

BEYOND ALL LIMITS CONFERENCE 2025

3rd International Conference on Sustainability
in Architecture, Planning, and Design

Proceedings Book of Papers



ÇANKAYA UNIVERSITY



Università
degli Studi
della Campania
Luigi Vanvitelli



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Universiteti

October
16-17
Ankara, Türkiye

Proceedings Book of Papers

BEYOND ALL LIMITS / 2025

3rd International Conference on Sustainability
in Architecture, Planning, and Design

ÇANKAYA UNIVERSITY
MAIN CAMPUS

October 16-17, 2025



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Cover Design: Dr. Çetin TÜNGER

Printed in: October 2025
Printed by: Çankaya University

e-ISBN: 978-975-6734-23-0

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Wilde, Professor of Energy and Building Design at Lund University (Sweden), recognized internationally for his expertise in building performance modelling and simulation.

This Proceedings Book compiles the written contributions presented at the conference, including both peer-reviewed papers and keynote addresses. All authors submitted papers (ranging between 1500 and 3000 words), which were blind peer-reviewed by the Scientific Committee to ensure academic rigor and quality. The accepted papers published herein represent a diverse and inspiring collection of ideas that reflect the conference's central aim to go *beyond all limits* in reimagining sustainability for the built environment.

On behalf of the Conference Organization Committee, we would like to express our deepest gratitude to all members of Çankaya University, Università degli Studi della Campania “Luigi Vanvitelli”, Lund University, and Azerbaijan Technical University for their invaluable contributions, dedication, and collaborative spirit in organizing this international event.

We would also like to extend our sincere appreciation to all authors, speakers, reviewers, and participants for sharing their research, insights, and visions. Your active participation and commitment to advancing sustainable design and planning make this conference a vibrant and meaningful academic platform.

We wish you all a productive and inspiring conference experience, filled with fruitful discussions, new collaborations, and lasting connections.

Conference Organization Committee

*BEYOND ALL LIMITS 2025 – 3rd International Conference on Sustainability in
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**PERCEPTION, EMOTION, AND BEHAVIOR IN IN-BETWEEN
SPACES: A NEUROARCHITECTURAL APPROACH TO CLIMATE
NEUTRALITY**

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Perception, Emotion, and Behavior in In-Between Spaces: A Neuroarchitectural Approach to Climate Neutrality

Abstract: The paper investigates how architectural and spatial design can influence perception, cognition, and emotion, thereby shaping sustainable behavior. The study examines how in-between spaces—transitional, and often overlooked environments, such as courtyards, atria, plazas, pocket parks, and pedestrian streets—can act as catalysts of pro-environmental action. Drawing on advances in neuroscience, environmental psychology, and environmental technological design, a conceptual framework links spatial features, multisensory perception, neural activation, affective states, and behavioral outcomes. In-between spaces are shown to function as cognitive and emotional interfaces that enhance social interaction, biophilic engagement, and behavioral nudging toward practices such as active mobility, recycling, resource sharing, and reduced energy use. The paper argues that sustainability should be understood not only as a technical or ecological objective, but as a lived and perceptual phenomenon embedded in everyday spatial experience. Ultimately, in-between spaces emerge as strategic thresholds for fostering resilience, well-being, and climate-conscious urban life.

Keywords: in-between spaces; sustainability; neuroarchitecture; climate neutrality; behavioral nudge

Introduction

In-between spaces occupy a strategic role in the transition of cities toward climate neutrality. Often conceptualized as liminal voids, absences, or thresholds between built forms (Piccinno & Lega, 2013), they constitute fertile grounds for experimentation with sustainable urban futures (Rahmann & Jonas, 2011; Tucci, 2018). Despite their frequent neglect, these spaces mediate everyday life, influence microclimatic regulation and foster social and spatial connectivity. Through environmental technological design, they can enhance environmental quality, regulate urban dynamics, improve safety and usability, and, in advanced scenarios, promote circular resource management (Tucci et al., 2021).

Evidence from suburban regeneration projects shows that attention to public and shared spaces generates systemic improvements at the district scale (Tucci et al., 2021). Such outcomes highlight the significance of relationships between buildings and common spaces, advancing health, well-being, and social equity. Emerging models such as decentralized energy systems (Bögel et al., 2021) and the “15-minute city” (Moreno et al., 2021) reinforce the role of proximity and functional diversity in shaping sustainable lifestyles.

Urban form conditions both bioclimatic performance and residents’ behaviors, which are mediated by sensory perception and emotional engagement. For example, integrating cycle paths, pedestrian corridors, and local services increase walkability and equitable mobility options, accommodating diverse needs across age and health profiles (Lee & Buchner, 2008; Gehl, 2011; Weng et al., 2019).

Certification systems such as LEED and BREEAM focus on environmental metrics, while TODS emphasizes mobility, and WELL prioritizes user well-being. In parallel, neighbourhood-scale frameworks, such as Green and Thriving Neighbourhoods (C40 & Arup, 2021), advance climate-neutral urban design.

In this context, in-between spaces emerge as connective infrastructures mediating interactions among users, functions, and technologies, thereby contributing to systemic decarbonization strategies and enhancing urban resilience (Angelucci, 2023; Andaloro et al., 2022). Their adaptability, combined with responsive technologies and flexible architectural forms, allows them to actively interact with changing environmental conditions.

Designing accessible and inclusive public spaces can support active mobility, counter sedentary lifestyles, and foster public health goals (WHO, 2017). Moreover, embodied practices such as Tai Chi Chuan and Yoga—known to modulate prefrontal and limbic activation, reduce stress, and enhance interoceptive awareness (Tang et al., 2015; Fox et al., 2016)—illustrate how spatial and bodily perception can reinforce emotional regulation and prosocial orientations. Incorporating opportunities for such practices into in-between spaces may further strengthen their restorative and pro-sustainability impact.

This contribution aims to investigate how in-between spaces can be strategically designed to foster sustainability not only as a technical performance but as a lived and perceived experience. Through a combination of theoretical grounding, case study analysis, and design strategies, integrating neuroarchitecture and environmental psychology features, the paper seeks to demonstrate how in-between spaces can act as active agents of behavioral change, supporting decarbonization, resilience, and social well-being in urban environments.

Spatial perception and behavioral nudging

From the environmental psychology perspective, space functions as a medium that affords action, physical environments can communicate possibilities for behavior (Gibson, 1979). In terms of sustainability, spaces may be designed to afford pro-environmental actions such as walking or recycling. Thus behavioral nudging—the use of subtle cues that guide decision-making without constraining freedom of choice—has emerged as a central strategy for promoting sustainable practices (Thaler & Sunstein, 2008).

Architectural and urban design interventions can make sustainable choices more intuitive, effortless, and socially desirable. Examples include the placement of an inviting, naturally lit staircase in a central lobby to promote active mobility, or the positioning of recycling bins in highly visible courtyards and plazas to encourage proper waste separation.

Similarly, shaded walkways, tree-lined seating areas, and public water-refill stations can encourage walking, lingering outdoors, and reducing single-use plastics. These interventions rely on perceptual salience and affective responses: environments that are attractive, comfortable, or socially engaging shape cognitive appraisal and increase the likelihood of sustainable habits.

From a neuroarchitectural perspective, transitional spaces can be chosen not only to accommodate but to actively foster pro-environmental behavior. Neuroarchitecture emphasizes that the brain response to build environments is neither neutral nor passive. Spatial qualities—form, materiality, lighting, and acoustics—elicit measurable neural activity that influences mood, attention, stress, and behavior. Key brain regions involved include the prefrontal cortex (executive function, decision-making), the insula (interoceptive and emotional awareness), and the limbic system (emotion and memory regulation) (Coburn et al., 2020; Edelstein & Macagno, 2012). Research also demonstrates that environmental features such as daylight, greenery, openness, and coherent visual patterns reliably activate positive affect and cognitive engagement (Kaplan & Kaplan, 1989).

To conceptualize these processes in relation to sustainability, a five-stage framework can be proposed. First, Spatial Features of in-between spaces—configuration, materials, natural light, vegetation, acoustic quality—establish the physical affordances of place (Higuera-Trujillo et al., 2021; Han et al., 2025). These features shape Multisensory Perception, where visual, acoustic, thermal, tactile, and olfactory stimuli are integrated into a holistic spatial experience (Djerrbbara et al., 2022). The Neural Activation is triggered, engaging regions linked to attention (prefrontal cortex), interoception (insula), emotional salience (amygdala), and contextual memory (hippocampus) (Vecchiato et al., 2015). This activation produces an Affective State characterized by comfort, safety, social connection, or aesthetic pleasure, which are critical for psychological well-being (Gehl, 2011; Qu & Ma, 2024). Finally, these affective states manifest as Behavioral Outcomes, expressed in social interaction, cooperation, and sustainable actions such as recycling, energy conservation, active mobility, or resource management (Han et al., 2025).

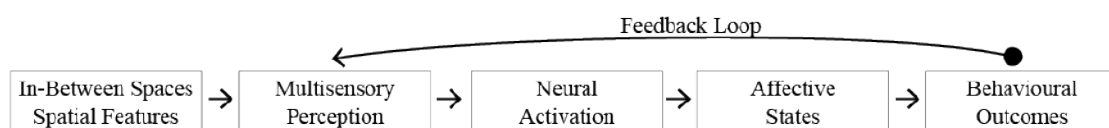


Figure 1. The five-stage process that exemplify the connection between spatial features and behavioral outcomes.

This model highlights that sustainability is not merely the result of design decisions or policies but is also perceived, felt, and enacted through everyday encounters with space. The design of in-between spaces thus extends beyond aesthetics and functionality, relying instead on empirically supported pathways linking spatial features to perception, neural activation, affect and behavior. Evaluation of these dynamics may combine subjective measures (e.g., surveys on comfort and perception) with objective indicators (e.g., behavioral patterns, space utilization), offering an evidence-based framework for shaping resilient and sustainable urban communities.

Defining In-between spaces

In social geography, the “betweenness of space” refers to the quality of places as contexts in which human action unfolds, positioned at the boundary between objective and subjective realities, framing in-between spaces as mediators between dual poles—Being and Staying—emphasizing their role as thresholds of experience (Entrikin, 1991).

Because of their transitional character, in-between spaces are particularly fitted to behavioral nudging: interrupting routine movement and providing moments of pause and sensory reflection, they create opportunities for intentional, sustainable action that may not arise in more static environments.

In-between spaces, for their transitory and transformative qualities, are resistant to fixed classification within binary logics (Carmona, 2010). Accordingly, they can be systematized through different approaches. For instance, they may be categorized according to their predominant dimension—design, socio-cultural, ownership, or climatic—or by their spatial relationship within the urban fabric: in-between spaces directly related to buildings, whether internal or external, often semi-public or private, such as courtyards, gardens, and shared residential areas; spaces between buildings, hosting a wide range of essential and optional urban activities, including streets, squares, parks, and residual voids. At a larger scale, networks of in-between spaces can be conceived as synergistic systems of interconnected typologies that collectively structure urban life (Tucci et al., 2023).

These spaces frequently accommodate hybrid functions—circulation, encounter, rest, or transition (Ghel, 2011). Their physical attributes, including enclosure, visibility, accessibility, and sensory qualities, vary widely yet consistently enable multisensory engagement and social affordance, making them dynamic environments strategically designed to support interaction, reflection, and sustainable practices.

A Holistic Design for In-between Spaces

Designing in-between spaces as catalysts for behavioral change requires strategies that integrate green and blue infrastructure, enhance functional proximity, and support circular and sharing economies.

Nature-based strategies, such as the enhancement of vegetation, water and soil, improve microclimatic comfort, enhance CO₂ absorption, foster biodiversity, and strengthen neighbourhood resilience to extreme events. Embedding green and blue networks across multiple scales—from building courtyards to metropolitan parks—and ensuring access to natural areas promotes both physical and psychological well-being.

Strategies of proximity emphasize functional and social diversity, sustainable mobility, and urban vitality, reinforcing belonging, safety, inclusivity and equity while supporting healthier lifestyles. Mixed-use development, where essential destinations are within walking or cycling distance, fosters active mobility. Public spaces with active frontages, well-lit pathways, bike lanes, and recreation areas promote safety, livability, and social cohesion. Spatial rhythms, sightlines, and sensory gradients (light, sound, texture) can modulate attention, encourage exploration, and ensure accessibility for all users, regardless of age or ability.

Several international projects illustrate the transformative potential of in-between spaces.

The skyscraper CapitaSpring (BIG and CRA, 2021), Singapore, hosts a Green Oasis that mimics tropical rainforests. The green buffer is extended across four central floors, connected by a spiral walkway, and offers a variety of spaces for work, relaxation, exercise or events. Together with the roof garden guarantees a 1:1,4 ratio of ground surface/green areas, providing tenants and residents with abundant access to green spaces.

Tainan Spring (MVRDV, 2020) is a virtuous reuse of an abandoned shopping centre in the city centre of Singapore into a urban lagoon, that connect city and nature through large planting areas, providing multiple layers of vegetation, according to the active street frontage. During hot periods, nebulizers improve microclimate condition with a positive impact both on the heat island phenomenon and on the reduction of air conditioning use.

The Central Park of Taichung (Rahm Architects, 2020), Taiwan, was realized on an abandoned airport and designed according to the specific climate to offer cooler, drier, and less polluted places, encouraging outdoor activities. The park acts as retention basins, preventing flooding. Walkers can choose paths on their smartphone, thanks to a real-time map of climatic variations, measured through heat, humidity, and air pollution sensors. At night lighting is

dimmed to preserve the circadian biological cycles of animals. The photovoltaic canopies produce all the energy used in the park, which is thus totally carbon neutral.

Park'n'Play (JAJA Architects, 2016) is a parking house in Copenhagen with a vibrant rooftop, equipped with a playground and spaces for physical exercise. Incorporating playful elements in the building and in the plaza nearby, make them more engaging and inviting for physical activity. Similarly, in Karen Blixen Plads (Cobe, 2019) the domes offer shelter for an hypogeal bike parkings and on top stages or community places, connecting the plaza to the natural area nearby.

Using a repeatable approach to sustainable urban development, One Green Mile (MVRDV, 2022) transforms the space beneath the flyover concrete structure of one of the major roads of Mumbai, into a safe pedestrian insula with amenities and greenery. The sinuous blue stripes create a cohesive visual identity across all elements of the space and a strong visual identity, making it a new benchmark for underused space. On the other side, in Seoul, Seoulllo 7017 converts the former highway into a skygarden that connect the city to nature (MVRDV, 2017).

These cases highlight how reimagining in-between spaces can expand ecological performance, promote active mobility, and foster inclusive urban life. By strategically repurposed neglected or residual sites, cities can transform structural voids into vibrant hubs that simultaneously advance sustainability, resilience, and collective well-being.

Conclusion

As sustainability challenges intensify, design must expand its focus from technical efficiency to lived experience. In-between spaces hold significant potential to foster sustainability through perception, affect, and behavior. Informed by neuroarchitecture and environmental psychology, these thresholds can be reframed as perceptually rich environments that prime individuals for pro-environmental action.

Well-designed neighborhoods exemplify this shift by repurposing underutilized areas, encouraging active lifestyles, and promoting engagement through participatory and collaborative initiatives. Within this framework, circular and sharing strategies, supported by behavioral nudges, enable practices such as waste reduction, resource recovery, and energy self-sufficiency.

Despite methodological challenges—such as measuring neural responses in dynamic contexts and accounting for cultural heterogeneity—the implications are substantial. For urban

planning, it suggests a transition from infrastructure-centred paradigms to user-centred and perception-based approaches. For architecture, it calls for design strategies that integrate sensory richness, inclusivity, and ecological performance. For policymakers and communities, it underscores the importance of fostering environments where sustainability is not an abstract goal but a distributed, tangible, and lived experience.

Ultimately, sustainability should not only be encoded in buildings as technical performance indicators but also embedded in the experiential logic of space. Transitional environments are catalysts of awareness, social connection, and sustainable action. Applying the lens of neuroarchitecture to in-between spaces provides a powerful paradigm shift: rethinking “the spaces between” as generators of well-being, relationality, and ecological responsibility.

Acknowledgments

The research is part of the project entitled: “In-between spaces and climate neutrality: identification, analysis, and development of indicators for the qualitative-quantitative assessment of the contribution to CO₂ emission reduction deriving from design strategies adopted in urban in-between spaces”, P.I.: arch. Ph.D. Maria Michaela Pani, Supervisor: Prof. Fabrizio Tucci.

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