

# Living Labs for Climate Adaptation: Civic Participation, Co-creation, and Experimental Innovation

Taedong Lee<sup>1</sup>, Juyeon Park<sup>2</sup>

<sup>1</sup> Underwood Distinguished Professor, Department of Political Science, Yonsei University, Seoul, South Korea (tdlee@yonsei.ac.kr)

<sup>2</sup> Department of Political Science, Yonsei University, Seoul, South Korea (juyeon.park0202@yonsei.ac.kr)

## Abstract

In the era of climate crisis, the importance of local climate adaptation strategies is growing. Given that the impacts of climate change vary across regions, a bottom-up approach involving various stakeholders is crucial. This article introduces living labs, where diverse stakeholders collaborate to define problems and experiment with solutions, as a viable approach for climate adaptation. Through the case studies of the three living labs: corporate climate adaptation, ESG information disclosure framework, shade infrastructure against heat waves, and climate disaster text message. We explore the applicability and effectiveness of living labs and discuss their implications for sustainable development and enhancing the resilience of local communities in the Asia-Pacific region.

## Introduction

In 2015, sustainable development became an international agenda. Under the overarching vision of harmonizing the environment, economy, and society, the Sustainable Development Goals (SDGs) are being pursued at various levels. Among them, climate change has become a serious issue worldwide; hence, designing an appropriate response to it is becoming significant. Both climate mitigation, reducing greenhouse gases (GHGs), and climate adaptation, strengthening resilience and adaptive capacity to climate risks are crucial. As the impacts of climate change vary across regions, effective responses require tailored strategies reflecting local characteristics and needs. This necessitates an integrated and transformative approach involving diverse fields and interests. In other words, it demands us to go beyond top-down approaches to establish and implement bottom-up climate adaptation.

This article introduces living labs as a method for enhancing sustainability and

realizing bottom-up climate adaptation policies. It is an approach that creates social value through user-driven innovation, representing an experimental environment where diverse stakeholders jointly define problems and develop solutions. By fostering collaboration, living labs pursue not only public benefit but social acceptability, making them highly suitable for addressing complex, multi-layered challenges. As a form of social innovation, living labs can contribute to going beyond mere technical solutions and enhancing practical resilience to the climate crisis, as well as community resilience and autonomy.

The structure of the article is as follows: the next chapter addresses the concept of the necessity of living labs. The subsequent chapter presents the methodology of living labs, focusing on how living labs facilitate participatory and innovative approaches to local climate adaptation. Then, two case studies follow: the corporate climate adaptation living lab and the shade living lab. In this section, we explore how living labs can be utilized both in a corporation and local

government context. In conclusion, we discuss implications for sustainable development in the Asia-Pacific region.

## Concept and necessity of living labs

Living labs are public innovation platforms where diverse actors collaborate to define problems and experiment with solutions within real-life environments (Bergvall-Kåreborn and Ståhlbröst 2009; Voytenko et al. 2016). This approach contributes to enhancing the suitability of climate adaptation measures and fostering a sense of shared responsibility by actively utilizing the knowledge and creativity of citizens who were previously marginalized in the policy process (Nesti 2018, Shin and Lee 2025).

Arias et al. (2025) analyzed over 80 living lab cases across Europe, confirming that living labs have evolved into innovation platforms integrating citizen participation, co-design, interdisciplinary collaboration, and institutional structures. They emphasized that social value, inclusivity, and locally tailored contexts play a decisive role in living lab design and outcomes. Campos and Marín-González (2023) have also argued that living labs should be designed to integrate social value, ethics, and inclusivity.

While living labs are generally citizen-led, they possess a multi-layered structure and incorporate diverse institutional support. Universities and research institutions provide a knowledge and technology base, while government and private companies handle financial and administrative support (Evans et al. 2015). Civil society groups also play crucial roles in operation and collaboration coordination (Mukhtar-Landgren et al. 2019).

Features of living labs can be summarized in several ways. First, in terms of participation, living labs transform policy recipients from mere beneficiaries into co-designers of solutions. Citizens and

communities can reflect their practical needs, ensuring adaptation strategies are designed to fit the local context. Second, in terms of innovation, living labs provide a structure to experiment with technical and social solutions in real-world environments and improve them based on experimental results. Third, living labs facilitate the exchange of knowledge and experience among diverse stakeholders, enabling the combination of new policies, technologies, and social practices. This contributes not only to short-term problem-solving but also to strengthening long-term adaptive capacity.

In summary, living labs provide an innovative process. They offer participant-centred problem definition, experimental solution development, and continuous improvement. They establish themselves as a crucial approach that enhances the effectiveness and feasibility of community-tailored adaptation strategies. Particularly in today's situation, where rapid climate change coexists with social vulnerability, living labs are able to improve the efficiency of climate adaptation and provide a practical platform for diverse stakeholders to manage climate risks.

### How do living labs facilitate participatory and innovative approaches to local climate adaptation?

Figure 1 conceptually presents the development of living lab techniques,

consisting of four steps: planning, co-creation, experiment and verification, and realization. Among these, the planning steps include diagnosing climate vulnerability and identifying the target group for living labs. It serves as a crucial step to determine the overall direction of living labs. It is essential to clearly define the type of entity and specify objectives, since methods and procedures depend on the nature and purpose of the implementing entity. This is followed by a preliminary diagnosis to lay the foundation for living labs operation, such as investigating the baseline status of the project or targeted problem and developing the operation plan. When designing new climate adaptation projects or restructuring existing projects, a review of the relevant legal basis is mandatory. In particular, local governments are directly constrained by statutes and ordinances. It entails a thorough prior analysis of the relevant legal and institutional framework.

The second step, co-creation, encompasses co-design (problem discovery and identification) and prototype development (ideation and prototyping). From this step onward, the participation and interaction of key stakeholders (such as citizens, civil society organizations, experts, public officers, and corporate workers) become fully engaged. During the co-design process, workshops are conducted to discover problems and select and refine the identified problems. Workshops are generally structured according to the following three-process flow.

- **Sharing findings from real-life context investigations:** Share observed problems with stakeholders to establish shared problem recognition and support redefining problems in user-centred language.
- **Organizing and structuring problems:** Based on investigation results, categorize discussed issues by theme and type to derive a concrete list of problems.
- **Problem prioritization:** Evaluate the importance and urgency of the derived problems to establish priorities.

Based on this process, an idea workshop generates solutions, followed by prototype development to visualize and concretize these ideas.

The third step, experiment and verification, involves reviewing the effectiveness and suitability of prototypes through pilot experiments. For example, in a corporate climate adaptation living lab, the developed solution is evaluated for its applicability and potential to deliver tangible results. Living labs' core element is experiment, which involves (1) assembling specific tools and participants, (2) inducing change, and (3) measuring that change (Karvonen and van Heur 2014). Therefore, it is indispensable to set clear evaluation criteria for experiments. During verification, stakeholder surveys, priority assessments (e.g., AHP: Analytic Hierarchy Process), and comparisons of pilot application outcomes are employed.

The final step, realization, consists of assessing the feasibility of the derived

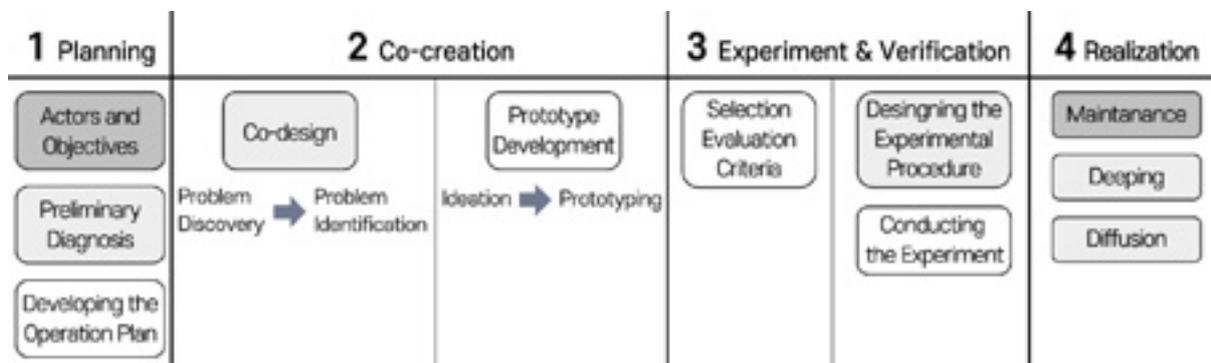


Figure 1. Development of Living Lab Techniques

\* Source: Lee and Shin et al. (2025)

\*\* The above content systematizes practical methodologies, based on the experience accumulated by the Yonsei University Climate Adaptation Living Lab R&D.

solutions and connecting them to institutionalization or commercialization. It is achieved by three stages: maintenance (continuous development of solutions), deeping (refining co-created outcomes), and diffusion (Shin and Lee 2025). Living labs should not remain confined to the laboratory level; if experiments validated at the local or small-scale level fail to scale up into broader systems, the creative efforts of diverse stakeholders may face limitations (Hakkarainen and Hyysalo 2013). That is, even if living labs start with local-level experiments, they can be realized as tangible products, services, and institutions through processes of scaling and transition (Lee et al. 2014; Von Wirth 2019).

Remember that the guidance provided in this article is not the definitive answer. Certain steps may be omitted, or it may be necessary to return to a previous step. The essence of living labs lies not in rigidly adhering to frameworks and steps, but in the engagement of multiple stakeholders and the realization of solutions through experiment and verification. Therefore, it is recommended to use the guidance as one practical milestone on the journey toward enabling a collective response to the climate crisis and advancing toward a sustainable future.

## Case studies on climate adaptation living labs

This chapter introduces two living lab cases and explores how living labs actually support developing solutions and advancing them to the level at which they can be institutionalized. The three cases are conducted by the Yonsei University Climate Adaptation Living Lab R&D in South Korea (Lee and Shin et al. 2025). They have distinct environments, targets, and risk structures, yet both share the commonality of enhancing the coherence and effectiveness of climate adaptation policies.

The first case is the corporate climate adaptation living lab. It structured the private sector's climate risk and adaptation capabilities and laid out the groundwork for building a corporate climate adaptation disclosure system. The second case is the shade living lab conducted

in collaboration with Seodaemun-gu (local government in Seoul) from 2023 to 2025 (Lee and Shin, 2025). It empirically reviewed heatwave climate adaptation policies based on the living environment and derived policy design requirements.

### Corporate living lab

The climate crisis has become a key factor in exerting structural and persistent impacts on corporate management. The necessity of ESG (Environmental, Social, Governance) management is emphasized, with environmental responses serving as a core pillar of corporate sustainability. However, the trend in ESG disclosures has largely focused on mitigation. Unlike mitigation, corporate climate adaptation lacks a robust institutional foundation and reporting standards, necessitating the development of evidence-based indicators tailored to industry-specific characteristics. Given this context, living labs are deemed a proper research methodology. They reflect real-world environments while enabling collaborative problem-solving through stakeholder interaction.

To conceive the corporate climate adaptation disclosure system, a research institute-led living lab platform is set up to structure corporate climate adaptation information and ensure the effectiveness of disclosure indicators. This platform was designed as an experimental collaborative structure where corporations collectively design and review the entire process. Figure 2 describes the co-creation process of a corporate living lab. The living lab comprised five steps: problem identification and agenda setting; co-inquiry and knowledge integration; ideation; prototype development; and verification and institutionalization.

Figure 2 describes the co-creation process of a corporate living lab. The living lab comprised five steps: problem identification and agenda setting; co-inquiry and knowledge integration; ideation; prototype development; and verification and institutionalization. First, ESG officers in private companies were recruited considering diversity by industry and size. A preliminary assessment of each company's climate risk awareness level and adaptation capacity laid out the groundwork for living lab discussions. Subsequently, systematic training

on international standards and climate risk assessment techniques was provided to strengthen the companies' capabilities, enabling their participation in the design process. During the co-creation, companies, researchers, and experts jointly conducted an in-depth analysis of climate risk factors, identifying candidate adaptation disclosure indicators.

The resulting indicators underwent in-depth verification by an expert group. It included detailed discussions on the feasibility of applying industry-specific frameworks and methods for integrating qualitative (such as social values) and quantitative (such as market values) indicators. This verification procedure played a crucial role in ensuring the disclosure framework reflects the realities of corporate operating environments and climate data infrastructure. Through this process, the corporate climate adaptation disclosure framework was derived. This globally applicable framework was constructed by synthesizing empirical data collected from living labs, analysis of international disclosure standards, and review results of quantitative evaluation systems (ND-GAIN: Notre Dame Global Adaptation Initiative) and VESTAP: Development of the Korean Climate Change Vulnerability Assessment Tool).

Table 1 presents the framework for corporate climate adaptation disclosure. The research team categorized corporate climate adaptation information into two major categories: climate risk and corporate climate adaptation capacity. It is found on the quantifiability of future indicators, data accessibility, and operational simplicity of the disclosure framework. Climate risk refers to the physical and transition risks faced due to climate change, consisting of climate exposure and climate sensitivity. Climate exposure indicates how directly a company is exposed to current and future climate risks, while sensitivity signifies how significantly or easily the impacts of climate change affect a company's operations.

Meanwhile, the corporate climate adaptation capacity refers to the resources, capabilities, strategies, systems, and policies a company possesses to identify, manage, and mitigate climate risks. It is composed of climate readiness and

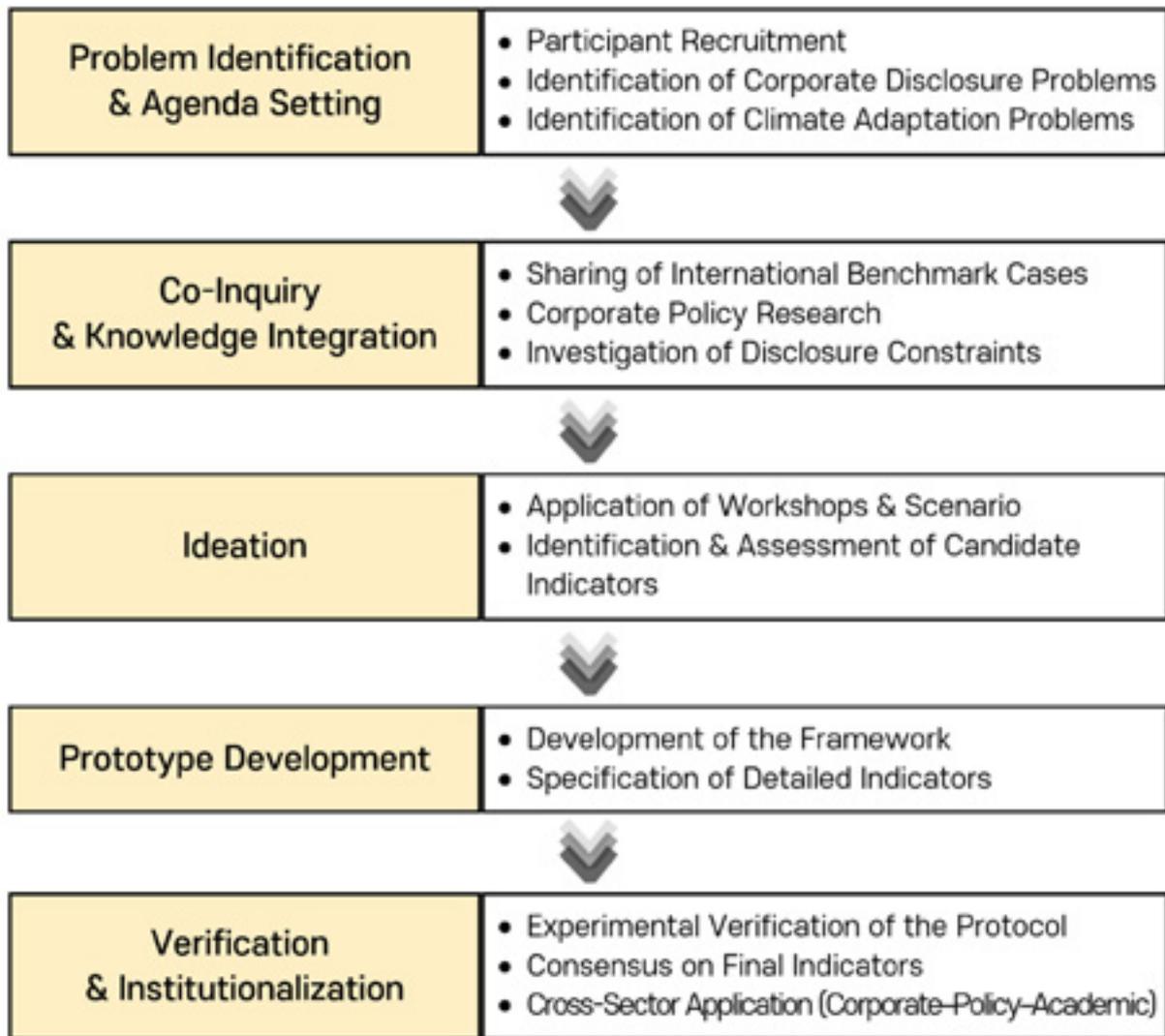


Figure 2. Co-creation Process of Corporate Living Lab

\* Source: Lee et al. (2025)

climate responsiveness. Readiness means the level of preemptive readiness a company has to respond to when confronted with climate risks. Climate responsiveness denotes the company's ability to respond immediately and effectively when an actual climate crisis occurs, encompassing its execution capability and resilience.

### Shade living lab

Climate change has intensified exposure to heatwaves in urban spaces, and as an adaptation policy, outdoor shade has been widely adopted by local governments. However, existing projects have shown policy limitations, being implemented in a fragmented manner

with insufficient evidence regarding their power-saving effects and lacking verification of practical impacts. Recognizing these issues, Seodaemun-gu (Seoul, South Korea) introduced a living lab approach to analyze the feasibility, effectiveness, and resident acceptability of the outdoor air conditioner shade project.

Figure 3 depicts the process of the shade living lab. During the planning, a preliminary investigation reviewed the project's legal basis, effectiveness, and feasibility. The investigation revealed that Seodaemun-gu's ordinance system lacked a legal foundation for supporting the shade project, and there were almost no scientifically verified

cases demonstrating power-saving effects. This initial analysis suggested that the living lab should be an experimental policy design process integrating policy, technology, and resident participation.

Based on this, the living lab established a participatory structure encompassing diverse stakeholders. Participants included citizens with outdoor unit installation experience, government officials responsible for climate and energy policy, energy diagnosis experts, outdoor unit management and cleaning specialists, and shade manufacturers and installers. The living lab adopted an issue-focused workshop approach, creating a structure to translate each

**Table 1.** Framework for Corporate Climate Adaptation Disclosure

Major Category		Subcategory	Indicators	
Corporate Climate Risk	Climate Exposure	Physical Risk	Climate Risk Modeling	
			Climate Impact Assessment	
		Transition Risk	Policy and Regulatory Risk	
			Market and Reputation Risk	
	Climate Sensitivity	Infrastructure Sensitivity	Human Infrastructure	
			Physical Infrastructure	
		Corporate Value Chain Sensitivity	Supply Chain Sensitivity	
			Revenue Sensitivity	
Corporate Climate Adaptation Capacity	Climate Readiness	Risk Mitigation and Management	Climate Adaptation Awareness	
			Green Infrastructure Development and Operation	
			System Efficiency Improvement	
		Corporate Value Creation	Social Value Creation	
			Market Value Creation	
			Climate Adaptation Implementation	
		Climate Responsiveness	Climate Disaster Response Capacity	Adaptation Impact Assessment
				Scale of ESG Investment
				Financial Planning for Climate Risk
	Corporate Governance		Emergency Communication System	
			Climate Disaster Management	
			Employee Safety Management	
			Internal Rules and Regulations	
			Stakeholder Engagement	
			Climate Disclosure	

\* Source: Lee et al. (2025)

stakeholder’s expertise and experience into concrete policy elements. Key issues identified during this process were summarized as: (1) lack of ordinance and policy basis, (2) reduced effectiveness due to formal linkage programs, (3) absence of criteria for users, (4) insufficient verification of effectiveness, and (5) safety risks.

During the co-creation, three experiments were designed to address these issues. The first was a cleaning and management experiment, examining how maintenance affects energy efficiency and safety. Results revealed accessibility and safety issues with outdoor units in high-rise apartments, frequent overheating and fire risks

observed, and the need for safe cleaning methods and management training.

The second was an installation experiment requiring residents to install the shade themselves to evaluate installation difficulty, safety, and structural constraints. While most participants reported being able to install it themselves,

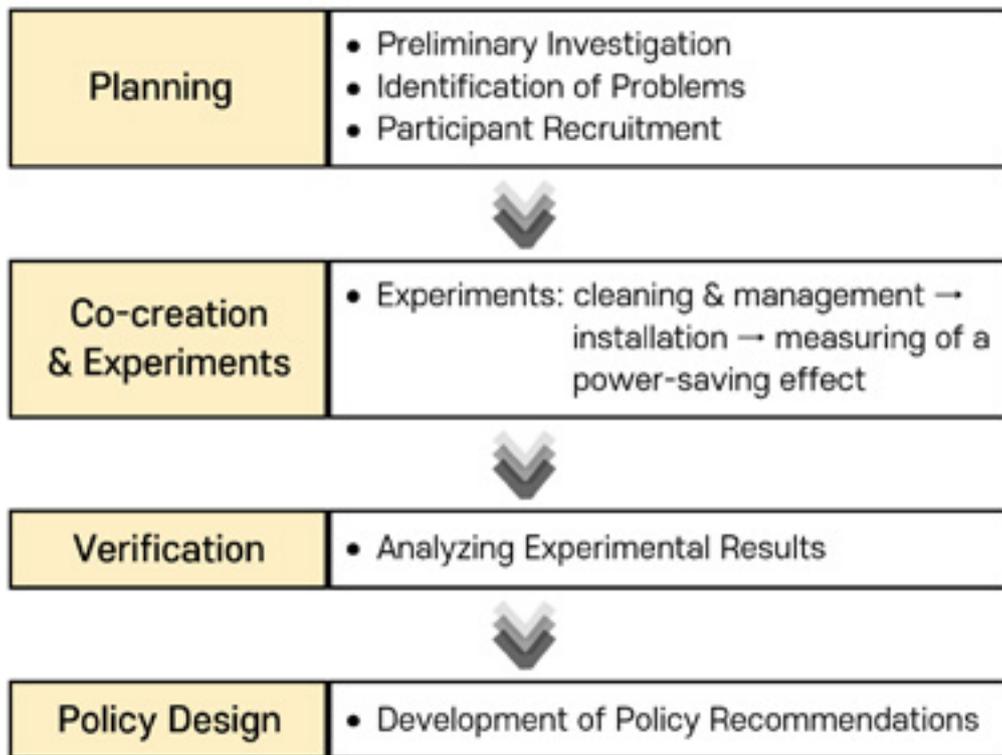


Figure 3. Process of Shade Living Lab

significant risks were identified in confined installation spaces or on high-rise external balconies. This suggests the need for installation guidelines and prior training, and that professional installation support may be required for certain housing types.

The most critical experiment was to verify the power-saving effect in 2025 (Lee and Shin et al. 2025). Of the 29 resident researchers, 22 provided valid data, enabling an analysis. The researchers were residents of Seodaemun-gu, selected from 13 out of 14 administrative districts, living in various housing types (apartments, villas, detached houses, etc.). They measured and recorded their daily electricity consumption and reported it via SNS (Social Networking Services). This experiment was conducted during summers and was based on actual measurements of changes in outdoor unit power consumption. The analysis confirmed that the shade has a practical effect, but its effect is limited to specific residential types.

In the final step, policy design directions were derived based on the experimental

results. First, shade support is not a universal policy applicable to all households; therefore, differentiated application by housing type is essential. Second, the outdoor unit cleaning and management program should be linked to transforming it into a comprehensive policy. Third, evidence-based policy design must be strengthened, incorporating the effectiveness of verification as an essential procedure. Fourth, the SNS-based real-time feedback model proved effective for resident participation and communication methods.

### Climate disaster text message living lab

The Republic of Korea is sending a climate disaster text message (Lee et al. n.d). However, there is insufficient verification on whether it actually increases risk awareness and induces behavioral change. Despite the increasing frequency and intensity of climate disasters, the current alert system has been criticized for failing to reflect recipients' situations and characteristics, causing alert fatigue and lacking concrete action guidelines. Based on this

problem awareness, the research team determined that a living lab approach involving both citizens and experts is necessary to improve disaster text message (Lee et al. n.d.).

Figure 4 illustrates the process of the climate disaster text message living lab. In the first living lab, a focus group interview (FGI) was held with 7 citizens of diverse ages (20s, 30s, 40s, 50s, and 60s) to review heatwave disaster messages and identify problems at Seoul (Yonsei University) in 2024. Citizens emphasized that messages lack relevance because they fail to reflect actual risks and situations, and that repeated messages from multiple agencies lead to fatigue. They also pointed out that abstract expressions like "be careful of the heat" made it difficult to know when, what, and how to act, arguing that more specific, action-oriented information was needed.

In the second step of the living lab, the technical and institutional feasibility of the citizen suggestions was reviewed by 2 citizens (of the first step living lab participants) and 3 experts

\* Source: Lee and Shin et al. (2025)



Figure 4. Process of Climate Disaster Text Message Living Lab

\* Source: Lee et al. (n.d.)

(from the climate change research institute, news media, and disaster message management institute). Experts explained the authority and legal responsibilities of each message-issuing agency, the structure of communication systems, and the limitations of information provision, discussing how citizen ideas could realistically be implemented. While citizens stated they trusted the messages from the Korea Meteorological Administration (KMA), which provides weather and climate change related information, the most, experts worried that if the KMA provided action guidelines, it could lead to role conflicts or responsibility issues between agencies (such as local governments). Through these discussions, the research team and participants jointly designed a two-stage structured message, where the KMA provides risk information, and health/disaster management agencies provide action guidelines.

In the final living lab, the prototype messages were delivered to all participants. They thoroughly examined messages without time constraints, evaluating the clarity of phrasing, the effectiveness of action guidelines, the safety of provided links, and the placement and role of hashtags. The research team supplemented the context of opinions through phone interviews when necessary. This remote review process compensated for the time, power, and participation constraints of in-person meetings, verifying whether the message content would function naturally and effectively within the actual context of disaster alerts.

### Implications for sustainable development

This article focuses on the concept and practice of climate adaptation living labs, discussing how living labs facilitate participatory and innovative approaches to local climate adaptation. Three living lab cases introduced in this study empirically demonstrate that living labs can simultaneously provide the institutional framework of evidence-based approaches and multi-stakeholder engagement. These position living labs as experimental and verification platforms for localized climate adaptation.

Living labs can function as a core policy and socio-technical mechanism for sustainability transition, going beyond simple participatory programs. Their operation mechanism serves as a catalyst for the enhancement of contextuality, coherence, and feasibility by enabling stakeholders to experience climate risks in real-life, reframe problems, and co-create solutions. Furthermore, living labs hold significant theoretical implications as they facilitate the interaction between societal, technological, institutional, and behavioral changes - core elements of the transition perspective emphasized sustainability. From a policy perspective, the co-creation process of living labs has stakeholders directly engage in review, experimentation, and discussion from the initial stage. This institutionally implements the core principles of sustainability policy - inclusiveness and co-production - and strengthens long-term sustainability by building trust in climate policies.

The Asia-Pacific region is experiencing the world's fastest urbanization and industrialization, with an extremely uneven spatial distribution of climate risks and stark socioeconomic vulnerabilities. Besides, significant disparities in policy capacity, financial conditions, and data accessibility make applying a uniform adaptation model difficult. Considering these regional characteristics and constraints, the living lab approach can promote climate adaptation policies in the Republic of Korea and some other Asia-Pacific countries such as the Philippines, Indonesia, and Viet Nam. First, through real-life experiments, it can derive locally customized adaptation strategies reflecting differences in residential environments, corporate structures, and social vulnerabilities. Second, the co-creation structure is well-suited for building multi-stakeholder participation-based adaptation systems. Third, accumulating evidence-based data can ensure policy credibility and alignment with international standards, thereby contributing to the institutionalization of climate adaptation policies.

### References

- ✓ Arias, Alba, Claudia Pennese, Olatz Grijalba and Youstra Sidqi (2025). "Application of living lab concept: Where, how and for what is being used in Europe to support energy, social and environmental transition", *Sustainability*, Vol. 17, No. 6, 2727.
- ✓ Bergvall-Kåreborn, Birgitta and Anna Ståhlbröst (2009). "Living Lab: An Open and Citizen-Centric Approach

- for Innovation”, *International Journal of Innovation and Regional Development*, Vol. 1, No. 4, 356–370.
- ✓ Campos, Inês and Esther Marín-González (2023). “Renewable energy living labs through the lenses of responsible innovation: Building an inclusive, reflexive and sustainable energy transition”, *Energy Research & Social Science*, Vol. 101, 103100.
  - ✓ Evans, James, Ross Jones, Andrew Karvonen, Lucy Millard and Jana Wendler (2015). “Living labs and co-production: university campuses as a platform for sustainable science”, *Current Opinion in Environmental Sustainability*, Vol. 16, 1–16.
  - ✓ Hakkarainen, Louna and Sampsa Hyysalo (2013). “How Do We Keep the Living Laboratory Alive? Learning and Conflicts in Living Lab Collaboration”, *Technology Innovation Management Review*, Vol. 3, No. 12, 16–22.
  - ✓ Karvonen, Andrew and Bas van Heur (2014). “Urban Laboratories: Experiments in Reworking Cities”, *International Journal of Urban and Regional Research*, Vol. 38, No. 2, 379-392.
  - ✓ Lee, Heeseob, Kyeongho Lee, Yeyoung Lee and Taedong Lee (2025) a. “Corporate Climate Adaptation-related Disclosure Framework: A Living Lab Co-creation Approach”, *Journal of Environmental Impact Assessment*, In Print.
  - ✓ Lee, Taedong, Jeeyoun Kim, Giha Shin and Jarim Kim (n.d.) b. “Co-creating Disaster Alert Messages with Communities for Climate Adaptation and Public Health”, *Journal of Health Communication*, In Print.
  - ✓ Lee, Taedong, Sangbum Shin et al. (2025) c. *Living Lab: Co-creation and Experiment for Sustainable Development* (Seoul, Sahoipyounghon Academy).
  - ✓ Lee, Taehwa, Taedong Lee, and Yujin Lee (2014). “An Experiment for Urban Energy Autonomy in Seoul: One Less Nuclear Power Plant Policy”, *Energy Policy*, Vol. 74, 311-318.
  - ✓ Mukhtar-Landgren, Dalia, Annica Kronsell, Yuliya Voytenko Palgan and Timo von Wirth (2019). “Municipalities as enablers in urban experimentation”, *Journal of Environmental Policy & Planning*, Vol. 21, No. 6, 718–733.
  - ✓ Nesti, Giorgia (2018). “Co-production for Innovation: The Urban Living Lab Experience”, *Policy and Society*, Vol. 37, No. 3, 310-325.
  - ✓ Shin, Sangbum and Taedong Lee (2025). “The realization of living labs at the post-experiment stage: the role of University in Korea”, *Science and Public Policy*, 2025.
  - ✓ Voytenko, Yuliya, Kes McCirmick, James Evans and Gabriele Schliwa (2016). “Urban Living Labs for Sustainability and Low Carbon Cities in Europe: Towards a Research Agenda”, *Journal of Cleaner Production*, Vol. 123, 45-54.
  - ✓ Von Wirth, Timo, Lea Fuenfschilling, Niki Frantzeskaki and Lars Coenen (2019). “Impacts of Urban Living Labs on sustainability transition: Mechanics and strategies for systematic change through experimentation”, *European Planning Studies*, Vol. 27, No. 2, 229–257.