challenges in terms of connectivity with street spaces and the creation of vibrant public life.[15] Representative examples of these policies can be seen around Ikebukuro Station in Toshima Ward and Tokyo Station in Chiyoda Ward. In Ikebukuro, projects have consolidated fragmented plots within densely built wooden housing areas to construct large-scale facilities,[16] including complexes integrating the Toshima City Hall with high-rise residential towers.[17]Tokyo Station stands out as a rare case in Japan: Despite being a central business district with many commercial facilities, bold urban developments have incorporated extensive greenery into the urban core.[18]

By contrast, Paris has implemented the PLU (Plan Local d'Urbanisme),[19] which has been promoted at the scale of multiple blocks and enforces strict height regulations, such as the 31-meter limit, in order to preserve the cohesion of the urban landscape. Through the ZAC, Paris requires the integration of commercial and public functions at the ground level to enhance street continuity and promote diverse urban activities. Representative examples include projects around Saint-Lazare Station in the 8th arrondissement and the Clichy-Batignolles district in the 17th arrondissement. The Gare Saint-Lazare development introduced a complex facility where the ground floor integrates commerce, services, and public spaces, fostering vibrancy and pedestrian circulation.[20] Meanwhile, the Clichy-Batignolles project strategically relaxed certain height restrictions to secure generous public spaces, creating a mixed-use district that accommodates diverse functions and provides housing for people of different ages and socioeconomic backgrounds.[21]

METHODOLOGY

Selecting Indicators

We used indicators of landscape ecology to quantify the extent of land-use impacts, considering the scale and layout of facilities. Landscape ecology emphasizes the relationship between organisms and their habitats and has developed an analysis of landscape patterns that focuses on the spatial arrangement of different land cover types such as vegetation and water bodies that constitute habitats.[22] We quantified these patterns by applying them to the land-cover patterns of urban areas where humans live. We selected from the indicators used in FRAGSTATS[23] and the indicators proposed by Turner et al.[24] based on their compatibility with our objective, understandability, and measurability in the validity check. Table 1 shows the indicators, their meanings, formulae, and equations. These indicators are classified into two types: indicators of "land diversity" (richness and evenness) and indicators of "the impact of specific uses" (the proportional abundance of each class [PAC], division, and continuity), which indicate the layout and size of the town. However, in this research, we defined a class in landscape ecology as a group of facilities with the same use, whereas a patch refers to an individual facility.[25]

Setting the Living Space Scale

Thomas et al.[26] proposed an appropriate mesh size based on saturation from the species–area curve, because the number of species generally increases as the biological survey area increases. Therefore, we evaluated the appropriate mesh size by looking at the saturation of the number of facilities (richness) contained within a mesh of 500, 1000, 2000, and 5000 m per side. We calculated the mean and standard deviation, which are shown in Figure 1. The mean richness shows a gradual slope at a mesh of 1000 m per side, and the standard deviation is lowest with a mesh of 1000 m. Therefore, a mesh of 1000 m is neither too small nor too large, and we used a 1000-m mesh in this research.

Calculation of Indices

For Tokyo's 23 wards, we used the current land-use maps from 2006, 2012, and 2021,[27] and for Paris, we used the CLMS(Copernicus Land Monitoring Service) land-use database from 2018 and 2020 (i.e., the years that were available).[28] Because the 2006 and 2012 data for Tokyo were not publicly available, we obtained them from the Tokyo Metropolitan Government Bureau of Urban Development. Using QGIS[29] (Quantum Geographic Information System), an open-source geographic information system software, we divided the maps of both cities into the living area scale and calculated the five aforementioned indicators for each unit. The classification codes of Tokyo's current land-use maps differ from those of the Paris database. (Table 2) Globally, there are differences in the availability of land use data. Within the EU, while land use classification is unified, it is quite broad. It resembles data from the natural environment sector rather than classifications for urban land use. (Table3)

We determined the representative to use in this research based on statistical analysis. For the living area scale units that contained facilities designated as special districts where urban development projects had been completed, we assigned representative values at the district level by aggregating the corresponding units.

Index	Meaning	Formula
Richness	Richness of different patches	m (Number of facility types)
Evenness	The degree to which land-use types are evenly distributed based on their area proportions	$\frac{-\sum_{i=1}^{m}(P_i ln P_i)}{ln\, m}$ Pi (percentage of mesh occupied by facilities)
Proportional Abundance of each Class (PAC)	Percentage of class to total district	$a_{ij}^{c}\left(\frac{1}{10000}\right)$ a_{ij}^{c} (maximum facility area)
Diversity	The degree to which an area is divided into individual patches	$1-\sum_{j=1}^{n}\left(\frac{a_{ij}}{A}\right)^2$ A (mesh area)
Connectivity	Connectivity of a landscape of size m × n rows	$\frac{LC_i}{p_i \times m \times n}$ LC_i (maximum facility area)

Table 1. Indicators of diversity and magnitude of impact of specific uses

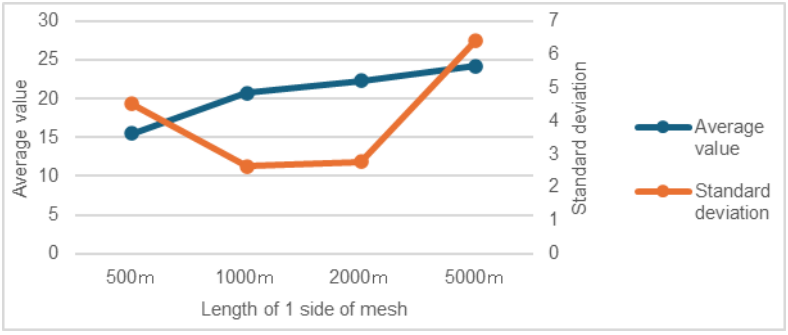


Figure 1. Comparison of richness for different mesh sizes

Classification Codes for Tokyo Land Use Maps					
Government and Public Facilities	Outdoor Use Areas / Temporary Structures	Mixed Residential and Commercial Buildings	Crop Fields	Residential and Factory Combined Buildings	Others
Educational and Cultural Facilities	Parks, Sports Grounds, etc.	Accommodation and Entertainment Facilities	Orchards and Tree Gardens	Warehouse and Transportation Facilities	Unknown
Welfare and Medical Facilities	Unused Lands, etc.	Sports and Event Facilities	Grassland and Pasture	Agricultural, Forestry, and Fishery Facilities	Inconsistent / Mismatched
Supply and Processing Facilities	Roads	Detached Houses	Water Surfaces, Rivers, Waterways	Dedicated Factories	Forests
Office Buildings	Railways, Ports, etc.	Apartment Buildings / Multi-family Housing	Wastelands	Dedicated Commercial Facilities	Rice Fields

Classification Codes for Paris Land Use Maps						
Agriculture	Air Network	Secondary Industry	Residential use	Fisheries and aquaculture	Service logistics	Road network
Forestry	River and sea	Mixed use	Transition Zone	Other primary industries	Public Works Network	Railway Network
Extraction activity	Other transport networks	Tertiary Industry	Ruins	Unexplored land	Not clear	

Table 2. Land-use classification codes for Tokyo and Paris

Country	Open Status	Land Use Data	Age	Number of data categories
Tokyo	Application required	Current land-use maps	2006, 2012, 2021	30 types
Paris	Open	CLMS	2018, 2020	17 type
Netherlands	Open	BAG	2010, 2015, 2017	38 type
Denmark	Free registration required	BBR	None	105 type
Finland	Open	NLS	None	40 type
Sweden	Partially free	Topographic Building Dataset	None	18 type

Table 3. Country Data Comparison

RESULTS

Calculation of Indices

Because the data for each indicator did not meet the assumption of a normal distribution, we used the median as the representative value in the analysis. Table4 shows the annual changes in the median values of the indicators, which were tested using the Kruskal–Wallis test followed by Dunn's multiple comparison. Richness did not show significant differences in the Kruskal–Wallis test ($p = 0.586$), and Dunn's test also revealed no significant differences between years ($p > 0.33$). This lack of significance may be because the mean values for each year changed very little, as also shown in Figure 2. In contrast, evenness, division, continuity, and PAC showed significant differences in the Kruskal–Wallis test ($p < 0.001$), with Dunn's test indicating particularly significant differences between 2006 and 2011, and between 2006 and 2021. In this research, when analyzing temporal changes, we focused not on the magnitude of changes between years, but on the presence of statistically significant differences and the direction of change. This is because focusing solely on the absolute differences could lead to overemphasizing variations that are not statistically meaningful or simply reflect differences in value magnitude.

Indicator	Test	Comparison	Statistic (χ^2 or Z)	p_value
Richness	Kruskal-Wallis	Entirety	1.069	0.586
	Dunn	2006-2011	0.185	0.853
		2006-2021	0.965	1.000
		2011-2021	0.772	0.661
Evenness	Kruskal-Wallis	Entirety	19.306	0.000
	Dunn	2006-2011	2.493	0.019
		2006-2021	4.387	0.000
		2011-2021	1.787	0.074
Division	Kruskal-Wallis	Entirety	23.140	0.000
	Dunn	2006-2011	2.786	0.008
		2006-2021	4.798	0.000
		2011-2021	1.893	0.058
Continuity	Kruskal-Wallis	Entirety	26.070	0.000
	Dunn	2006-2011	4.163	0.000
		2006-2021	4.689	0.000
		2011-2021	0.351	0.726
PAC	Kruskal-Wallis	Entirety	-2.573	0.015
	Dunn	2006-2011	-3.793	0.015
		2006-2021	1.111	0.000
		2011-2021	-1.111	0.267

Table 4. Median Test Results

Tokyo

Figure 2 presents the temporal changes of each indicator for Tokyo's 23 wards. The axes of all indicators except richness are standardized to the maximum and minimum values for Tokyo's 23 wards. We observed the following trends:

- Regarding the indicators measuring "land-use diversity", **richness**, representing the number of land-use types, has not changed, while **evenness** has decreased. This indicates that although the variety of land-use types has remained stable, the distribution of area and facilities has become increasingly uneven.

• For the indicators representing "the impact of specific uses", **division** has decreased and **continuity has** increased, suggesting a trend toward the consolidation of dispersed land uses. The land use that occupies the largest proportion of the mesh units is roads, and this share has increased over time.

Based on these results, the overall trend for Tokyo's 23 wards indicates that ground-level land-use diversity has become increasingly uneven, with certain uses becoming concentrated, shaping the city into an urban form where similar land uses are experienced continuously while walking.

We did not observe a similar trend in the seven Special Districts. We focus on the areas around Tokyo Station and Ikebukuro Station. Ikebukuro exhibits a similar trend to that of Tokyo's 23 wards, showing a bias in land-use distribution and a tendency toward concentration. In contrast, Tokyo Station displays an opposite trend to Tokyo's 23 wards, suggesting that it reflects a distinctive development pattern unique to Tokyo's urban transformation.

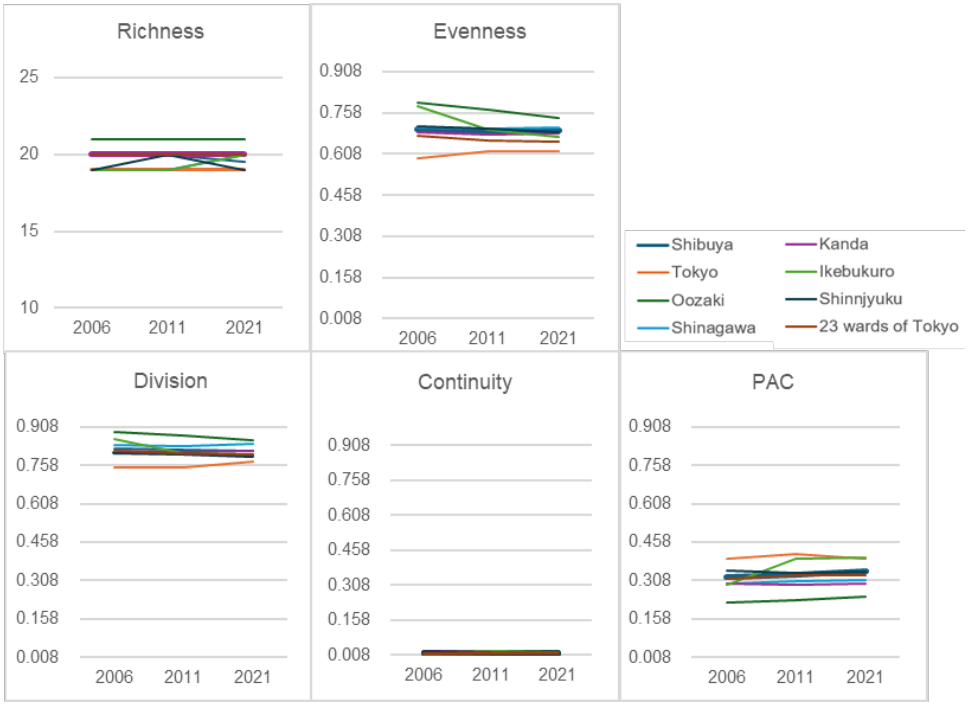


Figure 2. Change over time for Tokyo's 23 wards and seven Special Districts

Paris

The temporal changes of each indicator for the entire city of Paris are presented in Figure 3. All indicators except richness show trends opposite to those observed in Tokyo.

• For the indicators representing "land-use diversity", evenness have increased.

• For the indicators representing "the impact of specific uses", division has increased while continuity has decreased, indicating a shift toward an urban form where different land uses are interwoven. The land use occupying the largest proportion of mesh units is residential, and its share has decreased over time.

These results suggest that, at the city scale, land uses are more dispersed and mixed, creating streets where pedestrians experience a variety of land uses. The three ZAC development sites selected as targets did not exhibit the same trends. Given the short time span of the comparison, the changes were not drastic, but the Clichy-Batignolles district showed trends similar to those observed in Tokyo, whereas the Gare Saint-Lazare area reflected the overall trends for Paris.

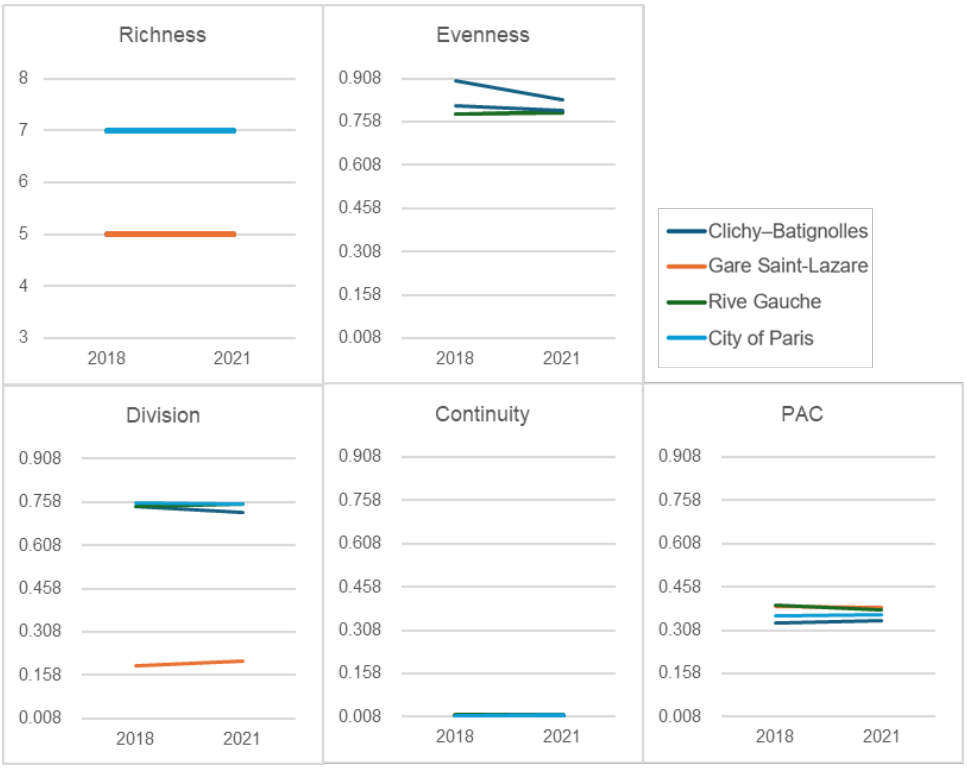


Figure 3. Median changes over time for the entire city of Paris and three ZAC districts

DISCUSSION

According to Christian et al.,[30] the system introduced in the United States in 1961, which relaxes floor area ratio regulations in lieu of public contributions, has been adopted in many countries including Japan, Hong Kong, and Thailand. The Special Districts in Tokyo embraces this system. While total floor area is efficiently maintained , ground-level uses tend to be biased toward roads or other uses required for FAR exemptions. Additionally, because development occurs individually for each block by private developers, nearby blocks may implement similar developments due to economic considerations, potentially resulting in lower diversity and biased land-use distribution at the ground level. In Europe, however, such provisions are fundamentally built into the system from the outset rather than being offered as incentives. In other words, while this study compared the impacts of Tokyo and Paris's systems, the results obtained can also be seen as illustrating a comparison between the American system and the European system.

The result shows, the institutional differences between the representative Special Districts in Tokyo and ZAC districts in Paris appear to produce clear distinctions in ground-level urban patterns, reflecting the contrasting urban development philosophies of the two cities. We found that Tokyo's 23 wards have exhibited a tendency for a decrease in ground-level "land-use diversity", whereas Paris has shown a trend for increased ground-level diversity. These findings support with our hypothesis.

Figure 4 presents scatter plots comparing all mesh units in Tokyo's 23 wards with those within the Special Districts, allowing us to discuss how the Special District meshes differ from those of the overall Tokyo area. The left-hand figure shows the 2006 scatter plot, where points closer to the upper right indicate areas with high values for both indicators, representing neighborhoods with high land-use diversity. Because richness has not changed, as shown in Figure 2, the right-hand figure uses the difference in evenness from 2006 to 2021 on the vertical axis. There is no particular concentration of

high diversity in the Special Districts: Richness remains around 20, while evenness decreases by approximately 0–0.1 in most meshes.

However, not all indicators followed the expected trends. In particular, richness, representing the number of land-use categories, has remained unchanged in either the Tokyo's 23 wards or Paris. This may be because, with a maximum of 27 land-use categories, a richness value of 20 maintained over 15 years is already near the upper limit for a large urban area. Still, Paris's data classification differs significantly from Tokyo's, being much coarser. This makes it difficult to reflect increases or decreases, potentially resulting in an apparent lack of change.

Besides,figure 5 illustrates development around Tokyo Station, which deviates from the general trends of Tokyo's 23 wards. This developments may influence surrounding land use and change in surrounding land use may have contributed to higher evaluations. The area is primarily an office district, so most buildings are classified as office buildings, making visual differences less apparent. Nevertheless, specific examples show functional diversity: the left building serves as a multipurpose hall promoting arts, culture, and international exchange, while another nearby building incorporates green space extensively, as discussed in the "Target" section.

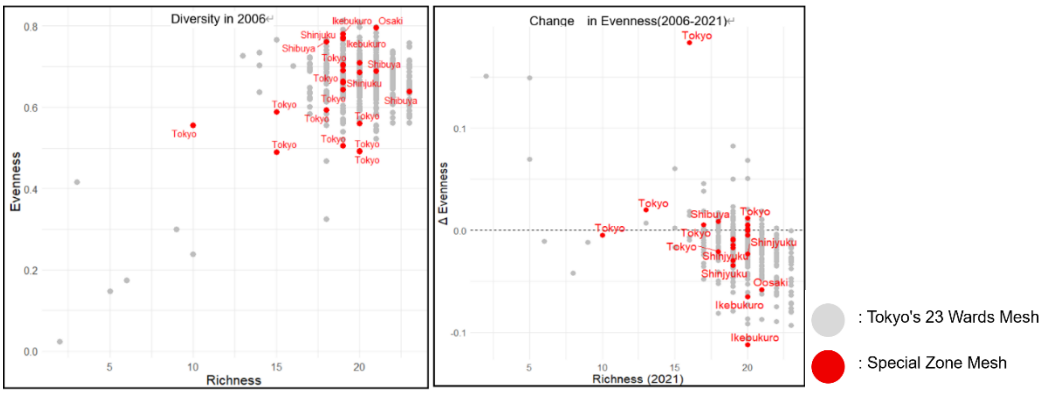


Figure 4. Transition in land-use diversity from 2006 to 2021



Figure 5. Cases of urban development around Tokyo Station

CONCLUSIONS

Over the past 20 years of policy implementation in Tokyo, large-block developments and high-intensity utilization have progressed. While the construction of landmark buildings contributes to the city's image, these developments have not necessarily been favorable from the perspective of ground-level land-use diversity. However, developments around Tokyo Station show positive trends in terms

of ground-level diversity. Buildings constructed under the Urban Regeneration Special Measures Act around Tokyo Station are symbolic landmarks within Tokyo and represent large-scale development projects. Consequently, it was anticipated that they might score low under this study's metrics. However, such developments also influence surrounding land use. In fact, the changes in surrounding land use may have contributed to higher evaluations. The Tokyo Station development serves as a model for promoting human-centered urban environments, offering lessons that can elevate diversity indicators not only in the developed block but also in surrounding areas. It could function as a model district for Japan's future urban planning. As target values for the indicators, Tokyo Station in 2021 exhibited richness of 19, evenness of 0.617, division of 0.771, continuity of 0.016, and PAC of 0.393. Similar trends observed in Tokyo's 23 wards may also be seen in other countries, suggesting that incorporating ground-level perspectives into urban development could enhance livability in other Asian cities like Tokyo that have adopted volume relaxation policies. In the event of future integrated development projects, it would be beneficial to implement the design philosophy of prioritizing ground-floor use guidance and public spaces through district planning and area management.

For future research, the current land-use classification does not capture detailed facility types. To obtain results that more accurately reflect reality, it would be beneficial to conduct quantitative analyses using facility point-data, allowing for a more precise assessment of ground-level diversity.

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Front cover image: Colin Lloyd

La Salle - Universitat Ramon Llull

16-18 July, 2025

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