Future scenario building for a climate resilient society

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Abstract

Future Scenario Building (FSB) is an essential method in foresight studies, particularly for addressing climate change. It enables the collaborative development of diverse, long-term visions of climate-resilient societies, which can support policy-making and social innovation. This paper presents the application of Future Scenario Building methodology within the Chios Living Lab to generated climate-related scenarios, highlighting factors that contributed to developing robust, grounded futures. Initially, the CLIMAS team created clear guidelines to support the use of the FSB methodology. These guidelines were then applied in two living labs—Chios and Vilnius—to build scenarios and identify areas for improvement. The process began with identifying key drivers, or influential factors affecting future outcomes. Various projections were developed for each driver and organized into a morphological box, from which consistent combinations were used to construct long-term (30-year) scenarios. The Chios lab focused on blending traditional and innovative approaches to climate adaptation, ecosystem health, and sustainable agriculture and tourism, considering both top-down policies and grassroots initiatives. Lessons learned emphasized the need for careful planning, inclusive participation, clarity of purpose, awareness of participant time limits, and efficient time management. Overall, the study highlights the value of structured, participatory scenario building in fostering climate resilience through informed, community-driven future planning.

Keywords: Climate Resilience, Key Drivers, Morphological Box, Living Labs, Social Innovation

1. Introduction

Future studies is an interdisciplinary field focused on systematically exploring possible and preferred futures (Valciukas, 2017). It supports proactive decision-making under uncertainty. Participatory future workshops are among the most common tools in this field, used for co-creating knowledge and generating alternative futures. As Dufva and Ahlqvist (2015) note, these workshops offer "spatially and temporally intensive" environments that foster collective sense-making, dialogue, and creative ideation. Scenario-building helps participants imagine and discuss potential future paths across various policy-relevant areas (Godet, 2006; Pereira et al., 2019). The approach has been widely applied in diverse participatory settings, often adapted to local contexts and policy priorities.

Living Labs (LLs) are user-centered, open innovation ecosystems embedded in real-life environments, where diverse stakeholders—citizens, researchers, policymakers, and businesses—collaboratively design, develop, and test new ideas and solutions (ENoLL, n.d.; Hossain et al, 2019). Their participatory and co-creative nature makes them especially well-suited for FSB exercises. LLs offer an inclusive, dynamic, and iterative setting that fosters active engagement, enabling local actors to co-envision futures that

are closely aligned with local needs, priorities, and lived experiences. Scenarios that are grounded in specific contexts reflect real community dynamics and are more likely to inform relevant, actionable strategies.

The Chios Living Lab was established in 2017 at the University of the Aegean through a bottom-up initiative led by students from the voluntary environmental group Aegean Greeners. Motivated by a desire to protect and improve the environmental conditions of Chios Island, the group initiated collaborations with local stakeholders, including non-governmental organizations, the Marine Scouts, the Coast Guard, the Merchant Marine Academy, and the Municipality of Chios. The Living Lab facilitated a series of participatory environmental activities, with a core focus on organizing beach clean-up events targeting marine litter. Data collected from these events were submitted to the European Environment Agency's Marine Litter Watch (MLW) database, thereby contributing to EU-wide efforts to monitor and reduce plastic pollution. In addition to hands-on environmental actions, the Living Lab hosted public workshops aimed at raising awareness of climate change and broader environmental issues. Citizen participation was further encouraged through initiatives such as air quality monitoring using a network of low-cost sensors. Through these diverse activities, the Chios Living Lab has developed into a locally embedded, participatory platform for environmental monitoring, education, and action, aligning with the principles of open innovation and community-based sustainability.

In this context, the objective of this paper is to present the application of a Future Scenario Building (FSB) methodology within the Chios Living Lab and to analyse the resulting scenarios in relation to local environmental conditions, societal needs, and climate-related vulnerabilities. The paper further identifies key factors that facilitated the process and contributed to the development of robust, locally grounded scenarios.

The remainder of the paper is structured as follows: First, the methodology of the FSB workshop is described in detail; next, the critical factors and the five climate resilience scenarios generated during the workshop are presented and discussed; finally, a set of recommendations is offered based on the lessons learned from the design and implementation of the FSB process.

2. Methodology

This study applied a structured Future Scenario Building (FSB) methodology through a participatory workshop aimed at envisioning climate-resilient futures. The process consisted of four key phases: workshop preparation, identification of key drivers, scenario generation, and scenario synthesis.

The preparation of the Chios Living Lab FSB workshop involved a series of coordinated steps to ensure inclusivity, clarity, and logistical readiness. An internal team kick-off meeting was held to align on the workshop's objectives, review the methodology, and assign responsibilities. Three academic staff members were designated as facilitators, supported by technical and administrative staff and student assistants. Weekly meetings followed to monitor progress, design the agenda, and address anticipated challenges, such as communicating the workshop's purpose, ensuring inclusivity, and managing participants' time constraints.

Participant selection followed the Quadruple Helix model, aiming for balanced representation across civil society, business, public authorities, and academia. Additional criteria included gender, age, and the inclusion of under-represented groups. A comprehensive invitation package was prepared in Greek, including information on

climate change, regional adaptation plan, the CLIMAS project, the workshop agenda, and the FSB methodology. Personalized outreach ensured participants understood their role and contributed meaningfully. The workshop venue was carefully selected for accessibility and comfort. It was arranged to promote interaction, with adequate technical support and designated resource and refreshment areas.

During the workshop implementation, in the first phase, participants identified key drivers—factors likely to shape future climate resilience—through moderated group discussions supported by the STEEP framework (Social, Technological, Economic, Environmental, Political). These drivers were then categorized and discussed in plenary to build shared understanding. Next, scenario generation was conducted using a Morphological Analysis (MA) matrix. Participants defined multiple developments for each key driver and combined them to form internally consistent scenario narratives. This iterative, co-creative process resulted in five diverse and plausible scenarios, grounded in local realities and stakeholder insights. The final step was to conduct a scenario refinement workshop, with a diverse group of experts to provide feedback and recommendations aimed at improving the quality, accuracy, and relevance of the generated scenarios. The insights gathered during the workshop were subsequently shared with Chios Living Lab core group, enabling them to collaboratively decide on a refined version of the scenarios.

3. Results and Discussion

3.1. FSB workshop participants

Ensuring diverse representation of societal groups and stakeholders was key to the success of the Future Scenario Building process for building a climate-resilient society. Figure 1 shows the stakeholder composition of the 18 workshop participants (eight females and ten males) to the FSB workshop held at the Living Lab of Chios. Citizens formed the largest group, with eight individuals from diverse backgrounds, including the maritime sector, education, environmental NGOs, the military, and healthcare. While most were residents of Chios city, some came from northern and southern settlements. Public authorities were the second-largest group, with five participants representing the Municipality of Chios and the North Aegean Region, specifically the Environmental and Civil Protection divisions. The business sector included three participants from the Chios Hoteliers Association, the Chios Mastiha Growers Association, and an energy consultant. Academia was represented by two PhD candidates. The group also included facilitators, assistants, and note-takers.

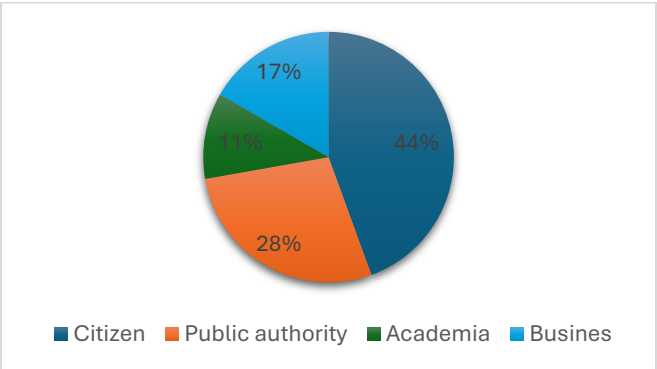

Figure 1. The stakeholder groups of participants in the future scenario building workshop of the LL of Chios

3.2. The key drivers and the generated future scenarios

The initial step in scenario development involved the identification of key drivers (Johansen, 2018), factors characterized by both high impact and high uncertainty that are likely to influence climate resilience at the local level. These drivers were subsequently categorized using the STEEP framework (Social, Technological, Economic, Environmental, Political) (Szigeti et al, 2011) to ensure a comprehensive and systematic approach.

Within the social dimension, two key drivers were identified: S1 – Population patterns, and S2 – People's values and lifestyle. For the technological dimension, two drivers were proposed: T1 – Innovation in transport, and T2 – Technological advancements in critical economic sectors, such as tourism and agriculture. In the economic domain, the selected drivers included E1 – Resource consumption and circular economy, and E2 – Energy footprint. The environmental category included three significant factors: EN1 – Water preservation and forest resilience, EN2 – Sea-level rise, and EN3 – Increase in temperature. Lastly, the political dimension was represented by a single, yet critical, driver: P1 – Policies and regulatory frameworks. This structured identification and classification of drivers served as the foundation for the subsequent stages of scenario building, enabling participants to explore plausible future pathways in a consistent and interdisciplinary manner.

Building on the identified key drivers, multiple plausible future developments were formulated for each driver through structured group discussions. These developments were then systematically combined using morphological analysis to construct internally consistent scenario narratives. Figure 2 illustrates an example of the morphological box, showing selected combinations of developments across three critical drivers and the formation of two indicative scenarios.

Scenario development was carried out through an iterative process, beginning with subgroup deliberations focused on evaluating coherent combinations of driver developments. These subgroup outputs were then synthesized in plenary sessions to refine and consolidate the final scenario narratives. In total, five distinct scenarios were generated, each reflecting a unique configuration of socio-technical and environmental dynamics. The thematic focus of the scenarios varied, encompassing pathways based on traditional ecological knowledge, bottom-up community resilience, and top-down innovation-driven approaches. This process supported a diverse and locally grounded exploration of plausible climate-resilient futures for the Chios region, with potential for adaptation and use in other settings. In Table 1, a summary of the 5 scenarios is presented.

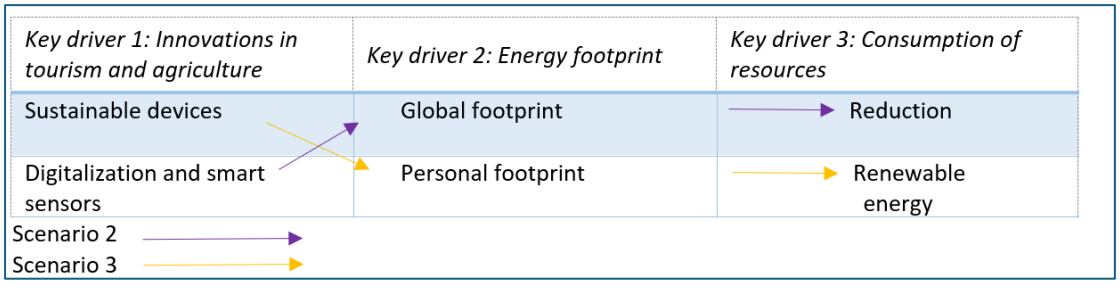

Figure 2. Example of a morphological box illustrating selected combinations of developments across three key drivers, leading to the construction of two scenarios.

Table 1. List and summary description of the five scenarios generated in Chios Living Lab for a resilient future to climate change

Scenario number	**Short description**
Scenario 1. Integrating Tradition and Innovation for Ecosystem Protection	This scenario combines traditional practices like controlled burning with innovative technologies such as drone surveillance to protect Chios's vulnerable pine forests. Water resource management includes reuse, desalination, and nature-based or traditional solutions. Emphasizing climate justice, investments prioritize vulnerable communities, while education campaigns empower citizens. Infrastructure adapts proactively to moderate sea-level rise, ensuring ecosystem preservation and climate resilience through a balanced global and local response.
Scenario Two: Smart Agriculture through Digitization and AI	Advanced digital technologies enable precision farming, using sensors and high-resolution maps to optimize irrigation, fertilization, and pest control, reducing agriculture's environmental footprint. Regenerative practices enhance productivity sustainably. Supportive education, economic incentives, and ethical industry cooperation foster farmer adoption and consumer awareness. This scenario promotes efficient resource use and climate-friendly food production through a synergy of technology, knowledge, and policy.
Scenario Three: Sustainable Tourism Adapting to Climate Change	Tourism adapts to climate pressures by respecting local culture, extending seasons, and limiting overcrowding. Policies encourage eco-friendly infrastructure and promote blue tourism to diversify fishermen's income. Awareness campaigns target visitors to reduce environmental impacts, securing tourism's future. This scenario balances economic viability with environmental protection and cultural preservation amid increasing Mediterranean climate challenges.
Scenario Four: Centralized Policy and Technological Innovation	Top-down governance drives climate action with enforced pro-environmental policies and industry innovations. Durable, low-carbon products, electric and autonomous vehicles, and delivery drones reduce emissions. Education and campaigns promote citizen compliance. Responsibility centres on policymakers and industries, with limited emphasis on individual or community-led initiatives, reflecting a command-and-control approach to sustainability.
Scenario Five: Grassroots Sustainability and Social Transformation	A bottom-up movement fosters sustainability through education, inclusive governance, and community engagement. Lifestyle changes prioritize reduced consumption, recycling, and circular economy principles. Political pressure leads to adaptive green policies. Diverse transport modes reduce fossil fuel use. Social integration ensures inclusivity, overcoming bureaucratic hurdles to build a resilient society aligned with long-term environmental and social goals.

The five scenarios present distinct yet complementary pathways for strengthening climate resilience, each highlighting different actors and mechanisms of change. The scenarios are grounded in the life experiences and contextual knowledge of the participants—all residents of Chios Island—but also emerge as a synthesis shaped through their creative interactions during the workshop (Dufva & Ahlqvist, 2015). Located in the northern Aegean Sea, Greece, Chios has a Mediterranean climate characterized by hot, dry summers and mild, wet winters. As of the 2021 census, the island's population stood at approximately 50,361, with 27,000 residents in Chios city. The island is known for its maritime tradition, with a notable number of shipowners originating from the area and serves as a tourist destination featuring medieval villages and the UNESCO World Heritage Site of Nea Moni. The cultivation and trade of mastiha—a unique resin harvested from *Pistacia lentiscus* trees—remains a significant economic activity. However, Chios has faced environmental challenges, including a series of severe forest fires over the past five decades that have reduced forest cover, and persistent issues with potable water supply in Chios city. It is unsurprising, in this context, that the generated future scenarios for climate resilience emphasize issues such as water and forest preservation, agricultural development, and sustainable tourism.

Specifically, Scenario One (Table 1) blends traditional ecological knowledge with cutting-edge technology, fostering ecosystem preservation and water management while ensuring climate justice. This approach is rooted in local cultural practices, enhancing acceptance and effectiveness. Scenario Two focuses on digital transformation in agriculture, leveraging precision farming and AI to optimize resource use and reduce emissions, highlighting the vital role of technology and education in sustainable food systems.

Scenario Three addresses tourism, an important economic sector in Chios, by promoting sustainability through policy, cultural integration, and technological innovations, adapting to climate impacts while preserving heritage and livelihoods. Scenario Four adopts a centralized, top-down governance model, relying on strong policies and industrial innovation to reduce environmental footprints, yet it risks limited public participation. Lastly, Scenario Five emphasizes bottom-up social change, driven by collective values, education, and inclusive governance, highlighting the transformative power of civic engagement and lifestyle shifts.

Together, these scenarios illustrate a spectrum from community-driven to policy-led actions and from traditional knowledge to high technology, reflecting the economic sectors and environmental conditions of the island. Ultimately, a hybrid model may be most effective, combining the systemic coordination of Scenario 4, the technological and ecological integration of Scenarios 1 and 2, and the participatory ethos of Scenarios 3 and 5, reflecting the complex socio-environmental dynamics of Chios and similar Mediterranean regions. Overall, integrating elements from multiple scenarios may offer the most resilient and equitable pathway for Chios and similar regions facing climate change.

3.3. Critical Factors for a Successful FSB Workshop

Reflecting on the workshop proceedings, several key factors emerged as essential for ensuring effective participation and meaningful outcomes:

1. Participant Recruitment: Personalized communication with potential participants prior to the workshop proved vital for engaging interest and allowing time for reflection—both conscious and subconscious—on the topic. It is important to

emphasize that all individuals, regardless of expertise, can contribute valuable insights based on their lived experiences and unique perspectives (Dufva and Ahlqvist, 2015).

2. Promoting Inclusivity: Discussions with local authorities in Chios revealed that past citizen deliberation efforts suffered from low and repetitive participation. Considering this information, the FSB workshop benefited from inclusive strategies, such as translating supporting materials into Greek, using accessible yet precise language, and distributing printed information instead of relying solely on digital communication. These steps facilitated broader participation across different segments of society.
3. Clarifying the Workshop's Purpose: Participants must fully understand the objectives of the workshop and the relevance of their contributions. Communicating how their input may influence policymaking—such as informing authorities during the scenario evaluation phase—can enhance motivation. Additionally, it is important to convey that the aim of the exercise is not only to envision plausible futures but also to interpreting the results to present actions to address emerging challenges (Dufva and Ahlqvist, 2015).
4. Clear Methodological Guidance: A brief overview of the scenario-building methodology should be provided at the outset, followed by detailed explanations before each phase. Real-life examples and ample time for questions help ensure participant comprehension and engagement.
5. Time Management: Balancing the depth of exploration with participants' limited availability is crucial. Adequate preparation and early engagement can help optimize workshop efficiency while respecting participants' time constraints.

4. Conclusions

This study demonstrated the value of applying a participatory Future Scenario Building (FSB) methodology within a Living Lab setting, using the Chios Living Lab as a case study. By involving a diverse group of local stakeholders, the process generated five robust, context-specific scenarios addressing climate resilience in key sectors such as water, nature, agriculture, tourism, transport and governance. The scenarios reflect a wide spectrum of approaches—from grassroots activism and traditional ecological knowledge to top-down policy interventions and advanced technologies—each offering complementary strategies to address the environmental vulnerabilities and societal needs in the path of resilience.

The integration of the FSB process within the Living Lab framework proved effective in fostering inclusive dialogue, knowledge co-production, and creative problem-solving. Critical success factors included thoughtful participant recruitment, cultural and linguistic adaptation of materials, clarity of purpose, and methodological transparency. These elements helped ensure meaningful engagement and the development of actionable insights grounded in local and global realities.

Overall, the FSB workshop in the Chios Living Lab experience underscores the importance of participatory foresight in shaping climate adaptation strategies. It suggests that hybrid approaches—combining community-led initiatives with supportive governance and innovation—may offer the most effective pathways for sustainable and resilient futures in Mediterranean island contexts and beyond.

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