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A Participatory SWOT-Based Approach to Nature-Based Solutions Within Urban Fragile Territories: Operational Barriers and Strategic Roadmaps

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Abstract

Nature-Based Solutions (NBSs) are increasingly financed in urban, regional, and national contexts due to their proven capacity to reduce climate risks and deliver multiple co-benefits. Several challenges affect the successful implementation and long-term maintenance of NBSs, especially in climate-sensitive and fragile urban territories (e.g., the Mediterranean basin), characterized by intense urbanization, environmental vulnerability, socio-economic disparities, and fragmented governance. Key barriers include difficulties in economically evaluating NBS benefits, uncertainty about their effectiveness under changing climate conditions, and implementing multi-functional projects with an interdisciplinary perspective. To address these challenges, a participatory process was conducted involving three thematic working tables focused on the following: (1) economic evaluation, (2) co-design for climate resilience, and (3) multi-functionality and disciplinary integration. All groups applied a shared SWOT (Strengths, Weaknesses, Opportunities, Threats) methodology structured

in four phases: (i) individual reflection and collective brainstorming; (ii) collaborative SWOT matrix development; (iii) roadmaps formulation; and (iv) narrative synthesis and submission. Grounded in their knowledge and practical experiences, stakeholders identified operational barriers and strategic advantages to identify research gaps and designing adaptive, inclusive, and context-sensitive NBS roadmaps. Although the stakeholders were primarily based in Northern Italy, they also brought national and international experience, making the findings relevant and transferable to other urban areas in the Mediterranean and Europe, facing similar socio-environmental challenges and governance issues. Thus, the study supports more effective planning and governance in comparable contexts, emphasizing integrated and flexible approaches to address urban fragility and optimize projects governance and management.

Keywords: SWOT analysis; stakeholder involvement; Nature-Based Solutions; adaptive cities; multi-functionality; co-planning; collaborative approach

1. Introduction

Territorial fragility is a multi-dimensional concept encompassing ecological vulnerability, socio-economic instability, and the limited adaptive capacity of human and natural systems to external stressors. It has been defined in various ways across disciplines, often referring to areas that are particularly susceptible to socio-political disruptions (e.g., post-conflicts), environmental degradation, natural hazards, coupled with highly fragmented institutional frameworks and weak management [1–3].

However, in recent decades, rapid and often unregulated urban expansion has also emerged as a driver of territorial fragility [4]. With the accelerated pace of global urbanization [5], ecosystem structures and functions have been strongly altered with critical damages to Ecosystem Service (ES) supply, essential for urban sustainability [6,7]. These dynamics are particularly severe in climate-sensitive regions (e.g., the Mediterranean basin), where urban growth affected ecosystem resilience but also exacerbated public health risks and social inequalities [8–10]. Moreover, urban expansion has triggered increasingly complex governance challenges in managing urban spaces, often marked by overlapping competencies, institutional fragmentation, and a lack of long-term strategic coordination [11]. Indeed, several studies highlight that the economic benefits of urban growth are frequently decoupled from social equity, with wealth and opportunities often concentrated in specific areas while large segments of the urban population remain excluded from the advantages of development [12–14]. The uneven spatial distribution of infrastructure, services, and environmental quality across neighborhoods reinforces socio-economic disparities [15], contributing further to territorial fragility and deepening patterns of segregation and vulnerability within the urban fabric [16]. As a result, many contemporary cities, even though not located in conflict areas, are increasingly being recognized as fragile territories, where the tensions between economic development, environmental integrity, and social cohesion pose significant challenges for sustainable urban planning [17].

In response to these critical challenges, recent research and policy agendas have emphasized the need to reframe urban planning through the lens of ES [18,19]. This promotes a more integrated understanding of the multiple benefits that ecosystems provide to urban areas, including climate regulation, air purification, water management, recreational value, and social inclusiveness [20,21]. In this context, Nature-Based Solutions (NBSs) have been increasingly promoted and financed by many national and international policy instruments [22,23]. As key strategies to restore ecosystem functions, they mitigate the negative

impacts of land consumption and contribute to more equitable urban environments [22]. By enhancing green and blue infrastructure, NBSs not only contribute to environmental quality but also offer opportunities to reduce social disparities, providing more equitable access to nature, public health benefits, and climate adaptation resources.

As such, planning cities through NBSs holds significant potential to address the intertwined ecological and social dimensions of territorial fragility [24], encompassing interventions across sectors, spatial scales, and disciplinary domains [25,26]. However, despite the increased political and scientific endorsement, the implementation of NBSs remains fragmented and mainly limited to emblematic cities and/or neighborhoods [27]. Furthermore, the broad diversity of scientific terminologies, intended functions, and ES associated with NBSs can both support more tailored implementation; and conversely, it can also introduce confusion and misalignment [28], especially in urban contexts characterized by institutional fragmentation. This condition implies important and severe operative challenges concerning a limited public and institutional awareness, knowledge gaps about NBS effectiveness, a lack of estimating NBS costs and benefits, misalignment among stakeholders' values and perceptions about NBSs, and an underdeveloped policy and financial instruments [29–31]. This research investigates these challenges through the lens of territorial fragility [32], understood not only in terms of environmental vulnerability but also about the fragility of decision-making processes, shaped by uncertainty, fragmented governance structure, and limited knowledge of the context-specific characteristics of NBS interventions [33]. Within this perspective, fragility is interpreted as the governance complexity of managing participatory and interdisciplinary approaches in settings marked by conflicting interests, divergent values, and limited institutional capacity [34].

The study adopts the perspective of a multi-disciplinary group of stakeholders who have worked at various stages in contexts where urbanization- and governance-driven fragility constitutes a particularly urgent dimension of the wider debate on sustainable and inclusive urban planning. This perspective grounds the research in practical, situated experiences, emphasizing the need to address fragility not as a static conflict and post-disaster condition [35], but as a dynamic and evolving challenge in rapidly transforming urban territories. To operationalize this approach, a seminar was organized within the Competence Center Anti-Fragile Territories[1] (CRAFT) of the Department of Architecture and Urban Studies (DAStU) of the Polytechnic of Milan. Through participatory working tables, the seminar engaged a range of stakeholders, public administration, academics, experts, and private actors, operating mainly in the Lombardy Region (Northern Italy), with broader experience at the national and international levels. This co-design process aimed at fostering inclusive dialog and critical reflection on NBS planning and the development of roadmaps for their management in urban and peri-urban areas. The core objective of this research was to identify both operational barriers and enable conditions for the implementation and governance of NBSs in fragile contexts. Particularly, through a participatory SWOT (Strengths, Weaknesses, Opportunities, Threats) analysis, the study aimed to understand how to mitigate such barriers and leverage existing advantages by co-developing shared strategic roadmaps as actionable frameworks for NBS implementation and co-governance. Three thematic focuses guided this process as follows: (i) economic evaluation and resource allocation; (ii) adaptability and resilience to climate change; and (iii) multi-functionality and multi-actor governance. The initiative lies in the recognition that persisting gaps in NBS implementation, particularly in fragile territories, stem from the limited integration of socio-political, institutional, and economic dimensions into current policy frameworks. Overcoming these gaps requires broadening stakeholder engagement and embedding the plurality of values and perceptions into planning and decision-making processes [36]. This framework aligns with emerging models of inclusive and adaptive governance, which

seek to comprehensively tackle ecological goals, social equity, and long-term resilience of complex urban territories [37,38].

The paper is structured as follows: Section 2 presents the methodology developed, Section 3 illustrates the main results, Section 4 discusses emerging themes and strategic roadmaps, while Section 5 reports the conclusions of this work.

2. Materials and Methods

The seminar was conceived within the broader framework of two Italian research centers financed by the Italian Recovery and Resilience Plan, i.e., Agritech[2] and the National Biodiversity Future Center[3], to advance collective reflection and interdisciplinary knowledge on NBSs and ES in complex urban contexts threatened by urban pressure, demographic shrinkage, and climate change. Rather than functioning as a one-way dissemination event, the seminar was structured as a co-productive learning environment, where academic, institutional, and professional forms of expertise could engage in critical dialog. Attention has been given to new interpretative frameworks and operational roadmaps capable of addressing the multi-dimensional fragilities of contemporary urban territories, where the loss of ecosystem functionality, reduced resilience, and spatial disparities often coexist with decision-making uncertainty and institutional fragmentation.

Implementing effective and equitable NBSs in such fragile settings requires place-based, interdisciplinary, and transdisciplinary knowledge, which no single discipline or stakeholder can fully provide. Therefore, the seminar was grounded in deliberative planning approaches [39,40], where knowledge emerges from participatory dialog and the crossing of disciplinary and experiential boundaries.

This collaborative setup responds to an increasing recognition in the literature of the value of participatory and transdisciplinary approaches in the planning and governance of NBSs [25,41]. Such approaches are instrumental to building the capacity of policymakers and public officials, equipping them to deal with trade-offs, understanding socio-ecological synergies, and co-designing NBSs that are contextually appropriate and collectively owned [30].

2.1. Workshop Organization

Three working tables were organized and each focused on a distinct thematic area. Participants (approximately six per table) were carefully selected to ensure a diversity of expertise and perspectives, including scholars, practitioners, experts, and institutional representatives. Each table was supported by a table coordinator tasked with facilitating the process and synthesizing outputs. The thematic focuses were as follows:

- **Table A: Assessing Natural Capital in Urban and Peri-Urban Contexts**
  This thematic table examines and defines innovative approaches and tools for assessing natural capital in urban and peri-urban contexts, focusing on the identification and consideration of social, economic, and ecological dynamics. Opportunities and limitations of existing metrics are explored with respect to the high complexity of assessment demands, to identify emerging assessment needs to develop tools adaptable to different spatial contexts. The goal is to explore evaluation tools to support local governments and planners in implementing effective policies for natural capital management in urban and peri-urban contexts.
- **Table B: Co-design and Planning of NBSs for Climate Risk and Environmental Change**
  This thematic table addresses NBS co-designs as a tool to support the development of planning roadmaps as a response to climate risks. The goal is to propose cities that are

more resilient, flexible, and able to adapt to climate change by exploring roadmaps to involve different actors in decision-making.

- **Table C: Understanding and Designing Multi-Functional NBS Scenarios**
  This thematic table aims to develop planning roadmaps that enhance the design, implementation, and long-term maintenance of multi-functional and multi-stakeholder NBSs scenarios. These roadmaps seek to incorporate and address the diverse demands for ES expressed by different stakeholders, while addressing environmental, social, and economic challenges specific to vulnerable territories.

The methodology adopted was inspired by hackathon and design thinking formats, promoting rapid ideation and synthesis within a collaborative setting. Each table followed a structured four-phase process, with the SWOT analysis at its core.

SWOT, which stands for Strengths, Weaknesses, Opportunities, and Threats, is a strategic planning tool used to identify and categorize internal and external factors that can affect a project, policy, or initiative [42]. While traditionally applied in corporate strategy, SWOT has increasingly been employed in urban planning, environmental management, and participatory settings to facilitate structured group discussions and consensus building [23,43–48].

In the context of the seminar, the SWOT analysis supported multiple functions:

- It structured the initial diagnosis of the state of knowledge, governance, and implementation challenges around NBSs and ES;
- It facilitated the comparison of viewpoints and the identification of shared concerns and priorities;
- It grounded the subsequent development of design and planning roadmaps in a systematic reflection process.

2.2. Methodological Phases

The objective of the working tables was twofold: (1) developing a collective SWOT analysis on the assigned topics, and (2) translating the analysis into strategic and design-oriented roadmaps. This process was intended not merely as a moment of engagement but as a foundational step toward producing a collective output that synthesizes the results and reflections emerging from each table. The methodology unfolded through four consecutive phases, combining individual analysis, group discussion, strategic synthesis, and narrative integration (Figure 1). The chosen structure drew on collaborative planning traditions and was influenced by practices in transdisciplinary research workshops, particularly those that have successfully used SWOT analysis as a collective inquiry and planning tool (e.g., [49–51]).

Phase 1: Individual Reflection and Collective Brainstorming

The process began with a moment dedicated to individual reflection. Each participant was invited to draft a preliminary SWOT analysis based on their own experience and disciplinary lens. This step aimed to elicit personal and often tacit knowledge that might not immediately emerge in group discussions. It also helped participants clarify their stance toward the theme before being exposed to peer interpretations.

Subsequently, the group moved into a collective brainstorming session. Participants shared their initial inputs, which were then discussed and grouped under the four SWOT categories. The table coordinator acted as a moderator, facilitating convergence, clarifying ambiguous points, and encouraging critical questioning. The objective of this phase was to generate a shared conceptual starting point, recognizing both the internal and external dimensions of the problem at hand. “Strengths” and “Weaknesses” referred to internal conditions, i.e., institutional capacities, technical tools, or policy frameworks, while

"Opportunities" and "Threats" addressed external trends or drivers, i.e., socio-political change, funding schemes, or climate-related uncertainties.

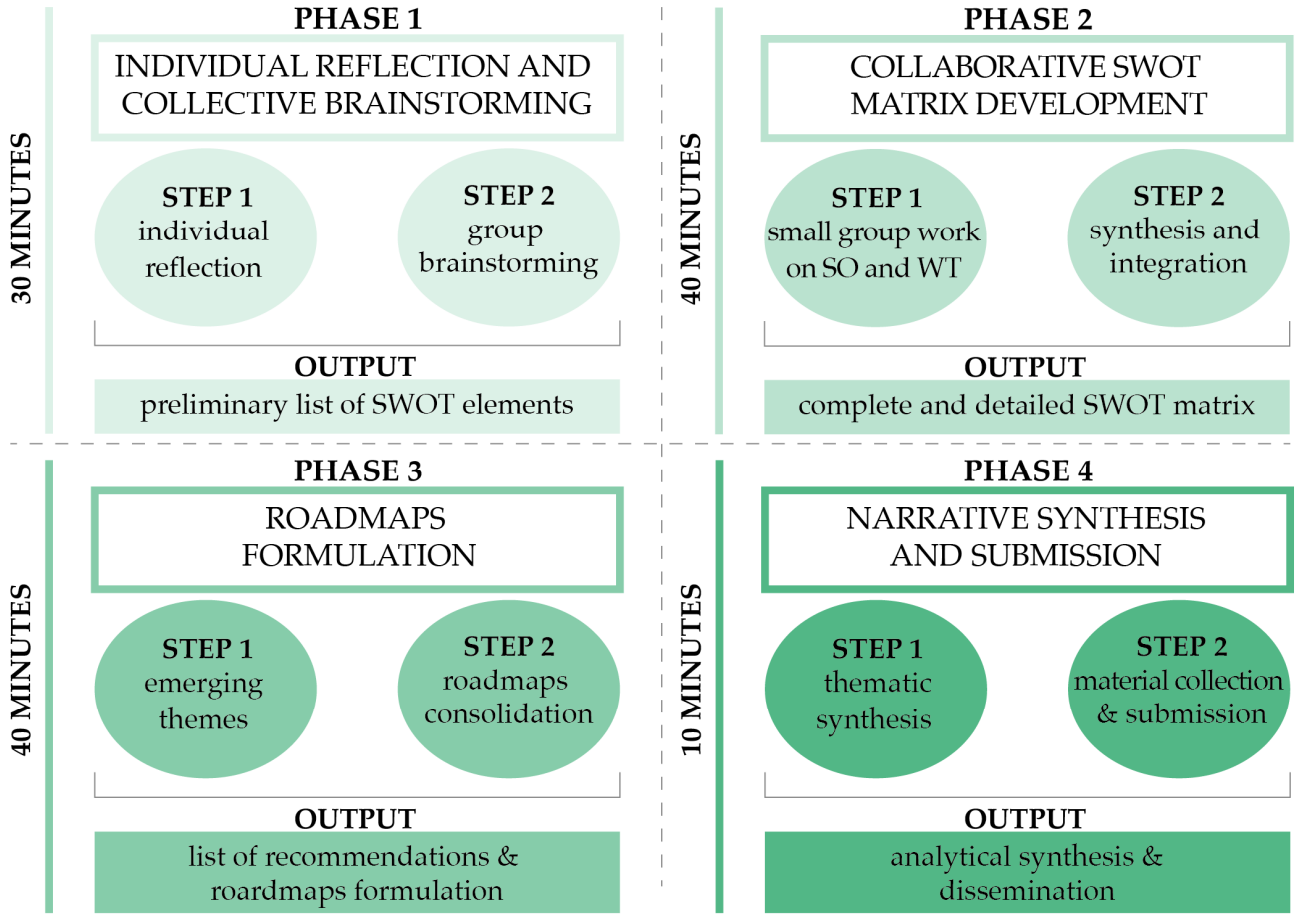

Figure 1. Methodological phases developed.

Phase 2: Collaborative SWOT Matrix Development

Following the initial discussion, the group was split into two subgroups. Based on the experiences of applying the SWOT matrix as a tool for situational analysis and roadmaps formulation in urban and environmental planning [52–54], one group focused on further developing and substantiating the identified Strengths and Opportunities (SO), while the other examined Weaknesses and Threats (WT). This subdivision allowed participants to deepen the analysis and explore examples, contradictions, and interconnections without the constraints of full-group discussion. In this application, the SWOT matrix was adapted and simplified by clustering the emerging themes into two macro-categories: (i) main barriers (WT) and (ii) main advantages (SO). This simplification was consistent with the main goal of the seminar, i.e., discussing the emerging themes to build functional roadmaps for NBS implementation, while also addressing the limited time available for Phase 2 of the applied method. Each subgroup was encouraged to go beyond generic entries by identifying patterns, case-based references, or empirical evidence that could support the themes. This helped ensure analytical depth and practical relevance. After this in-depth work, the two subgroups rejoined to merge their contributions into a single, coherent SWOT matrix (Appendix A). The table coordinator's role at this stage was critical to ensure the matrix maintained internal consistency, thematic clarity, and alignment with the table's focus.

Phase 3: Roadmaps Formulation

Building on this shared work, participants were invited to collectively identify possible strategic roadmaps. These roadmaps represent shared and co-designed ideas that were meant to leverage the Strengths and Opportunities previously identified while addressing or mitigating Weaknesses and Threats. The discussion, moderated by the table coordinator, was guided by a future-oriented lens: how could insights from the SWOT analysis inform planning, policy, or research?

Participants proposed a variety of ideas, ranging from governance models and participatory mechanisms to spatial interventions, evaluation frameworks, and policy incentives. These contributions were then distilled into a short set of 3–5 roadmaps or recommendations. Each was formulated clearly, avoiding jargon and ensuring accessibility for broader dissemination.

Phase 4: Narrative Synthesis and Submission

In the final stage, each group synthesized its work into a concise narrative summary. This text, written by the table's coordinators in collaboration with participants, provided a holistic overview of the findings, highlighting the most pressing issues, innovative ideas, and potential for future action. The narrative was explicitly connected to the overarching goal of the seminar: exploring how NBSs and ES can offer actionable and replicable responses to territorial vulnerabilities and contribute to the transformation of urban and peri-urban landscapes.

All outputs, including the final SWOT matrix (Appendix A), roadmaps, and narrative synthesis, were collected and formatted to enable comparative reading across the three tables. This documentation process is intended to support the subsequent phase of the project that will consolidate and reflect on the results, methodological insights, and implications for practice and policy.

This process echoes findings from previous participatory studies on NBSs, such as those by Buijs et al. [55], who emphasize the role of collaborative design in creating socially robust and ecologically sound solutions. Similarly, Pauleit et al. [56] advocate for stakeholder-inclusive approaches as essential for embedding NBSs in real-world planning frameworks. The results of each working table, analyzed in the next section, reflect the richness of this participatory methodology and its potential for informing transdisciplinary urban roadmaps grounded in ecological and social resilience.

3. Results

3.1. Stakeholders Involved in the Three Thematic Tables

Table 1 shows the panel of stakeholders engaged across three thematic tables, including academic experts in project evaluation and urban planning, policymakers, politicians involved in negotiated planning, planners specializing in natural capital management in urban and peri-urban areas, architects, business owners, and sales professionals. Their experience stems from ongoing practices in urban and peri-urban contexts, particularly across the Lombardy Region (Northern Italy), where land use pressure, ecological degradation, funding management, and institutional fragmentation are critical challenges for urban resilience [57,58].

The stakeholders were carefully selected and distributed to ensure the multidisciplinary nature of the groups, while also considering the wide spectrum of their operational knowledge, having all been directly involved in NBS implementation projects at various scales and stages. Drawing on their specific case studies in fragile urban territories, characterized by unbalanced development patterns, ecosystem vulnerability, and fragmented governance frameworks, participants were actively involved in compiling the

SWOT analysis, aiming to identify both recurrent operational barriers and strategic opportunities. Their inputs, grounded in direct involvement in real-world planning processes, allowed the SWOT to reflect concrete, practice-based insights relevant to the governance and effective deployment of NBSs in complex and fragile urban settings.

Table 1. Panel of stakeholders engaged across the three Thematic Tables A, B, and C.

Thematic Table	Name and Surname	Typology	Field
A	Giulia Datola	Academic and table coordinator	Real estate appraisal and project evaluation
	Francesco Sica	Academic	Real estate appraisal and project evaluation
	Francesca Torrieri	Academic	Real estate appraisal and project evaluation
	Silvia Pisciotta	Politician	Negotiated planning
	Marianna Merisi	Architect	Landscape Director in Park Associati
	Alberto Fedalto	Academic	Urban planning
B	Silvia Ronchi	Academic and table coordinator	Urban planning
	Maria Chiara Pastore	Academic	Urban planning
	Daniela Maiullari	Academic	Urban planning
	Valentina Gagliulo	Expert	Landscape
	Diego Baronchelli	Expert	Architecture
	Gianpiero Calvi	Expert	Natural science
C	Elena Di Pirro	Academic and table coordinator	Urban ecology
	Sandy Attia	Architect	Architecture
	Maddalena Buffoli	Academic	Urban Health, Hygiene
	Simona Collarini	Architect and Planner	Urban Regeneration
	Andrea Fantin	Expert	Green Roofs product manager
	Andrea Benedini	Academic	Urban planning
	Stefano Salata	Academic	Urban planning

Although the stakeholders' experiences were primarily rooted in the Lombardy Region (Northern Italy), the challenges and dynamics they addressed are highly representative of broader urban contexts across the Mediterranean and Europe, where cities increasingly face overlapping pressures related to land consumption, habitat loss, socio-spatial inequalities, and the escalating impacts of climate change.

3.2. Thematic Table A—Assessing Natural Capital in Urban and Peri-Urban Contexts

Table A highlighted the need for more adaptable and multi-dimensional evaluation frameworks to capture the full value of NBSs in fragile urban contexts. Participants emphasized that current economic tools insufficiently support planning and policy design, calling for integrated approaches that link evaluation with strategic decision-making.

3.2.1. Emerging Themes in Thematic Table A

As previously illustrated, stakeholders work on the given topic according to different tasks (Section 2.2). The main emerging themes here are illustrated and discussed to better understand and conceptualize the proposed roadmaps. Table 2 summarizes the main

themes that emerged among phases 1 and 2 (Figure 1) of the assigned tasks. The table's emerging themes have been categorized into "main barriers" to address weaknesses and threats (WT) and "main advantages" to highlight the strengths and opportunities, as explained in Section 2.2. The emerging themes were then investigated and connected to develop shared roadmaps aiming to mitigate barriers and valorize advantages (Table 3).

Table 2. List of the emerging themes of Thematic Table A.

Emerging themes	**Main barriers** (Weaknesses and Threats)	(WT1) Issues in estimating costs and benefits of NBSs in monetary terms; (WT2) Lack of data and context-based information; (WT3) Limited knowledge of NBS meaning and features; (WT4) Long-term strategies, difficulty in addressing long-term effects in the ex-ante phase.
	Main advantages (Strengths and Opportunities)	(SO1) Evaluation as a support tool; (SO2) Transparency and integration of different values and disciplines; (SO3) Multi-dimensionality and multi-scalarity; (SO4) Budget vs. performance: effective economic resources allocation.

Table 3. List of the proposed roadmaps by participants of Thematic Table A.

ID	Roadmaps
A1	Reformulating market values for the OMI zones
A2	Pricing list of NBS intervention
A3	Integrated evaluation framework to support the evaluation according to the budget and performance

The main identified criticality relates to the difficulty of estimating both NBS costs and benefits in monetary terms. In particular, with regard to costs, the absence of standardized parametric cost tables represents one of the significantly recognized limitations to estimate both implementation and maintenance expenses. Another significant challenge for properly performing an evaluation is the lack of accessible and transferable data. Available data are often context-based, which limits their applicability in different geographical or institutional settings. Furthermore, public administrations are not always structured to systematically collect or share open data, which negatively affects the possibility of performing context-based evaluation for NBS interventions. Moreover, the wide meaning of the NBS concept has also been identified as a critical issue. Given the umbrella nature of the term and the existence of multiple definitions, there is still a limited understanding and awareness of the specific features and functions of NBSs. This condition hinders the definition of key elements to be included in the evaluation and obstructs the proposal of a comprehensive, multi-dimensional, and robust evaluation framework [59].

Despite these barriers, several advantages were discussed. Evaluation has been recognized as a suitable support tool for the strategic integration of NBSs into urban planning and programming, ensuring alignment with local and regional plans. Multi-dimensional evaluation approaches enable considering different values and dimensions, thus facilitating the integration across spatial and temporal scales and the transparency in the decision-making process. Furthermore, evaluation tools can be applied throughout the following different stages of the intervention cycle: in the ex-ante phase (to support planning and decision-making), the in-itinere phase (to monitor progress and performance), and the ex-post phase (to assess outcomes and potential trade-offs). Additionally, evaluation frameworks can be used for medium- and long-term impact assessment [60], as well as for spatial analysis to identify suitable locations and/or the appropriate scale of intervention [61]. The involvement of multiple disciplines and expertise can support the identification of the

most appropriate NBS typologies, considering both contextual and economic factors. Finally, evaluation is fundamental to comparing the costs and benefits of the proposed NBSs. Therefore, it should also contribute to the monetization of NBSs benefits, including ES, thus enabling their recognition as compensatory measures and supporting their integration into strategic planning and more efficient resource allocation processes.

3.2.2. Proposed Roadmaps by Participants of Thematic Table A

Three different roadmaps have been proposed to overcome the identified barriers and to strengthen the positive elements. They can be considered synergistic and complementary, as all three aim to address the problem of inadequate evaluation tools. The first two roadmaps, A1, "Reformulating market values for the OMI[4] zones", and A2, "Pricing list of NBS intervention", focus on the monetary values of NBSs, which represent the most critical aspects, considering the intangibility of the value of natural capital. Roadmap A1 aims at addressing the monetary value of NBS benefits, and it aims to overcome the barriers by using the real estate value as a proxy. On the other hand, Roadmap A2 is focused on cost estimation. The lack of appropriate approaches to estimate the construction cost of NBSs negatively affects their operational implementation. Roadmap A3, conversely, aims at proposing an evaluation framework able to strategically support the identification and the design of the NBSs intervention, by managing both costs and benefits. Table 3 lists the proposed roadmaps to overcome the addressed barriers (threats and weaknesses) and advantages (strengths and opportunities).

3.3. Thematic Table B—Co-Design and Planning of NBSs for Climate Risk and Environmental Change

Table B emphasized the strategic role of NBSs in climate adaptation, highlighting the need for inclusive co-design processes. Participants identified stakeholder engagement and integrated approaches as key enablers to strengthen community resilience and embed NBSs in urban planning. The promotion of integrated and shared approaches is recognized as a critical factor in strengthening urban communities' capacity to address the challenges of contemporary cities. Finally, the discussion also highlighted several emerging themes, such as knowledge gaps, terminological ambiguities, and temporal mismatches.

3.3.1. Emerging Themes in Thematic Table B

From the discussion among the engaged stakeholders in working Table B, several barriers are highlighted in the co-design of NBSs as a planning tool in response to climate risks. One fundamental issue at the heart of the co-design process is determining which stakeholders should be involved and how their participation should be structured. The absence of explicit selection criteria often results in two potentially conflicting risks. On the one hand, the inclusion of an overly diverse and broad group can lead to confusion, lack of focus, and decreased operational effectiveness, at the same time, on the other hand, the exclusion of significant stakeholders whose opinions may be pertinent to the process can limit its legitimacy and success. To address this issue, it is necessary to establish a shared understanding of the roles and responsibilities of each actor and define which knowledge, skills, social positions, and points of view are useful to involve. Identifying stakeholders is also essential for the post-process activity, as it strengthens the perceived value of participation and the long-lasting effects of their involvement, strengthening the connection between actors and the concrete results of the co-design interventions. Encouraging communities or stakeholders to take care of and maintain NBS interventions, also implemented thanks to their support, proves essential for strengthening local stewardship over environmental resources and public spaces.

Following this issue, one of the most critical issues is the level of knowledge and awareness among co-design activity participants about the importance of specific environmental and social dimensions of human well-being. In many participatory contexts, citizens and even some stakeholders may lack the necessary background to grasp the ecological and climatic complexities. This knowledge gap can jeopardize the depth and quality of the discussion, and thus the legitimacy of the design outcomes. Reducing the gap can ultimately hinder meaningful dialog and limit the participants' ability to contribute consciously and effectively to design decisions. As a result, including preparatory training sessions or introductory meetings is often required. These moments serve to build a shared understanding of the common knowledge needed to enable informed and constructive engagement throughout the co-design process. At the same time, there is a risk that some participants may disengage before the process is completed, especially those who already possess technical expertise and may find the initial preparatory training sessions redundant or insufficiently stimulating. Balancing foundational capacity-building with the need to maintain the engagement of more experienced participants remains a delicate challenge.

Another major flaw regards terminology. Some key concepts, such as "resilience", "green and blue infrastructures", or "climate adaptation and mitigation", often remain open to several and different interpretations without a consolidated or universally shared definition. These differences in terminology may cause misunderstandings and misalignments, reducing the decision-making process's coherence and efficacy. Defining a common language is essential to start a clear and effective collaboration, but this requires identifying the authority to define these terms in participatory planning and what their responsibilities are. Finally, temporal mismatches pose an additional challenge. Planning and participation processes frequently have administrative or political deadlines that require measurable outcomes in a short amount of time. More than that, many ecological processes that NBSs activate over long periods frequently contradict these expectations. This contradiction creates a structural conflict between the political need to demonstrate results immediately and the ecological concerns, where major effects may not be felt for some time. The legitimacy of participatory efforts may be harmed, or early and ineffective interventions may result from improper handling of this tension. Therefore, it is crucial to recognize these divergent temporal dynamics to strike a balance between immediate governance needs and long-term ecological processes using flexible techniques and open communication of expected timelines and results (Table 4).

Table 4. Schematization of the emerging themes in Thematic Table B.

Emerging themes	**Main barriers** (Weaknesses and Threats)	(WT1) Absence of clear criteria for stakeholder selection. (WT2) Knowledge and awareness gaps among participants. (WT3) Risk of disengagement from experienced participants. (WT4) Terminological ambiguity. (WT5) Temporal mismatches between political and ecological timelines.
	Main advantages (Strengths and Opportunities)	(SO1) Stakeholder engagement in post-intervention phases. (SO2) Promoting local stewardship. (SO3) Building shared understanding through preparatory sessions.

3.3.2. Proposed Roadmaps by Participants of Thematic Table B

Two main roadmaps are proposed to enhance the long-term effectiveness of NBSs intervention for climate adaptation. Roadmap B1, "Inclusive stewardship and post-intervention engagement", regards the creation of an inclusive stewardship and post-intervention engagement for involving several social groups in the post-implementation phase of a specific project/intervention. The clear definition of a multi-actor group with precise roles,

competencies, and responsibilities can ensure continuity in the maintenance of the intervention addressing the barriers WT1 and WT4 and strengthen the advantages SO1 and SO2 (Table 4), thereby enhancing the durability and legitimacy of outcomes. Roadmap B2, "Shared knowledge on environmental issues", highlights the need to reduce asymmetries in environmental knowledge among stakeholders, increasing and improving the spread of awareness of the benefits of ES. Defining a shared knowledge base from the outset of the participatory process can address barriers WT2 and WT4, supporting the advantage SO3.

Table 5 lists the proposed roadmaps to overcome the addressed barriers (threats and weaknesses) and advantages (strengths and opportunities).

Table 5. List of the proposed roadmaps by participants of Thematic Table B.

ID	Roadmaps
B1	Inclusive stewardship and post-intervention engagement
B2	Shared knowledge on environmental issues

3.4. Thematic Table C—Understanding and Designing Multi-Functional NBS Scenarios in a Multi-Attribute and Multi-ES Perspective

Table C focused on enhancing the multi-functionality of NBS projects by analyzing diverse cases and identifying roadmap plans to improve design, implementation, and maintenance. Emphasis was placed on aligning ES demands from multiple stakeholders with context-specific environmental, social, and economic challenges to foster integrated, durable, and locally responsive NBS interventions.

3.4.1. Emerging Themes in Thematic Table C

The multi-functionality of NBS projects presents a wide range of strengths and opportunities, recognized as particularly relevant in current urban and territorial planning practices, especially within environmentally and socio-economically fragile territories. These insights emerged from the discussion of a multi-disciplinary group composed of architects, academic researchers, business managers, and municipal administrators, who collaboratively assessed the potential and limitations of NBSs across diverse contexts (Table 6).

Table 6. Schematization of the emerging themes in Thematic Table C.

Emerging themes	**Main barriers** (Weaknesses and Threats)	(WT1) Establishing clear responsibilities and priorities among stakeholders; (WT2) Scarce communication and sharing of the effectiveness and performance of projects; (WT3) Limited integration with existing projects and with social and environmental networks; (WT4) Mismatch between innovation and regulatory frameworks; (WT5) Uncertainty in environmental, political, and civic contexts, along with the proliferation of legislative requirements.
	Main advantages (Strengths and Opportunities)	(SO1) Optimization of spatial resources, often limited in urban and peri-urban contexts; (SO2) Multi-functional projects are easily perceived and esthetically appreciated by a wide array of stakeholders; (SO3) The multidisciplinary investigation and involvement foster a transversal approach to complex challenges, supported by vertical, multi-layer, and multi-scale methodologies; (SO4) Networking opportunities; (SO5) Enhanced potential for innovation—particularly through mechanisms such as Public–Private Partnerships (PPPs).

A key strength identified is the capacity of NBSs to deliver multiple ES, enabling a single intervention to address environmental, social, and economic challenges in an integrated and resource-efficient manner. This multi-functional character is identified as an opportunity, particularly valuable where both space and budgets are limited, allowing for optimizing land use and costs through layered and synergistic functionalities. Moreover, the visible and spatially tangible character of these interventions contributes to their public recognition and esthetic appreciation, fostering broader community support and engagement from a diverse range of stakeholders. The interdisciplinary character of NBS planning also promotes a transversal and systemic approach to addressing complex urban challenges, activating collaboration across sectors and scales. Such characteristics were identified to support innovation, foster knowledge exchange, and facilitate the formation of collaborative frameworks, e.g., Public–Private Partnerships (PPPs), that can enhance projects' impact and long-term viability.

Nonetheless, the group identified several key weaknesses that frequently threaten the effective implementation and durability of NBS initiatives. Among these, the lack of clarity in assigning responsibilities and priorities among stakeholders is particularly evident during the early planning stages and in the post-project phase. This governance ambiguity can threaten the accurate assessment of ES demand and weaken project continuity over time. The absence of robust, standardized methods for monitoring, evaluating, and communicating project performance further limits the ability to demonstrate outcomes, hindering both citizen engagement and the replication or upscaling of successful models. Participants also noted a recurring lack of integration with existing projects and territorial roadmaps, often resulting in fragmented, isolated, or "orphan" interventions. In addition, mismatches between innovative NBS approaches and prevailing regulatory frameworks—frequently based on prescriptive rather than performance-oriented standards—were highlighted as critical barriers to implementation. These challenges are further compounded by broader contextual uncertainties, including environmental change (e.g., climate change), political volatility, institutional fragmentation, and the overlapping nature of legislative constraints in multi-stakeholder governance contexts.

3.4.2. Proposed Roadmaps by Participants of Thematic Table C

Two primary strategic approaches were identified to mitigate the weaknesses and threats while leveraging the strengths and opportunities of NBS multi-functional projects:

Both roadmaps emphasize the necessity of embedding new project areas within an existing project infrastructure. This approach aims to minimize the emergence of so-called "orphan projects" and is considered fundamental to ensuring the long-term multi-functionality of interventions and enhancing their value over time in a multi-stakeholder perspective. The overarching goal of Roadmap C1, "Governance mediator among stakeholders", is oriented to overcome the barriers WT1, WT4, and WT5 and enhance SO5 (Table 6), through the identification of a mediator. Roadmap C2, "Valorization and prioritization of intervention areas within a network perspective", is oriented to overcome barriers WT2 and WT3 and enhance advantages SO1, SO2, SO3, SO4 (Table 6), prioritizing new projects according to a gap analysis based on ES demand and environmental justice. Table 7 lists the proposed roadmaps to overcome the addressed barriers (threats and weaknesses) and advantages (strengths and opportunities).

Table 7. List of the proposed roadmaps by participants of Thematic Table C.

ID	Roadmaps
C1	Governance mediator among stakeholders
C2	Valorization and prioritization of intervention areas within a network perspective

4. Discussion

This section synthesizes the cross-cutting themes that emerged from the three working tables, highlighting the systemic challenges in implementing and governing NBSs within territorially fragile contexts. It further outlines roadmaps derived from the workshop's findings and supported by recent scientific literature.

4.1. Shared Emerging Themes Among Working Tables

The three thematic tables addressed different and specific, yet complementary, dimensions of NBSs planning and management, focusing, respectively, on natural capital assessment, the role of co-design in addressing climate risks, and the enhancement of NBSs multi-functionality. Despite their different focuses, the discussions converged on a set of systemic barriers that reflect the complexity of operationalizing NBSs, particularly in territorially fragile contexts. Participants consistently emphasized that overcoming these barriers and leveraging the recognized advantages requires a multi-level, multi-disciplinary approach. This should be grounded in participatory governance structures, supported by robust evaluation mechanisms and the adoption of shared conceptual and methodological tools. The following sections outline the key cross-cutting themes that emerged across the three tables.

As identified through the SWOT analysis of stakeholder interactions across Tables A, B, and C, a prominent issue concerns persistent knowledge and educational gaps in the three fields faced in the thematic tables, which limit the effectiveness of participatory processes and evidence-based decision-making. Indeed, a lack of mutual comprehension between researchers and non-academic actors often hampers the creation of new knowledge and innovative solutions [62]. For instance, the limited understanding of the value of natural capital can lead to underestimating the economic benefits of ES supply [63], as well as the inhomogeneous knowledge of the management costs of NBSs [64] can affect the selection of the most cost-effective implementation scenarios [65]. This aspect is strongly connected with the lack of shared definitions for key concepts such as "resilience" and "climate adaptation"—as highlighted in Table B—which often causes misunderstandings among actors about required commitment and co-planning actions [66]. Accordingly, knowledge is frequently attached to sectoral actors (i.e., academic and non-academic) and their ability to communicate their knowledge and raise awareness around specific topics [62]. This challenge extends to educational gaps concerning the potential impacts of climate change and necessary actions to enhance urban resilience and adaptive capacity [30]. During the brainstorming sessions, participants consistently reported that the absence of a shared terminology and common glossary related to NBSs constitutes a major barrier across all thematic tables. Researchers engaged in the discussion displayed greater consensus on shared terminologies, reflecting their grounding in academic and scientific literature. In recent years, the literature has increasingly focused on the development of a shared terminology and taxonomy for NBSs and their impact, recognizing that conceptual clarity is essential for effective implementation, evaluation, and cross-sectoral communication and planning [28,67]. Conversely, politicians and experts from the business and architectural sectors often struggle to grasp the terminology, frequently conflating synonyms and com-

plementary concepts and pursuing different ideas and pre-existing ways of managing local challenges [31].

This also happens due to the controversial aspect of multi-functionality. Although all tables converge on the advantages of NBSs in providing multiple ES simultaneously while saving time and space [15], this can also raise ambiguity on the broader meanings and functionality that NBSs represent [68,69]. However, as highlighted in the literature, the proliferation of NBS-related projects in recent years has facilitated a more effective translation of scientific knowledge and terminology into everyday language [70], thereby improving the capacity-building of both policymakers and municipal technical staff [71–73]. In this regard, Table C underscores how the multi-functional character of NBSs has triggered meaningful interactions among multi-disciplinary actors, contributing to an increase in cross-sectoral knowledge exchange and in facing sectors siloes [74,75]. Nonetheless, the majority of these initiatives have taken place in a fragmented manner [27], predominantly within a few pioneering and forward-thinking cities, able to capitalize on the opportunities offered by research–policy collaboration [25,76]. Consequently, the working tables stressed that in more vulnerable contexts, i.e., peripheral neighborhoods in metropolitan areas and small municipalities in inner or marginal territories, these knowledge exchanges have been largely limited or absent.

Data, best practices, and mapping efforts have often become concentrated in specific areas (i.e., city centers), leaving vulnerable territories, under the physical and socio-economic profile, without adequate ES biophysical quantification and economic valuation of their benefits [77] and raising concerns on environmental justice distribution [13,78,79]. The threat posed by this territory fragmentation and environmental injustice prompted stakeholders at Table C to reflect on scientific, governance, and technological innovation opportunities to connect territories with similar needs. This discussion led to the promotion of gaps and network analyses aimed at enhancing the implementation of new roadmaps in areas characterized by high ES demand but limited presence of actors with the scientific, political, and economic capacity and capability to implement and sustain these initiatives over time. Building upon this, all thematic tables emphasized the importance of shared data, standardized evaluation frameworks, and common performance metrics to enable effective NBSs implementation [59]. However, the literature highlights how the majority of the information collected at the local scale struggles to be effectively scaled up to regional or national levels or replicated in other territories [80]. Finally, Tables A and C emphasized the need for multiple stakeholders to converge on standardized parametric cost tables and biophysical performance metrics for NBSs. Such tools would improve the ability to predict expenses and benefits not only during the implementation phase but, most importantly, allow for the projection of medium- and long-term effects and their alignment with strategic and policy objectives [81,82].

A pervasive challenge across thematic tables, and largely shared in the literature, is the temporal mismatch between short-term political and administrative timelines and the long-term ecological impacts of NBS interventions [76,83]. Specifically, non-academic actors pointed out that participatory and planning processes are often constrained by administrative deadlines demanding immediate results in increasing resilience and adaptability to climate risks [84]. This issue arose from the need among stakeholders to identify transboundary actors to ensure alignment between objectives across temporal scales, supporting the design of shorter-term actions to foster the achievement of longer-term goals [85,86].

Finally, effective governance and stakeholder engagement emerged as essential themes across all tables, highlighting the critical need for participatory co-design approaches to support long-term planning and sustainability [66]. Table B underscored the risks associated with both over- and under-inclusion of stakeholders, which can undermine the

legitimacy and operational effectiveness of co-design processes, especially when aiming to align short-term actions with long-term ecological and social goals. Similarly, Table C identified ambiguities in assigning responsibilities during early planning and post-project phases, challenges that can compromise accurate assessment of ES demands and continuity over time. Table A complements these insights by noting that the absence of standardized evaluation frameworks, accommodating both short-term monitoring and long-term impact assessments, complicates stakeholder involvement. Addressing these governance challenges requires adaptive, transparent, and interdisciplinary decision-making mechanisms that not only break down siloes but also actively engage diverse stakeholders throughout the entire project lifecycle, fostering cross-sectoral collaboration and ensuring that co-designed solutions remain effective and resilient over the long term [25,30].

4.2. Roadmaps for Enhancing NBS Governance in Fragile Territories

Taken together, these strengths, weaknesses, opportunities, and threats highlight a shared recognition among the stakeholders involved of the pressing need to develop strategic frameworks that both capitalize on the inherent potential of NBSs and address systemic limitations. The roadmaps presented here respond directly to these challenges, aiming to strengthen long-term governance, expand accessible databases to enable cost-beneficial interventions, improve alignment with territorial needs and priorities, and integrate NBSs projects into broader, interconnected urban, social, and ecological networks, thereby enhancing real estate markets.

Roadmap A1—*Reformulating market values for the OMI zones*—aims at evaluating the economic benefits of the NBSs intervention, trying to reduce the intangible dimension of natural capital evaluation. OMI stands for "Osservatorio del Mercato Immobiliare", managed by the Italian "Agenzia delle Entrate" (i.e., Real Estate Market Observatory, part of the Italian Revenue Agency). It is an official service that provides comprehensive data on the real estate market in Italy. It offers information on property values, including purchase prices and rental rates, categorized by location and property type (residential, commercial, industrial, etc.). The OMI data are periodically updated and serve as a reliable reference for real estate valuations, market analysis, and fiscal assessments. This tool is widely used by real estate professionals, public authorities, and private citizens for informed property-related decisions. Therefore, according to evidence that green infrastructure and NBSs affect the real estate values [87,88], the purpose of this roadmap is to reformulate market valuation of real estate by considering and integrating the value of NBSs and ES as proxies into asset valuations. In this sense, it will be possible to capture the difference in the real estate values where NBSs are present within the specific OMI zone, thereby reducing the intangible nature of natural capital valuation.

Roadmap A2—*Pricing list of NBS interventions*—aims at overcoming the relevant issue of estimating the NBS cost of implementation. As highlighted in Table A, one of the main barriers is the absence of a parametric cost table for NBS, necessary for estimating both implementation and maintenance costs in the ex-ante phase [22,59]. Therefore, Roadmap A2 proposes developing a pricing list for NBS intervention, providing detailed information on implementation phases in urban and peri-urban contexts, along with parametric cost data to estimate project expenses accurately.

Building on the availability of cost data, Roadmap A3—*Integrated evaluation framework to support budget and performance evaluation*—introduces an integrated evaluation framework designed to balance budget considerations with expected performance outcomes, thereby supporting more informed and effective decision-making. For this purpose, the evaluation method of Portfolio Decision Analysis (PDA) has been proposed [89,90]. The PDA is a methodological framework used to support decision-making in contexts where multiple

projects or initiatives compete for limited resources. It combines principles from decision analysis and portfolio theory to evaluate and select a set of projects that collectively optimize decision-makers' objectives, considering trade-offs among risk, value, and resource allocation. PDA has been widely applied in various fields, including environmental management, healthcare, and strategic planning [91,92]. One of the key strengths of PDA is its ability to integrate quantitative and qualitative data, enabling stakeholders to systematically assess the impact of different combinations of projects. This approach enhances transparency and consistency in decision-making processes, particularly when dealing with complex multi-criteria evaluations [93]. By facilitating the analysis of multiple criteria and uncertainties, PDA helps organizations allocate resources more effectively, thereby improving the overall quality of strategic decisions. For instance, the study by Sarnataro et al. [89] presents a rigorous multi-objective PDA framework for selecting and scheduling urban planning projects and effectively addressing the inherently conflicting nature of urban interventions. By conceptualizing urban development as a portfolio problem, this approach captures the trade-offs among socio-economic, environmental, and infrastructural objectives, while recognizing the complex interactions of costs and benefits. The research further demonstrates the robustness of PDA as a methodological foundation for managing the complexities and competing values related to NBSs, facilitating conflict management, trade-off identification, and active stakeholder engagement.

While accurately assessing costs and benefits is fundamental, the long-term success of NBSs also depends on inclusive governance structures and stakeholder engagement [84,93]. Therefore, the following roadmaps focus on fostering collaborative management and shared knowledge.

Roadmap B1—*Inclusive stewardship and post-intervention engagement*—highlights the importance of maintaining the long-term functionality, ecological integrity, and social relevance of NBSs beyond their initial implementation phase. Integrating local management into governance frameworks enhances local capacity, promotes social learning, and allows for adaptive responses to future socio-environmental challenges. Awareness of inclusive and participatory governance is a critical prerequisite for maximizing the co-benefits of NBSs, especially in urban and peri-urban settings. The study proposed by Russo et al. [94] stresses that NBS success requires "collaborative management practices, long-term maintenance plans, and the integration of diverse local stakeholders" to ensure lasting impact and equitable benefit distribution. Collaborative management and maintenance are critical components of sustainable urban planning, especially when attempting to generate multiple ES and social benefits. However, Caggiano et al. [95] emphasize that, despite the recognized benefits of civic management of NBSs, there are frequent obstacles and limitations caused by persistent institutional fragmentation and a lack of recognition for informal civic practices. Additionally, it is recognized that maintaining a long-term management commitment is challenging, especially in cases where civic management is not supported financially or institutionally. Therefore, this approach requires formal acknowledgment of civic management within cross-sectoral and multi-level governance frameworks. Establishing a multi-actor group with clearly defined roles and continuous institutional support can mitigate these risks, ensuring the sustainability of results and fairness in governance procedures. Relevant case studies confirm these insights. In this sense, the EC-funded GrowGreen project[5] aims to enhance citizens' and stakeholders' involvement in the design and delivery of NBSs. In Wroclaw (Poland), the project supported climate change adaptation through NBSs by implementing demonstration solutions such as pocket parks, green walls, and green streets. These interventions were accompanied by an extensive stakeholder and citizens engagement program to mobilize the uptake and deployment of NBSs. Similarly, in Valencia (Spain), the Benicalap Living Lab demonstrated

the effectiveness of structured citizen engagement and stable local monitoring teams in embedding long-term responsibilities across different social groups [96].

Roadmap B2—*Shared knowledge on environmental issues*—addresses the urgent need to mitigate asymmetries in environmental knowledge among stakeholders involved in nature-based interventions. This need is further confirmed by the literature, which identifies the most frequently cited barrier to NBSs implementation as the lack of expertise and knowledge across all stages, from construction to monitoring and maintenance [97]. Establishing a common knowledge base early in participatory processes is essential for fostering collaboration, legitimacy, and informed decision-making. This is especially important given the ongoing terminological ambiguity and conceptual inconsistency surrounding NBSs. In this regard, Castellar et al. [28] point out that there is still a great deal of disagreement regarding the definition, typology, and performance evaluation of NBSs, even though their popularity is growing due to various European policies. This has confused the practitioner community, as concepts previously defined under a particular name have since been renamed or reinterpreted, making it challenging to distinguish between their similarities and differences. Likewise, similar interventions are frequently referred to using different terms. Stakeholder comprehension and the ability to replicate or scale successful interventions are hampered by such ambiguities. Pauleit et al. [56] emphasize the need for roadmaps and a common language to improve NBSs planning and execution in urban contexts. Accessible terminologies and shared conceptual frameworks facilitate cogent governance and empower stakeholders in co-creation and co-management. Roadmap B2 promotes a systematic, inclusive, and contextualized knowledge alignment process, helping to level the playing field by enabling less experienced actors to engage effectively with institutional stakeholders. Finally, by emphasizing the development of familiar environmental narratives and terminology, Roadmap B2 promotes the more efficient and equitable application of nature-based interventions.

Beyond local management and shared understanding, achieving scalable and resilient NBSs governance also requires institutional coordination and a strategic, network-based approach [15,98]. Accordingly, stakeholders consulted in Table C consistently identified long-term management of NBS projects as a critical arena of conflict, particularly in contexts characterized by institutional fragmentation and contested land ownership and management. These issues are shared in the literature, e.g., Scolobig et al. [99] analyzed government-led NBS projects in Germany, China, and Italy, revealing that while visions and planning stages often embed transformative potential, transformation of institutional frameworks lag behind. Innovative, polycentric collaborations, and inclusive stakeholder engagement tend to be short-term, contingent on local champions, and lack permanence. These conflicts are frequently rooted in issues of land use planning and ownership, where public–private interactions and corporate interests heavily influence territorial governance [100], e.g., in contexts like Northern Italy.

Therefore, Roadmap C1—*Governance mediator among stakeholders*—highlights the need for identifying an institutional figure acting as a mediator within relevant regulatory frameworks, facilitating governance innovation and interdisciplinary coordination. This mediator would guarantee stakeholder roles throughout the project lifecycle, helping define medium- and long-term responsibilities and stabilizing collaborative governance [74]. By reducing the risk of regulatory conflicts among disciplines involved, Roadmap C1 could facilitate and align technological innovation with ecological goals (e.g., smart cities [94]) and enhance project competitiveness. Recent advances in environmental technology, furthermore, can mitigate governance weaknesses by facilitating monitoring and preventing misuse of both information and money, and reassure potential investors [101]. Approaches such as conflict mediation and Social Impact Assessment have proven valuable in managing tensions on

avoidance of responsibility among actors. These tools can foster mutual understanding, clarify contested values and interests, and support the co-production of solutions, especially in fragile settings where urban development processes often prioritize economic gain over distributive or procedural justice [102]. Therefore, stakeholder engagement becomes both a method and a goal of effective governance mediation.

Furthermore, lessons from even more fragile governance settings underscore the universal relevance of these approaches. For instance, environmental auditing initiatives in Iraq's industrial sectors have demonstrated that the introduction of mediating institutional figures improve sustainability outcomes by stabilizing governance arrangements and clarifying stakeholder responsibilities [103]. Therefore, integrating conflict-sensitive approaches, participatory governance, and institutional mediation is not just better project design; it is essential for ensuring that NBSs achieve just and sustainable adaptation. With this vision, a governance mediator fostering a shared long-term vision can trigger a cascading effect, engaging more stakeholders and investors during maintenance, and enabling project value to grow over time.

The institutional role of a governance mediator supports the broader objective of Roadmap C2—*Valorization and prioritization of intervention areas toward a network perspective*—which advocates for selecting new intervention areas and typologies based on gap analyses considering the following: (i) the demand for ES (i.e., where key environmental and socio-economic challenges occur) [15,104]; (ii) the lack of projects involving marginal group of stakeholders and fragile/informal institutions [55]. This analytical approach can contribute to reducing uncertainty regarding project success, which may be compromised by environmental risks (e.g., climate change-induced extreme events) or socio-economic vulnerabilities, thereby promoting environmental justice [26]. Several authors proposed different methodologies to ensure a cost-effective NBSs implementation to enlarge the beneficiaries and meet the ES demand, e.g., [65,105–107]. Despite efforts towards inclusive decision-making, planning processes could be "deliberatively incomplete" [108], especially regarding informal, small, or semi-private areas and fragile territories that are difficult to integrate into strategic planning processes [85]. In this sense, policy must steer collective action while also being responsive to place-specific outcomes [26]. Therefore, governance of such new networks should be sensitive to "the physical diversity of urban green spaces, the cultural diversity of urban citizens and their use of green spaces and the institutional diversity of how citizens self-organize" (i.e., mosaic governance; [55]). Additionally, several examples in the literature [109–111] showed different methodologies to prevent new projects from presenting mono-functional designs (e.g., solely improving thermal comfort) and instead address a broader array of territorial needs, maximizing the value of the allocated space. Evaluations should also consider proximity to other initiatives to enable social, physical, and functional integration, facilitating the transfer of good practices and mitigation of previously encountered criticalities, adopting a landscape connectivity approach. Such a strategic vision, grounded in social skills and environmental connectivity, would encourage broader stakeholder involvement and stimulate imitation effects among institutions, fostering the replication of technically and regulatorily feasible solutions. Reducing systemic uncertainty through inclusive, networked governance fosters resilient and scalable NBSs initiatives. This proposal fits with recent advance in integrated landscape connectivity planning approaches, e.g., proposed by Newell et al. [112].

Together, the proposed roadmaps form comprehensive and shared actions that integrate economic valuation, participatory governance, and institutional coordination to enhance the effectiveness and sustainability of NBSs in fragile territories, as recognized by the multi-disciplinary teams involved in the three thematic tables.

5. Conclusions

This study underscores the importance of reframing Nature-Based Solutions not as isolated, technical fixes, but rather as key components of adaptive and anti-fragile governance systems, particularly in urban and peri-urban areas marked by institutional fragmentation, social marginality, and scattered investment. Drawing on a participatory seminar and interdisciplinary dialog, the notion of anti-fragility, understood as a system's capacity to learn and evolve through disturbances, emerged as a valuable conceptual and operational lens. It highlights the need to embrace uncertainty and complexity through iterative, co-designed planning processes that integrate diverse knowledge systems and stakeholder perspectives.

The strategic roadmaps developed through the seminar are organized around three operational pillars as follows: (i) evaluation and knowledge integration, promoting transparency and shared understanding through integrated assessment tools along the life cycle of NBSs [113]; (ii) governance and stakeholder engagement, emphasizing the critical role of mediating figures and collaborative models to ensure continuity and accountability across fragmented institutional landscapes; and (iii) strategic territorial integration, aiming to embed NBSs into broader spatial roadmaps to avoid isolated interventions and foster long-term systemic change. These pillars collectively advocate for a shift from risk-averse planning toward more resilient and responsive forms of territorial governance.

However, this work also recognizes several limitations. The proposed roadmaps are not formalized planning instruments and do not include a formal validation phase. Instead, they represent a stakeholder-informed foundation for further development consistent with evidence reported in international scientific literature. Their adaptability and usefulness will depend on future context-specific applications, participatory refinement, and policy integration efforts, not currently included in this work. Moreover, the complexity of institutional fragility, conflicting land uses, and socio-economic pressures poses ongoing challenges for the replicability and scalability of NBSs in similar contexts. As such, this work should be seen as an initial contribution to a broader, evolving research and practice agenda.

Starting from this, future research should focus on the following key areas: (i) developing monitoring and adaptive feedback mechanisms to assess the long-term performance of NBSs; (ii) designing flexible, context-sensitive governance models capable of functioning under uncertainty; and (iii) creating indicators of anti-fragility that can capture the potential of NBSs to transform diverse urban and ecological settings. Ultimately, this study reinforces the need to reimagine NBSs as adaptive infrastructures, embedded within dynamic socio-ecological systems, which require sustained political commitment, inclusive governance, and transdisciplinary collaboration. The participatory process tested here offers a promising direction for co-producing knowledge and practice aimed at more just, resilient, and anti-fragile urban futures.

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Appendix A. SWOT Matrix Developed in Table A, B, and C

Table A: Assessing Natural Capital in Urban and Peri-Urban Contexts

Strengths:	**Weaknesses:**
S1—Evaluation as supporting tool; S2—Multi-dimensionality; S3—Multi-scalarity; S4—Management of possible conflicts.	W1—Issues in estimating NBS costs and benefits in monetary terms; W2—Lack of data and context-based information; W3—Model(s) validation;
Opportunities:	**Threats:**
O1—Transparency and integration of different values and disciplines; O2—Effective economic resources allocation; O3—Interdisciplinary and multidimensional process.	T1—Limited knowledge of NBS meaning and features; T2—Difficulty in addressing long-term effects in the ex-ante phase;

Table B: Co-design and Planning of NBSs for Climate Risk and Environmental Change

Strengths:	**Weaknesses:**
S1—Stakeholder engagement in post-intervention phases; S2—Local stewardship for ensuring long-term NBS maintenance.	W1—Absence of clear criteria for stakeholder selection; W2—Knowledge and awareness gaps among stakeholders; W3—Risk of disengagement from experienced participants.
Opportunities:	**Threats:**
O1—Increasing availability of EU projects and funding frameworks promoting knowledge exchange and co-creation; O2—Building shared understanding through preparatory sessions and educational program.	T1—Terminological ambiguity: lack of common definitions; T2—Temporal mismatches between political deadlines and ecological processes; T3—Institutional fragmentation limiting continuity of participatory processes; T4—Lack of long-term financial or legal support for civic management initiatives.

Table C: Understanding and designing multi-functional NBS scenarios	
Strengths: S1—Versatility of solutions and multi-systemic capacity of the project; S2—Spatial optimization; S3—Multi-functionality facilitates communication of the problems to be addressed.	**Weaknesses:** W1—Costs: implementation and maintenance; W2—Difficulty in assigning responsibilities; W3—Difficulty in assessing the health and safety of the project and its impacts on citizens; W4—Difficulty in communicating project effectiveness and performance to citizens.
Opportunities: O1—Multi-layered, multi-scale approach with access to best practices and criticalities from other projects; O2—Multi-disciplinary expertise; O3—Access to multiple strategies/strategic designs from different disciplines.	**Threats:** T1—Uncertainty of the reference environment (climate change + political context); T2—Availability of space; T3—Misalignment between innovation, legislation, and production/supply chains; T4—Prescriptive (rather than performance-based) regulations; T5—Orphan projects—risk of project abandonment.

Notes

[1] CRAFT is the Competence Center for Anti-Fragile Territories (CRAFT), an initiative of the Department of Architecture and Urban Studies (DAStU) of the Politecnico di Milano. Established under the 2023–2027 Department of Excellence program, CRAFT focuses on developing methodologies and design approaches to address territorial fragility and fragmented decision-making. Through research, education, and collaboration with public institutions, it aims to foster anti-fragile capacities to navigate uncertainty, complexity, and socio-spatial challenges.

[2] Agritech Center. Available online: https://agritechcenter.it/it/ (accessed on 29 August 2025).

[3] NBFC (National Biodiversity Future Center). Available online: https://www.nbfc.it (accessed on 29 August 2025).

[4] Agenzia delle Entrate—Osservatorio del Mercato Immobiliare (OMI). Available online: https://www.agenziaentrate.gov.it/portale/aree-tematiche/osservatorio-del-mercato-immobiliare-omi (accessed on 29 August 2025).

[5] GrowGreen. Available online: https://growgreenproject.eu/ (accessed on 29 August 2025).

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