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Living labs as 'agents for change'

NICOLA ANTAKI

DOINA PETRESCU

VERA MARIN

*Author affiliations can be found in the back matter of this article

CORRESPONDING AUTHOR:
Nicola Antaki

Laboratoire Espaces
Transformations (UMR Lavue,
CNRS 7218), Ecole Nationale
Supérieure d'Architecture, Paris
La Villette, Paris, FR

nicantaki@gmail.com

HIGHLIGHTS

This special issue develops understandings of how living labs (LLs) build capacity among stakeholders, reshape spaces, and influence governance to support civic resilience and ecological transition. It highlights the role of LLs in empowering new and existing actors, mediating between diverse stakeholders, and fostering bottom-up agency for change. While many spatial LLs focus on urban contexts, this special issue calls for more iterations in the Global South, rural areas and practitioner-led initiatives. LLs can lay the social, institutional and material groundwork for future change in the built environment. This special issue underscores LLs' contribution to governance innovation, particularly through quadruple helix engagement that brings together public authorities, industry, academia and civil society. By catalysing policy learning and multi-actor coordination, LLs can influence how transitions are organised and implemented. As interest in LLs grows, the special issue argues for embracing conceptual diversity and reframing LLs not merely as methodological tools but as forms of social and civic infrastructure. Their transformative potential, however, depends on sustained funding, long-term commitment, inclusive practices, mediation ecologies and attention to power dynamics. Without these conditions, LLs risk reinforcing inequalities or remaining limited to short-term, unscalable projects. Policy frameworks are called for that prioritise learning and scaling up, and that research approaches remain accountable to the uneven, long-term nature of socio-ecological transitions.

1. CONTEXT

This special issue positions living labs (LLs) as 'agents of change'. 'Change' is understood in relation with the processes of ecological transition, the shift to more sustainable modes of production and consumption (Markard *et al.* 2012), and resilience, communities' capacity to thrive amid uncertainty (Brown *et al.* 2012), shifting from socio-ecological systems (Walker *et al.* 2004) towards empowered social resilience (MacKinnon & Derickson 2013).

What might a deeper understanding of the notion of LL be in relation to their capacity to support the transition?

The special issue focuses on LLs in relation to practices of civic resilience that can be described as the ability of (groups/networks of) residents to resist, adapt and transform their living environment in the face of socio-economic, political and climatic change, according to collectively held values and priorities. Civic resilience brings a civic dimension (one of taking part in and agency within community or governance) to the resilience discourse which introduces a dynamic perspective on change processes, addressed through subsequent notions such as 'adaptative capacity', 'transformation', 'transition' (Brown *et al.* 2012; Folke *et al.* 2010; Walker *et al.* 2004) and 'resourcefulness' (MacKinnon & Derickson 2013). It foregrounds aspects of community, citizenship and collective agency (Butterworth *et al.* 2022; Maharramli *et al.* 2021).

1.1 WHAT IS A LIVING LAB?

An LL is a real-world environment where research attends to innovation—of services or products—testing and co-developing with everyday participants in a collaborative setting. The first notion of the term 'living laboratory' has been traced to the field of operations research in the early 1990s, in Philadelphia (PA), US, where students were encouraged to engage with neighbourhood issues as a means of place-based learning (Bajgier *et al.* 1991). Then, in 1995, William J. Mitchell, from the MIT Media Lab and School of Architecture, developed the concept further in order to test information and communications technology in homes, neighbourhoods and cities (Mitchell 2003). The methodology then moved into business innovation (Nesti 2018), expanding into Europe in the early 2000s (Ståhlbröst *et al.* 2024). The method was recognised by the European Union (EU) as innovative, inclusive, and experimental governance and implementation frameworks that support innovation (Lupp *et al.* 2021) and institutionalised in the form of the European Network of Living Labs (ENoLL) in 2006, an international federation of LLs in Europe and world-wide that offers validation and certification.

Over the last two decades, the LL methodology has been strongly supported by EU policy as a way to 'integrate research and innovation processes in real life communities and settings' and encourage collaboration between a range of stakeholders towards innovation. Moreover, LLs have emerged across Europe as a central approach for research addressing ecological transition. They enable connections between researchers and citizens through collective action, supporting the identification of shared needs, the co-development of collaborative responses and the dissemination of methods for broader application (Puerari *et al.* 2018). LLs are also understood as mechanisms for strengthening citizens' capacity to participate in processes of change and for enhancing civic resilience (Rizzo *et al.* 2021; Petrescu *et al.* 2022).

Today numerous funding programmes encourage the involvement of various stakeholders in testing ideas and collaboration mechanisms in LL settings (Bulkeley *et al.* 2019). The frames for such LLs are not defined through academic research projects only. An LL can be initiated by collectives of practitioners looking for alternatives, civic organisations aware of the importance of collaboration or by the local public administration where the need for mediation is recognised. Moreover, the EU ambition through the Horizon 2020 Research and Innovation Programme (Climate Neutral and Smart Cities Mission) is placing high expectations on pilot cities to demonstrate results in cooperation with academia, local communities and private sector in helix collaborations for innovation.

The focus on bottom-up and top-down collaboration, in particular involving governments and municipalities in LLs, gained traction, evolving from the ENoLL idea of LLs through quadruple helix actors (government, industry, academia and civil society) (Nguyen & Marques 2022). Research into the relationship between municipalities and citizens, top-down and bottom-up, has continued to intensify over the last decade, and is exemplified by many of the papers in this issue, with a particular focus on the roles stakeholders play.

The scales and time frames of LLs and their associated networks are varied. Local small-scale labs may focus on a small number of people or a small site or issue. Multi-city or international labs may involve larger numbers of actors numbers with time frames ranging from months to many years. The networks might be existing or new, expanding or contracting.

The term 'living lab' is not necessarily spatial. This special issue includes a range of understandings of the term. As the concept has evolved, LLs have diversified and will continue to do so, hence the need for renewed assessment of the state of the art.

1.2 THE FOCUS OF THIS SPECIAL ISSUE

There is a gap in the current literature on LLs with particular regard to three critical questions. First, the understanding of how LLs can transform capacity—through learning, development of agency or behavioural change—is partial and requires some attention. Second, LLs often include site-situated spatial, material and ecological experimentation. There is an opportunity to update the state of the art of LLs in this area, with a particular focus on resilience questions. Finally, many LLs include action between multiple actors, including governing bodies with questions around top-down power dynamics. A deeper understanding of resilience governance and multi-actor coordination is needed. Addressing these questions will help practitioners and researchers develop the intention and capacity of LLs through their design, thereby enabling LLs to focus more clearly on the urgent polycrisis.

This special issue explores the overarching research question around LLs as agents of change: How do LLs increase civic resilience and support ecological transition? Subsequent questions arise from this start point:

- Given the proliferation of LLs as a contemporary research methodology that situates them at the threshold of action in the real world, what is their transformative capacity, in particular around enabling learning, developing agency and supporting behavioural change?

- LLs are often site-situated, attending to spatial questions at various scales. What is the state of the art of spatial and material LLs, with a particular focus on ecological questions and experimentation?

- How do LLs attend to governance and multi-actor coordination, with a particular focus on disrupting top-down and bottom-up power dynamics?

The call for papers attracted 60 abstracts, of which 22 full papers are published in this special issue, from different regions of Europe, Australia, Africa and Asia. The invited topic embraced a wide range of LL understandings and methods across different contexts, with interest in different topics such as:

- Analysis of practices and case studies.

- Tools, methods and methodologies.

- Definitions, theories and knowledge types.

- Roles, spaces and collaboration.

- Public policies and influence.

- Civic resilience and empowerment.

- Innovation and ecological transition.

- Research methodologies and critiques.

- Transformative research and learning.

The diversity of LLs more broadly is represented in this special issue through the papers and LLs having different goals, and some different names, including: energy living lab, urban room, urban living lab, real world experiment/reallabor, placemaking living lab, youth living lab, living knowledge lab, building technology lab, *etc.* Some LLs focus on the transformation of roles, spaces, capacities, governance or policy. Others focus on understanding or deepening relationships. Some LLs situate adjacent to existing long-term activities/organisations/ecologies; others catalyse new activities/ecologies (for the long term); and many encompass temporary/momentary investigation across new stakeholder ecologies. This diversity helps to create a clearer understanding of each typology's potential to address civic resilience and ecological transition.

2. CONTRIBUTIONS TO THIS SPECIAL ISSUE

All papers (Table 1) aim to show how LLs can be agents of change, in terms of changing transformative capacity, changing spaces or changing governance, across a wide variety of fields from health to grassroots civic action. Papers are grouped into three themes according to the main research questions.

Table 1: Articles in this special issue, 'Living Labs: Agents for Change', *Buildings & Cities* (2026), 7(1), guest editors Nicola Antaki, Doina Petrescu and Vera Marin.

AUTHORS	TITLE	DOI
N. Antaki, D. Petrescu & V. Marin	Living labs as 'agents for change' (Editorial)	https://doi.org/10.5334/bc.800
C.-C. Dobre & G. Faldi	Researchers' shifting roles in living labs for knowledge co-production	https://doi.org/10.5334/bc.622
H. Noller & A. Tarik	The importance of multi-roles and code-switching in living labs	https://doi.org/10.5334/bc.616
N. Antaki, D. Petrescu, M. Schalk, E. Brandao, D. Calciu & V. Marin	Mediation roles and ecologies within resilience-focused urban living labs	https://doi.org/10.5334/bc.608
Z. Li, M. Sunikka-Blank, R. Purohit & F. Samuel	Co-curation as civic practice in community engagement	https://doi.org/10.5334/bc.633
N. Charalambous, C. Panayi, C. Mady, T. Augustinčić & D. Berc	Youth engagement in urban living labs: tools, methods and pedagogies	https://doi.org/10.5334/bc.643
M. K. Barati & S. Bankaru-Swamy	A living lab approach to co-designing climate adaptation strategies	https://doi.org/10.5334/bc.626
A. Belfield	Co-learning in living labs: nurturing civic agency and resilience	https://doi.org/10.5334/bc.631
M. Dodd, N. Madabhushi & R. Lees	Placemaking living lab: creating resilient social and spatial infrastructure	https://doi.org/10.5334/bc.634
E. Akbil & C. Butterworth	Urban rooms and the expanded ecology of urban living labs	https://doi.org/10.5334/bc.607
T. Ahmed, I. Delsante & L. Migliavacca	Expanding the framework of urban living labs using grassroots methods	https://doi.org/10.5334/bc.632
J. M. Müller	Living labs: a systematic review of success parameters and outcomes	https://doi.org/10.5334/bc.624
J. Honsa, A. Versele, T. Van de Kerckhove, & C. Piccardo	Circularity at the neighbourhood scale: co-creative living lab lessons	https://doi.org/10.5334/bc.627
P. Palo, M. Adelfio, J. Lundin & E. Brandão	Urban living labs: relationality between institutions and local circularity	https://doi.org/10.5334/bc.629
A. Apostu & M. Drăghici	A public theatre as a living lab to create resilience	https://doi.org/10.5334/bc.623
O. Sloan Wood, E. Lupenza, D. M. Agnello, J. B. Knudsen, M. Msellem, K. L. Schiøler & F. Saleh	Co-creating interventions to prevent mosquito-borne disease transmission in hospitals	https://doi.org/10.5334/bc.636
J. Clossick, T. Khonsari & U. Steven	Living labs: epistemic modelling, temporariness and land value	https://doi.org/10.5334/bc.645
J. L. Fernández-Pacheco Sáez, I. Rasskin-Gutman, N. Martín-Bermúdez & A. Pérez-del-Campo	Living knowledge labs: creating community and inclusive nature-based solutions	https://doi.org/10.5334/bc.647
D. Ricci, C. Leiwakabessy, S. van Wieringen, P. de Koning & T. Konstantinou	Co-creating justice in housing energy transitions through local living labs	https://doi.org/10.5334/bc.591
E. Alatalo, M. Laine, & M. Kyrönviita	Increasing civic resilience in urban living labs: city authorities' roles	https://doi.org/10.5334/bc.610
E. Malakhatka, O. Shafqat, A. Sandoff & L. Thuvander	Positive energy districts and energy communities: how living labs create value	https://doi.org/10.5334/bc.630
P. Heger, C. Bieber, M. Hendawy & A. Shooshtari	Co-creating urban transformation: a stakeholder analysis for Germany's heat transition	https://doi.org/10.5334/bc.613
J. Hugo & M. Farhadian	Living laboratories and building testing labs: enabling climate change adaptation	https://doi.org/10.5334/bc.584

2.1 CAPACITY TRANSFORMATION: LEARNING, AGENCY AND BEHAVIOURAL CHANGE

Several papers offer new insights into the transformative capacities of LLs. Some of these focus on reconfiguring actor roles or identities, finding that actors who have dual and multiple roles are central to LLs, and that more is to be done to acknowledge the importance of mediation as a crucial LL methodology.

Dobre & Faldi explore researchers navigating shifting roles, conflicting institutional expectations and the pressures of co-production in two LLs focused on flooding in Brussels, Belgium. They highlight the tensions that arise when researchers must balance academic demands with facilitation, mediation and collaborative work inside LL environments, proposing the capacity transformation of researchers through 'hybrid roles' and reflection.

Noller & Tarik's conceptual–empirical reflection on two German LLs examines how LL practitioners navigate multiple professional roles and shift communicative registers ('code-switching') when working with diverse stakeholders. They call for 'institutional strengthening' to support mediation processes and 'translational labour' as currently invisible and unacknowledged work that reproduces inequalities.

Antaki *et al.* examine four European LLs to analyse how ecologies of mediation enable civic resilience in ecological transition contexts. The labs function as 'mediation ecologies' that connect fragmented actors, redistribute resources and sustain collective action through reciprocal learning. Identifying mediation types, roles and obstructions, the authors show how LLs can help build negotiation capacity and 'resourcefulness' and empower smaller, less connected actors.

LLs have also been investigated as enabling emergent civic and community capacities in two papers, both proposing LLs as a sustainable embedded infrastructure with political potential.

Li *et al.* analyse an urban room LL in Cambridge, UK, where 'co-curation' is used to nurture civic agency, shared imaginaries and participatory engagement, reshaping relationships between residents, cultural practitioners and municipal actors. They identify a 'co-curation' framework for urban rooms and LLs to function as transformative infrastructures.

Charalambous *et al.* explore five youth LLs in embedded European cities, exploring how structured co-creation processes enable young people to develop civic voice, political awareness and collaborative capacity. They propose a model for embedding youth LLs within higher education and governing systems as spaces that mediate between young citizens, educators and institutions.

Barati & Bankaru-Swamy attend to LLs' capacity to transform behaviour, mindset and normative change. They examine a participatory modelling LL in rural India, where farmers, researchers and facilitators co-design climate-adaptation strategies. The authors show how experiential learning and shared modelling processes redistribute decision-making power, integrate local ecological knowledge, and support behavioural and institutional change in agricultural climate adaptation.

The transformative capacities of LLs is also researched by addressing the roles of co-design, co-production and collective learning practices by Belfield and Dodd *et al.* Both studies function at different network scales: one focuses on a neighbourhood embedded network, the other works across neighbourhoods and attends to wider governance. The former examines a neighbourhood-based urban LL in the UK that nurtures citizen civic agency through long-term co-design work, participatory workshops and collaborative placemaking. It shows how an LL can catalyse new roles/initiatives by providing a structure for community members to gain confidence, voice and organisational capacity, in particular through 'hosting' in the space. The latter analyses placemaking as an LL practice for community-led disaster resilience in Australia. Co-design as a place-making methodology is shown to enable adaptability in terms of improving civic resilience, an alternative to top-down post-disaster reconstruction. In both cases, the LL creates empowerment through co-design, disrupting the bottom-up and top-down binary highlighting the importance of space in creating collective agency.

The transformative capacities of LLs are also investigated through the lens of pedagogies, learning frameworks and knowledge infrastructures. Akbil & Butterworth explore the Live Works urban room in Sheffield, UK, comparing it with the LL framework. They find the urban room is complementary to

LLs as a long-term spatial infrastructure of mediation and of 'productive uncertainty', a relational spatial ecology for public engagement that supports dialogue, experimentation, situated learning and shared interpretation with marginalised groups.

Learning and pedagogy is further explored through Ahmed *et al.*, who draw on the co-production of the Commoning Kirklees toolkit in West Yorkshire, UK. The authors show how LLs can be informed by activist knowledge, redistribute authorship and sustain collective agency beyond institutional partnerships.

A systematic review of the LL literature is presented by Müller, identifying how efficacy, outcomes, and success are conceptualised and measured. The synthesis of evaluation parameters across diverse LL types highlights gaps in how learning, agency, governance and long-term impacts are assessed, and proposes directions for more robust LL evaluation frameworks.

Collectively, these papers show that LLs can generate capacity transformation through civic agency and meaning-making. Civic agency is not a predefined outcome, but an emergent capacity built through participation over time. LLs can create productive spaces of uncertainty, catalysing new or attending to existing activities and networks of stakeholders. The potential for capacity-building is broad: citizens, governments, municipalities, and organisations can all benefit from a space for experimentation and debate.

It is apparent that bottom-up initiatives (such as Commoning Kirklees and R-Urban) are powerful in cultivating agency and imagination as well as alternative pathways. However, the question arises whether alternative pathways can be created without support that allows continuity or longer term demonstrations.

It is also evident that multi-actor collaboration does not self-organise. Instead, it requires continuous mediation: Antaki *et al.* develop a mediation framework encompassing strategise, catalyse, support, sustain and negotiate; Akbil & Butterworth theorise mediation in urban rooms as hybrid interfaces sustaining epistemic pluralism amid institutional tensions; and Dobre & Faldi highlight researcher role-shifts in co-production, legitimising reflexivity to navigate power dynamics.

2.2 CHANGING SPACE: SITUATED SPATIAL, MATERIAL AND ECOLOGICAL EXPERIMENTATION

A second group of papers offers insights into the role of LLs as built, material, ecological spaces that contribute to addressing urgent ecological questions in neighbourhoods and wider territories.

Several papers focus on territorial and spatial infrastructures of LLs. Honsa *et al.* analyse neighbourhood-scale circularity LLs in the region of Flanders, Belgium, highlighting the role of institutional arrangements, community participation, situated knowledge and multi-actor collaboration in enabling or constraining circular practices at the neighbourhood level.

With a further focus on spatial transformation, Palo *et al.* examine Fixoteket, a case study of a reuse and repair centre in Gothenburg, Sweden. Their analysis shows institutionalisation altered roles, relationships and circular practices, and how they might be 'reactivated' as an LL by grounding 'circularity in local vocabularies and networks'.

Apostu & Drăghici investigate a resilience LL situated at the Masca Theatre in Bucharest, Romania. Provided evidence shows how artistic practices, co-creation processes and institutional partnerships enable policy change, civic engagement and adaptive reuse of cultural infrastructure. The theatre acts as a mediator between communities, public authorities, resilience and urban transition agendas.

Sloan Wood *et al.* present an LL process conducted in hospitals across Zanzibar, Tanzania, where researchers, clinicians and health workers collaboratively design interventions to reduce mosquito-borne disease transmission. Through co-creation workshops, prototyping and environmental analysis, the LL generates spatial, behavioural and ecological insights for improving hospital-based vector control.

Clossick *et al.* explore two long-term LLs in London, UK. They identify temporary architectural interventions as 'epistemic artefacts', tools for learning and thinking—and architecture's ability to informally critique urban situations and land value.

Four papers attend to existing spaces, either focusing on new potential activity (Masca, theatre; Apostu & Drăghici), analysing socio-spatial relationships (Fixoteket; Palo *et al.*), co-designing improvements (Sloan Wood *et al.*); or inserting new interventions in the urban realm (Clossick *et al.*). These papers make clear that spatial LLs can facilitate new spatial configurations or physical artefacts, support situated knowledge and relationships, or enable analysis of existing social activity.

Fernández-Pacheco Sáez *et al.* consider ecological and environmental embeddedness. They analyse a 'living knowledge lab' on decentralised composting in rural municipalities in Spain that aims to co-create inclusive nature-based solutions (NbS) in low-density contexts. An analysis of composting behaviour reveals the motivations and barriers at structural, collective and individual levels highlighting how situated social–ecological experimentation refines the LL approach.

Collectively, this group of papers shows that space, materiality and ecology are active, productive agents in LL dynamics. Each paper shows that spatial and material conditions actively shape the participation in and outcomes of LLs. As such, spatial configurations (Clossick *et al.*; Apostu & Drăghici), material arrangements (Sloan Wood *et al.*; Palo *et al.*; Honsa *et al.*) and ecological systems (Fernández-Pacheco Sáez *et al.*) are not neutral settings for participation, but they shape who can engage, how experimentation unfolds and what forms of action become possible or constrained.

Participation is also shown to depend on access to specific spaces (buildings, neighbourhoods, landscapes), tools, resources and environmental conditions. Spatial layouts, ownership and material affordances actively influence inclusion, exclusion and power relations. LLs can be located in different and somewhat unexpected institutions (*i.e.* a theatre, Apostu & Drăghici; a hospital, Sloan Wood *et al.*; or rural city halls, Fernández-Pacheco Sáez *et al.*).

LLs not only operate within space but also actively transform it through incremental, emergent processes of occupation, adaptation and care, rather than singular design interventions. As Apostu & Drăghici demonstrate, public theatres such as Masca emerge as resilience hubs via volatile partnerships and imaginative reworking of cultural spaces. Similarly, Honsa *et al.* and Palo *et al.* reveal neighbourhood-scale circularity labs incrementally reshaping material flows and institutional logics through situated repair/reuse practices. This processual spatial agency underscores LLs' transformative potential beyond planned outcomes.

2.3 CHANGING GOVERNANCE: INSTITUTIONS AND MULTI-ACTOR COORDINATION

One research gap identified the need for a deeper understanding of governance and multi-actor coordination in the co-creation processes of socio-ecological or resilient urban transformation. Responding to this gap, a group of papers examine the mediation and coordination role LLs have in relation to different institutions and the governance of urban transformation processes.

Ricci *et al.* show how energy LLs in four Dutch cities enable residents, housing providers and energy agencies to create 'socially embedded retrofit and energy transitions'. LLs have the potential to enable energy justice within institutional processes by linking this to everyday situated knowledge.

Alatalo *et al.* examine an LL in Finland. Foregrounding the involvement of local authorities, they argue that governance structures can act as hosts and guides of transition. This is achieved through a process of participating in, shaping and evolving the local authority through civic resilience LLs that encourage bottom-up citizen involvement.

Governance and multi-actor coordination is further explored by Malakhatka *et al.* Comparing six European cases, they challenge the framing of LLs as universally replicable pilots, revealing them as situated co-produced spaces of transition. They show value as embedded infrastructures that mediate between niche innovation and regime change. This underscores the need to institutionalise learning and long-term governance capacity.

Heger *et al.* analyse a 'real-world experiment': an LL embedded in Bochum, Germany, focused on heat transition. They examine how transdisciplinary and participatory formats enable reciprocal learning between academic, municipal and civic actors in a 'neither top-down nor bottom-up' LL. Using stakeholder analysis, they reveal how evolving roles, institutional constraints and governance fragmentation shape co-creation in contested urban energy transitions.

Hugo & Farhadian investigate relevant case studies of LLs and 'building testing laboratories' as socio-technical infrastructures for climate adaptation. Their findings are discussed for their relevance and suitability for implementation in Southern Africa. They analyse how experimentation, actor reconfiguration, and behavioural change operate across technical testing environments and participatory LLs, positioning them as mechanisms for accelerating learning, coordination and adaptation in climate transitions.

Regardless of their framing, all the papers identify the potential and importance of bottom-up, everyday input into LL research, and the positive potential impact on top-down structures. Heger *et al.* show transdisciplinarity in particular as an ingredient for learning. LLs often function as stress tests for governance systems: they make visible where institutions delegate responsibility without devolving resources, revealing structural limits to participation-led governance (Akbil & Butterworth; Honsa *et al.*). The primary policy contribution of LLs lies in redefining what are the problems, not in prescribing how they should be solved. This is a form of influence that is powerful but difficult to trace and formalise (Ricci *et al.*; Alatalo *et al.*; Malakhatka *et al.*).

3. NEW KNOWLEDGE

The papers show that LLs can be agents of change by offering opportunities for developing civic agency, transforming space and testing/proposing modes of governance adaptation. The special issue contributes to knowledge about the capacity for change with a focus on actors, roles and methods, focused on key learnings on typologies (*e.g.* network-driven addition; strategic/civic/organic hybrids); evaluation (context-bound parameters; relational/epistemic metrics); and processes inside of/generated by LLs (mediation, governance, *etc.*).

They demonstrate change in stakeholder capacity-building (Ahmed *et al.*; Charalambous *et al.*; Li *et al.*; Barati & Bankaru-Swamy); bottom-up agency (Akbil & Butterworth; Belfield; Noller & Tarik; Clossick *et al.*); diversification of governance (Ricci *et al.*; Alatalo *et al.*; Dobre & Faldi; Malakhatka *et al.*; Heger *et al.*; Hugo & Farhadian; Müller); and spatial activation (Apostu & Drăghici; Antaki *et al.*; Dodd *et al.*; Honsa *et al.*; Palo *et al.*; Sloan Wood *et al.*; Fernández-Pacheco Sáez *et al.*). The issue contributes new knowledge in terms of roles and relationships, spatial change, and governance. The new knowledge, limitations and challenges are discussed below, as well as some implications for future research, policy and practice that emerge from this special issue.

3.1 NEW METHODS AND TYPOLOGIES

An array of new LL methods and typologies is explored in the issue. Time is a contributing factor throughout: some LLs are long term (*e.g.* Palo *et al.*; Belfield; Malakhatka *et al.*), others short term (*e.g.* Ahmed *et al.*; Charalambous *et al.*; Honsa *et al.*; Li *et al.*; Barati & Bankaru-Swamy; Apostu & Drăghici), impacting focus, stakeholder engagement and capacity for change. LLs involve bottom-up and top-down stakeholders: some work by building new stakeholder relationships, others deepen existing ones. LLs work through different lenses, focusing on a particular topic, a process or a space. Different LL typologies exhibit varying levels of resilience depending on their institutional and spatial configurations. Urban rooms, for instance, can be understood as extensions of universities into neighbourhood contexts, facilitating forms of institutional–community hybridisation. Hybrid models, such as 'organic–civic' LLs (Belfield & Petrescu 2024), have been shown to support sustainability and resilience locally, as illustrated by cases such as Masca (Apostu & Drăghici) and Fixoteket (Palo *et al.*). Similarly, spatial LLs (Akbil & Butterworth; Noller & Tarik) contribute to resilience through their long-term, community-friendly presence, which enables continuity across projects and fosters expectations of ongoing collaboration and co-production of research.

3.2 LIVING LABS AS INFRASTRUCTURES

LLs are not just methodological frameworks or projects. They can function as *infrastructures* that are relational, epistemic, spatial and governance-oriented, which sustain, channel and shape transformative processes over time. This conceptual shift foregrounds LLs as knowledge infrastructures mediating rules, redirecting evaluation from outputs to conditions enabling experimentation and learning.

LL relational infrastructures nurture trust across temporal and social differences though their invisible labour resists conventional metrics (as seen across papers focused on civic agency (Noller & Tarik; Belfield; Ahmed *et al.*; Akbil & Butterworth; Li *et al.*; Apostu & Drăghici; Antaki *et al.*); governance infrastructures catalyse experimental arrangements that adjust policies and roles without fully upending formal rules (Ricci *et al.*; Alatalo *et al.*; Malakhatka *et al.*; Heger *et al.*; Honsa *et al.*; Müller; Dobre & Faldi); while spatial–material forms actively configure possibilities, per situated analyses (Palo *et al.*; Honsa *et al.*; Apostu & Drăghici; Fernández-Pacheco Sáez *et al.*; Dodd *et al.*; Belfield; Ahmed *et al.*; Antaki *et al.*). Complementing Bulkeley *et al.*'s (2019) tripartite typology—strategic testbeds, civic accelerators, organic responses—an emphasis is placed on infrastructural durability over project temporality, revealing LLs' power in reconfiguring what counts as evidence, expertise and intervention.

3.3 TRANSFORMING CAPACITY: ACROSS SPACE, GOVERNANCE AND CIVIC AGENCY

LLs can act as agents of change by empowering smaller actors (Antaki *et al.*; Belfield; Ahmed *et al.*; Noller & Tarik; Li *et al.*), transforming governance and leveraging space (Palo *et al.*; Ricci *et al.*; Alatalo *et al.*; Malakhatka *et al.*; Heger *et al.*; Dobre & Faldi). They create empowerment through multi or 'hybrid roles' (Dobre & Faldi) and relational methods, enabling policy shifts via hybrid arrangements, and building resilience through spatial continuity. Capacity change can happen through LL spatial engagement, where space can be used as a tool for capacity building (an 'epistemic artefact'; Clossick *et al.*), offering the opportunity for actors to take on new roles (Noller & Tarik; Antaki *et al.*; Belfield; Ricci *et al.*; Malakhatka *et al.*; Palo *et al.*; Apostu & Drăghici). LLs also offer a space of 'productive uncertainty' (Akbil & Butterworth) or openness and experimentation for risks to be taken without long-term implications resulting from perceived 'failure' (Müller; Honsa *et al.*; Ahmed *et al.*).

While LLs hold promise as platforms for situated innovation, their outcomes resist straightforward replication or generalisation across contexts, necessitating caution against universal evaluation frameworks decoupled from spatial–ecological specificities. As bundles of relations rather than managed projects, LLs facilitate collective analysis and learning around shared topics, though short-term limits undermine durability—making long-term, community-embedded forms essential for sustained impact. However, many of the papers in this special issue attach to longer term structures or frameworks (*e.g.* urban rooms), identifying the LL as a versatile lens through which to focus on a specific topic among larger/longer term projects. Here, the LL can act as an intensifier, a catalyst, creating a safe space for experimentation and research to be carried out.

3.4 CHALLENGES AND LIMITATIONS

The papers in this special issue confirm that one of LLs' challenges is their sustainability.

There is a crosscutting issue of time limitations linked to funding limitations. LLs confront profound challenges, with *continuity* as the central conundrum: short-term funding clashes with slow working demands, rendering labs transient pilots rather than enduring infrastructures (Ahmed *et al.*; Charalambous *et al.*; Honsa *et al.*). Urban rooms are identified as a potential solution as they are already set up; however, they still require continuous funding (Akbil & Butterworth; Alatalo *et al.*). Nevertheless, long-term LLs—or LLs attached to long-term structures—appear more resilient (Belfield; Palo *et al.*; Apostu & Drăghici; Fernández-Pacheco Sáez *et al.*). At the same time, long-term structures suffer from burnout, generated by prolonged reliance on unpaid mediation, care and emotional labour, which remains largely invisible and weakly supported (Noller & Tarik; Belfield; Dobre & Faldi).

Although institutionalisation enhances durability, visibility and access to resources, it can also constrain experimentation or recentralise control (Palo *et al.*; Alatalo *et al.*; Akbil & Butterworth; Belfield). Stability often comes at the cost of openness.

In addition, other LL challenges are revealed across the papers in this issue.

Power asymmetries reproduce exclusion (privileged dominance); and replicability is limited amid context-specificity/standardisation pressures (Noller & Tarik; Ahmed *et al.*; Li *et al.*; Antaki *et al.*; Dobre & Faldi). Long-term cases (*e.g.* decade-spanning; Alatalo *et al.*; Belfield; Palo *et al.*) highlight resilience, yet underscore fragility without structural support such as compensated roles or sustained investment.

Finally, it is worth highlighting the inherent limitations of the material covered by this special issue. While the collection advances conceptual clarity—notably through work on efficacy, roles and civic resilience (Müller; Belfield; Antaki *et al.*; Noller & Tarik; Ricci *et al.*)—it does so less convincingly in relation to shared, empirically tested indicators for resilience and ecological transition across cases.

There is also limited integration of ecological indicators (biodiversity, ecosystem services, material footprints) with social and governance metrics in a single framework. Ecological transition appears mainly through energy, circularity, NbS or climate adaptation cases, but multi-species or explicitly more-than-human perspectives (as invited in the call) are not consistently theorised.

This limitation is related to the profile of the contributors, often academic, social sciences or human-centred researchers (architects, urban planners, urban studies scholars) comfortable with peer-reviewed reflexive papers, producing analyses of agency, governance and relationality. Further, the papers present mostly academia-led or top-down municipality-led LLs.

Additionally, most of the papers do not look at the long-term impact of LLs, focusing instead on the actions within the LL time frame. Lastly, the majority of papers focus mainly on European-centred LLs (with four notable exceptions of papers focusing on LLs in India, Barati & Bankaru-Swamy; Australia, Dodd *et al.*; Tanzania, Sloan Wood *et al.*; and Southern Africa, Hugo & Farhadian). There is an urgent need to expand research into LLs globally, particularly in the Global South.

3.5 IMPLICATIONS FOR RESEARCH, POLICY AND PRACTICE

Several papers state time limitations leading to a lack of perspective. The conditions to observe LLs over time are rare; only a few papers are longitudinal studies (Palo *et al.*; Belfield; Alatalo *et al.*) that allow continuities and impact to be seen, in addition to the projects. Comparing long-term LLs could help identify resilience features.

More can be learnt in relation to questions around LL scaling up and out, civic resilience methodologies, and geographies such as the Global South—and the specific typologies that might develop in these areas.

These aspects could also be covered by a comparative approach that studies networks of LLs and how tools, concepts and methods travel between different LL types, roles of mediators and researchers, and spatial scales (site, neighbourhood, city, region). Research could also be more critical, enabling critical insights to keep to an LL rigour without it being exclusive. Several self-reflection papers have demonstrated the need to make mediation work or 'mediation ecologies' (Antaki *et al.*) more visible and measurable (Noller & Tarik; Belfield; Dobre & Faldi). They raise the issue of defining frames for the training needed, for recognition and compensation that would protect the LL mediators from burnout (Noller & Tarik).

LL research could also include context-adaptive evaluation frameworks. This could lead to transdisciplinary research in LL methodologies: urban/civic researchers and material/ecological scientists co-producing evaluation frameworks around specific typologies of labs (circular hubs, NbS pilots).

Recommendations can be drawn for policymakers. Municipalities have an important role to play in both top-down and bottom-up LLs. Several papers already contain strong ideas that can be translated into concise policy recommendations. Some identify possible answers to the bottom-

up/grassroots struggle with municipality engagement (*e.g.* Antaki *et al.*; Palo *et al.*); others speak of municipality-led struggle to remain accountable to regulation and funding frameworks while enabling open-ended, participatory experimentation and present the dual imperative that city authorities must face: they must 'drive transformation' and 'transform themselves' (Alatalo *et al.*). Municipalities struggle with departmental silos, short-term project logic and legal frameworks that resist adaptive collaboration. Possible indicated answers have to do with sustaining civic partnerships over long project cycles, avoiding loss of citizen trust when early openness gives way to bureaucratic planning (Ricci *et al.*; Malakhatka *et al.*; Heger *et al.*; Alatalo *et al.*).

Engagement of municipalities in LLs enables collaborations on specific key domains of public policy (energy transition, circularity, nature-based solutions, *etc.*) and with a more longitudinal impact. Moreover, municipality-led LLs tend to address policy issues already defined as relevant within a given context (Malakhatka *et al.*; Ricci *et al.*; Palo *et al.*), with their role often limited to piloting predefined objectives. This leaves little scope for feeding empirical insights back into the public agenda, particularly where mismatches emerge. These may concern the need to revisit core definitions (*e.g.* energy justice; Ricci *et al.*), regulatory or standardisation frameworks (*e.g.* building renovation), approaches to impact measurement (Palo *et al.*), or the translation of stakeholder interdependencies into formal procedures (*e.g.* Ahmed *et al.*; Heger *et al.*; Malakhatka *et al.*). The contributions therefore point to the need to embed LLs more fully within governance cycles, linking them to agenda-setting, consultation, implementation and evaluation rather than confining them to rigid experimental roles.

Person-dependent collaborations between the local public administration and an LL team proved to reduce the resilience within the LL itself (Antaki *et al.*). Therefore, setting up collaboration mechanisms inside municipalities/governments could help translate LL learnings into regulations, standards or dedicated programmes (Alatalo *et al.*; Heger *et al.*; Malakhatka *et al.*). There is a need to encourage municipalities and governance structures to recognise LL research (in a timely manner), without heavy institutionalisation requirements that overload fragile bottom-up structures (Antaki *et al.*; Akbil & Butterworth; Alatalo *et al.*).

There is a need to fund citizen attendance in order to recognise and pay for mediation and relational labour (Noller & Tarik; Antaki *et al.*; Belfield; Dobre & Faldi). In addition, widening support for hybrid and grassroots-led LLs, recognising cultural and educational institutions as eligible LL hosts would allow them to hold long-term roles in resilience and ecological transition (Ahmed *et al.*; Belfield; Charalambous *et al.*; Apostu & Drăghici).

The LL examples in this issue confirm that despite the different funding opportunities, practitioner-led LLs are still rare. Only three papers presented such LLs (Belfield; Antaki *et al.*; Apostu & Drăghici). Although the question why there are so few remains, LLs constitute a valuable opportunity for practice-based research and for practitioners to develop different forms of more engaged and interdisciplinary practice.

4. CONCLUSIONS

This special issue brings new knowledge about how living labs (LLs) change the capacity of stakeholders, spaces and governance, enabling the development of collaborations towards civic resilience and ecological transition.

LLs have a role to play in enabling capacity by empowering (new) actors, mediation between stakeholders and encouraging bottom-up agency to create change. The state of the art of spatial LLs (that tend to refer to urban LLs) needs more iterations in the Global South, in rural contexts and LLs more broadly led by practitioners. Even where no immediate physical transformation takes place, LLs are often spatial in nature, as they prepare the ground—socially, institutionally and materially—for change in the built environment. LLs attend to governance and multi-actor coordination by enabling and catalysing policy and governance change in particular through quadruple helix stakeholder engagement.

There is a growing interest in the term and concept of LLs. This *Buildings & Cities* special issue shows the value in the broadening of the term and accepting diversity in LL research. Beyond illustrating their diversity and potential, this issue reframes LLs not only as methodological tools but also as social and civic infrastructures that shape how transitions are governed and enacted. Their transformative capacity depends on sustained resourcing, attention to power and inclusivity from bottom-up initiatives, and long-term LLs. Without these conditions, they risk reproducing existing inequalities or remaining confined to short-term, unscalable project logics.

The special issue suggests the need for policy to make room for learning rather than only delivery; and for research to remain accountable to the uneven, long-term work that transitions actually require.

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AUTHOR AFFILIATIONS

Nicola Antaki orcid.org/0000-0001-9840-9610
École Nationale Supérieure d'Architecture de Paris-La Villette, Paris, FR
Doina Petrescu orcid.org/0000-0002-3794-3219
School of Architecture and Landscape, University of Sheffield, Sheffield, UK
Vera Marin orcid.org/0000-0003-0235-0103
Association for Urban Transition (ATU), Bucharest, RO

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