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Territorial Governance Pathways for Implementing Nature-based Solutions: Enablers and Barriers of the Italian NATALIE Case Study

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Abstract

Nature-based Solutions are increasingly recognised as a critical strategy for climate change adaptation and mitigation, yet their effective implementation depends not only on technical and environmental factors but on the governance systems that support them. This study aims to identify governance enablers and barriers for the implementation of Nature-based Solutions by combining a systematic literature review with an empirical assessment of stakeholder inputs from an Italian case study situated in the Veneto region, where a demonstration project tests vegetation-based riverbank restoration and selective maintenance strategies. The research adopts a two-stage thematic analysis. First, the literature review was inductively coded through design-related and intent-related leverage points, generating sub-themes categorised accordingly: information flows, institutional structure, planning instruments, and policy and legal frameworks (design-related); and awareness, community values, political will and trust, and stakeholder engagement and equity (intent-related). This framework was then applied deductively to the empirical practitioners data. Results show that enablers and barriers rarely operate as opposites, more often describing the same governance condition from two directions, and reveal a marked asymmetry between sources: the literature concentrates on design-related conditions, while practitioners concentrate on intent-related conditions such as awareness, cultural disposition, and trust. The research also illustrates that project-based interventions can accelerate the emergence of new governance practices without by themselves achieving the institutional legitimation needed to embed them into durable planning structures. The study concludes that the central challenge for upscaling Nature-based Solutions lies in the institutional translation of practices demonstrated at project level into ordinary territorial governance and planning frameworks, addressing in particular cooperative knowledge flows between expertise and institutions, coherence between planning and policy frameworks, participation as a mechanism of perceptual and cultural change, and trust as a relational condition for legitimation, so that the experience can generate a lasting political framework beyond a single point intervention.

Introduction

The consequences of climate change, including shaped temperature and precipitation patterns vary from one region to another. In response to mounting climate pressures of this kind, Nature-based Solutions (NBS) have emerged as a critical strategy that, within its many shapes and tools, can adapt to different contexts. Defined as "actions to protect, manage and restore natural or modified ecosystems, which address societal challenges, effectively and adaptively, providing human well-being and biodiversity benefits" (INBS, n.d.), NBS have the potential to provide over one-third of the cost-effective mitigation action needed by 2030 to stabilise global warming below 2°C (United Nations Global Compact [UNGC], 2019). Accordingly, the United Nations Sustainable Development Agenda explicitly calls for the upscaling of NBS for mitigation, resilience, and adaptation in the face of escalating climate threats (UNGC, 2019).

It is within this framework that NATALIE, a five-year Horizon Europe project funded under the Adaptation to Climate Change Mission, operates bringing together 42 partners across Europe to accelerate and mainstream the adoption of NBS for resilience to climate change. Through technological, financial and societal innovations, NATALIE implements 18 NBS across 6 bio-geographical regions, addressing climate risks such as floods, droughts, and sea level rise. The Italian case study, one of eight demonstration sites, is situated in the Veneto region. This region is experiencing the effects of climate change at a rate that significantly exceeds global averages, with annual temperatures increasing at + 0.57°C per decade against a global trend of + 0.38°C per decade, and 2022 recording the highest average annual temperatures in at least thirty years (ARPAV, 2023). Alongside rising temperatures, precipitation patterns have shown growing instability marked by intensified seasonal anomalies and an increasing frequency of extreme events (ARPAV, 2023). The site implementation is led by Thetis SpA (THETIS), the Università Iuav di Venezia (IUAV), and the Consorzio di Bonifica Acque Risorgive (CBAR), with the aim of implementing a more sustainable approach to the maintenance of the hydrographic network in the Venice Lagoon drainage basin. Specifically, the case study tests vegetation-based riverbank restoration and selective maintenance strategies along the Pianton canal in the municipality of Mogliano Veneto, with a view to generating evidence of the technical-economic feasibility and environmental benefits of such interventions and informing their replicability at the river basin scale and beyond.

The effective implementation of NBS, however, is not solely a technical or environmental matter as governance plays an essential role in ensuring that interventions yield broader social benefits and achieve long-term durability. This is consistently underscored across academic literature, with scholars highlighting that governance enablers are essential for NBS implementation and upscaling (Martin et al., 2021), that an inclusive and collaborative governance approach is fundamental to co-creating NBS (Frantzeskaki, 2019), and that meaningful outcomes require institutional and cultural paradigm reform alongside community empowerment (Davies and Lafortezza, 2019).

Territorial governance systems are not static principles, but rather, evolve through iterative cycles in which practices, discourses and institutional processes continuously reshape the codified structure of governance (Rivolin, 2012), a framework through which NBS governance can be understood on similar grounds.

Within NATALIE, the governance processes follow a similar, yet innovative position related to theory. The project focuses on governance dynamics that unfold after *implementation* and before formal institutional *legitimation*. This trajectory is accelerated by dedicated project funding rather than a conventional planning process. As the territory responds to the NBS *implementation*, *practices* emerge from the social experience of local actors. These practices are then *evaluated* by political institutions and society through information flows, stakeholder confrontations and dissemination activities, progressively constructing political recognition. This process takes place through formal project mechanisms, including dedicated stakeholder meetings, focus groups, transformation labs, and citizen science events, as well as through informal exchanges arising from internal project meetings and spontaneous interactions.

The legitimation of this emerging *discourse* is expected to facilitate the incorporation of NBS policies into institutional *structures*, enabling the development of new governance *tools* and system *practices*. For these changes to result in deep and lasting transformations, as described by Abson et al. (2016) through the concept of deep leverage points, it is essential that the process be grounded in territorial governance practices.

In this context, this article aims to bridge theory and practice in NBS governance by confronting enablers and barriers emerging from the literature with the empirical experience of the Italian NATALIE project, with the objective of informing an institutional framework conducive to NBS upscaling.

Theoretical Framework

Territorial Governance as an Analytical Framework

Governance has emerged as a well-consolidated conceptual framework within which public policies are designed and implemented (Esparcia & Abbasi, 2020). Given that NBS inherently engages with the physical environment, the concept of territorial governance constitutes a particularly appropriate analytical concept for this study. Territorial governance operates as a system structured around a double circuit. The first is a system of government that encompasses all forms of governance, political, economic, formal and informal, while the second is a system of territorial production and consumption, constituted by the practices that contribute to the transformation of the physical environment (Cotella & Janin Rivolin, 2025).

According to Cotella & Janin Rivolin's (2025) elaboration, the first circuit connects the governance system with the broader state apparatus, functioning as the primary instrument through which governments produce policies, plans and strategies, coordinating vertically across government levels and horizontally across policy sectors through the technical activity of spatial planning. The second circuit connects the governance system with the real world of spatial transformation, where developers, landowners and private actors drive most actual changes to space, and where the governance system's role shifts to regulating and negotiating between public and private objectives. Together, these circuits are continuously fed by the infinite variety of practices generated through the social experience of land use and spatial development in each institutional context, which constitutes the permanent creative source of the territorial governance system process. Understanding how this creative source develops over time requires a closer look at the process of system formation.

The territorial governance system can also be examined through a temporal lens, from the diachronic view of Janin Rivolin (2012), demonstrated in Fig. 01. Rivolin (2012) proposes that the process originates in the diverse range of *practices* emerging from the social experience of land use which constitute a permanent creative force of the process. Over time, recurring *practices* stimulate emulation and feed into technical and political debate, eventually producing dominant *discourses* that shape what is considered legitimate or desirable. Where institutional and political conditions allow, this selective process can lead

to the formal revision of the governance system's *structure* (such as laws, organisational arrangements and guiding principles) which in turn regulate how the system functions and ensures the wider propagation of its rules. This codification marks a turning point, in which newly established *tools* (such as plans, regulatory instruments and control devices) define the operational framework within which a fresh cycle of practices begins to emerge, often extending beyond the boundaries originally envisioned.

Governance dynamics in the Italian NATALIE case study

European research and innovation projects that include territorial case studies, such as NATALIE, typically operate through the introduction of externally designed experimental frameworks into local contexts. These frameworks act as exogenous inputs that interact with existing institutional settings, planning practices and social relations. Rather than producing immediate structural change, they generate situated processes through which new practices emerge, are tested and progressively translated into local governance dynamics.

Within this broader logic, the Italian case study of NATALIE represents a specific territorial application of Janin Rivolin (2012)'s framework, represented in Fig. 02. The project introduces an external set of *practices* into the territory, activated through the engagement of local actors involved in spatial transformation that are used to feed the creative source of territorial governance. These practices contribute to the emergence of incremental processes that may, over time, influence technical and political *discourses* shaping territorial decision-making.

This dynamic is being unfolded through a sequence of structured and semi-structured interactions with territorial actors. Formal activities realised so far include a focus group on agriculture, two transformation labs and a citizen science event. These governance activities were complemented by informal exchanges arising during project implementation, which contributed additional qualitative insights while remaining outside the formal methodological framework for this study.

The engagement process began with initial meetings involving key stakeholders, aimed at presenting the project and securing early involvement. IUAV played a central coordination role in structuring the governance pathway, with the participation of CBAR and THETIS, both project partners. The engagement strategy followed a progressive sequence, starting with involving the Municipality of Mogliano Veneto as the territorial authority hosting the intervention site. Given the predominantly private and agricultural nature of the land, specific attention was paid to landownership structures and related actors. A dedicated focus group was organised with local farmers to present the project activities and intervention approaches, and to collect initial feedback on perceptions, concerns and expectations. This served as an entry point for subsequent participatory activities.

Two significant participatory sessions were also held, designated as Transformation Labs (TL). Invitations were extended to a mapped range of stakeholders with a potential interest in the project,

including, beyond the municipality, the Consorzio, and the farming community, representatives from higher government levels (eg. Regione Veneto), academic institutions, NGOs, and environmental organisations. The first TL focused on jointly framing climate hazards and identifying opportunities for adaptation to climate change in the Venice Lagoon drainage basin, leading to the formulation of three co-creation actions. The second TL revisited and refined the outcomes, integrating additional context elements, and prioritising two co-creation actions dedicated to the promotion of NBS culture in the planning system, and on the accessibility of data to inform decisions. After each TL, a report was produced documenting the contributions to the guiding questions posed, as well as additional comments that arose organically during the discussions.

Citizen science activities complemented these processes by extending engagement to broader public beyond the targeted stakeholder groups, with the aim of increasing awareness of Nature-based Solutions and their relevance to local territorial dynamics. Collectively, these activities, besides reinforcing awareness of the value and relevance of nature-based approaches, contributed to the construction of a shared *discourse* of NBS, mapping what are possible enablers and barriers for their *legitimation* in the territory.

Deep Leverage Points as a Lens for NBS Governance

In the context of NBS, governance imperatives are explicitly codified in the "Inclusive Governance and Equity" principle of the Global NBS Standard which establishes five core requirements: (i) stakeholder identification, (ii) grievance and conflict resolution mechanisms, (iii) inclusive participation, (iv) transparent documentation of decision-making and (v) cross-boundary coordination (International Union for Conservation of Nature [IUCN], n.d.). Crucially, the Standard makes explicit that good governance goes further than mere consultation, actively empowering stakeholders as agents of the process (International Union for Conservation of Nature [IUCN], n.d.).

The five requirements of the Global NBS Standard's governance criterion can be read through the lens of leverage points, drawn from Meadows (1999), providing a structured way to interpret how governance conditions may enable or constrain NBS upscaling. Particularly relevant is the concept of *deep* leverage points defined by Abson et al. (2016) as more difficult to alter but potentially capable of producing transformational and long-term change.

Deep leverage points are distinguished between design-related and intent-related leverage points. Design-related concerns the structure of information flows, rules, power and self-organisation. Intent-related leverage points operate at the level of norms, values and goals underpinning dominant paradigms. Intertwined with the framework of the "Inclusive Governance and Equity" principle of NBS, it is possible to say that: stakeholder identification (i); transparent documentation (iv) and cross-boundary coordination (v) act primarily on the design-related leverage points, reshaping information flows,

mapping power relations and addressing jurisdictional fragmentation in favour of more ecosystem-oriented configurations. Inclusive participation (iii) and grievance mechanisms (ii) instead engage intent-related dimensions, addressing legitimacy, rights and the role of active citizenship, and contributing to the conditions for deeper systemic change.

Method

This study aims to identify governance enablers and barriers for NBS implementation by combining a systematic literature review with an empirical assessment of stakeholder inputs from the Italian case study of the NATALIE project. The NBS tested is vegetation-based riverbank restoration and selective maintenance strategies along the Pianton canal in the municipality of Mogliano Veneto, bordering private agricultural landscapes, with a view to generating evidence of the technical-economic feasibility and environmental benefits of such interventions and informing their replicability at the river basin scale and beyond.

The base method of the research adopted is thematic analysis (Braun and Clarke, 2006), identifying topics related to enablers and barriers in NBS governance. In order to bridge theory and practice, this study adopts a combined methodological approach, integrating systematic literature review with an empirical assessment of stakeholder inputs gathered from practitioners of the Italian NATALIE case study. Governance is understood here in alignment with the beforementioned Criterion 5 of the Global NBS Standard (International Union for Conservation of Nature (n.d.), and is specifically examined through the lens of *design* and *intent*, corresponding to what Abson et al. (2016) identify as deep leverage points for systemic change: those operating at the level of information, rules, goals, power and paradigms rather than surface-level parameters. A synthesis of the method is demonstrated in Fig. 03.

The thematic analysis followed the phases outlined by Braun and Clarke (2006) and was conducted manually by the authors, without the use of qualitative data analysis software. Coding proceeded in two stages. First, an inductive process was applied to the seven contributions retrieved through the systematic literature review: each article was read in full and coded according to the two overarching themes derived from Abson et al. (2016) of design-related and intent-related leverage points. Within these two themes, sub-themes were progressively delimited from the recurring concepts identified across the literature corpus, generating a structured coding framework grounded in the reviewed evidence. Second, this framework was applied deductively to the empirical corpus: extracts collected from the four NATALIE project activities (focus group, two Transformation Labs, and the Citizen Science event) were coded against the pre-established design/intent themes and their associated sub-themes, allowing the practice-based material to be systematically framed within the categories generated by the literature review.

The systematic **literature review** was conducted to identify governance enablers and barriers for NBS implementation as established across the existing systematic literature reviews. The search was carried

out using Scopus (Elsevier), selected for its broad coverage of peer-reviewed scientific literature and without a defined time restriction, as the oldest retrieved result dated to 2019 (Table 01). The search query combined title-level terms targeting NBS alongside barriers, enablers, and related concepts, further filtered by governance-related keywords spanning institutional, participatory, spatial planning, and multi-level governance dimensions, and restricted to articles conducting systematic or scoping reviews and evidence syntheses. The initial query returned 27 papers. Following screening based on abstract review, articles were excluded if they did not address explicitly NBS barriers or enablers, if they reported solely on a specific case study without drawing broader generalisable findings, if the barriers identified fell outside the governance scope as defined in this study (for instance, addressing exclusively financial constraints) or if they did not constitute a literature review that presented the compiling and analysis of multiple articles. This process yielded six papers, to which one additional article (Martin et al., 2021) was incorporated following identification through bibliographic citation within the selected corpus, reaching seven papers in total. All articles included were in English and the affiliations of the authors were based in Spain, Austria (2), Switzerland (3), Norway, Finland (2), Iran, Italy (2), United Kingdom, Netherlands (2). The list of articles analysed are presented in Table 02.

Table 01
Scopus search terms for peer-reviewed literature search.

Theme	**Scopus search terms**
Nature-based Solutions	("nature-based solution*" OR "NbS")
Barriers/Enablers	("barrier*" OR "obstacle*" OR "challenge*" OR "bottleneck*" OR "limitation*" OR "constraint*" OR "enabler*" OR "driver*" OR "facilitator*" OR "opportunity*" OR "incentive*" OR "success factor*") AND TITLE-ABS-KEY
Governance	("governance" OR "stakeholder*" OR "participation" OR "co-design" OR "institutional*" OR "accountability" OR "transparency" OR "legitimacy" OR "equity" OR "justice" OR "mainstreaming" OR "political" OR "policy" OR "legal" OR "regulatory" OR "multi-level governance" OR "polycentric" OR "coordination" OR "rights-based" OR "community engagement" OR "co-production" OR "territorial governance" OR "spatial planning" OR "land use" OR "landscape governance" OR "territorial planning" OR "urban governance" OR "rural governance" OR "watershed governance" OR "ecosystem governance" OR "transboundary governance" OR "cross-boundary" OR "administrative boundary" OR "jurisdictional")
Systematic literature review	("systematic literature review" OR "systematic review" OR "scoping review" OR "literature review" OR "bibliometric*" OR "meta-analysis" OR "evidence synthesis" OR "systematic mapping")

Table 02
Scopus literature selection.

Scopus Literature selection		
Title	**Year**	**Author**
Understanding barriers and enablers for the implementation of water-related nature-based solutions in the Andes: A mixed-methods study	2026	Recalde Aza, Y., Sánchez Galvis, L.K., Popartan, L.A., Rodríguez-Roda, I.
The nature-based solution implementation gap: A review of nature-based solution governance barriers and enablers	2025	Martin, J.G.C., Scolobig, A., Linnerooth-Bayer, J., Irshaid, J., Aguilera, R.J.J., Fresolone-Caparrós, A., Oen, A
Bridging NbS and legal literature: Institutional, procedural and substantive barriers to nature-based solutions implementation	2025	Venuti, F.
Nature-Based Solutions in Urban Green Infrastructure: A Systematic Review of Success Factors and Implementation Challenges	2025	Zarei, M., Shahab, S.
Nature-based solutions and urban planning in the Global South: Challenge orientations, typologies, and viability for cities	2025	Castaldo, A.G., Nocentini, M.G., Lemes de Oliveira, F., Mahmoud, I.H.
Catalyzing Innovation: Governance Enablers of Nature-Based Solutions	2021	Martin, J. G. C., Scolobig, A., Linnerooth-Bayer, J., Liu, W., & Balsiger, J.
Key enablers of and barriers to the uptake and implementation of nature-based solutions in urban settings: A review	2019	Sarabi, S.E., Han, Q., Romme, A.G.L., de Vries, B., Wendling, L.

The **empirical review** followed a deductive approach, drawing on inputs gathered from stakeholders of the NATALIE project in order to frame observed governance dynamics against the categories identified in the literature review. Data were collected through four key project activities realized in person: a focus group with farmers, two Transformation Labs, and a Citizen Science public event (Table 03). For each activity, extracts were drawn from reports produced immediately following the event, with the exception of the Citizen Science event, for which audio recordings were transcribed and used as the primary source material.

The focus group was conducted on 3 July 2023 at the premises of the Consorzio di Bonifica Acque Risorgive, in collaboration with Thetis SpA and the Università Iuav di Venezia. It was structured as a round-table discussion and brought together 12 participants representing a range of agricultural stakeholder organisations, including Confagricoltura Venezia, Coldiretti Padova, Coldiretti Treviso, CIA Venezia, Veneto Agricoltura, alongside three members of the NATALIE project team representing the IUAV, CBAR, and THETIS. Notes taken during the session were used to produce a subsequent report, from which the extracts for this study were drawn.

Transformation Lab 1 was held on 6 October 2024 and brought together 23 participants representing academia, the business sector, public institutions, and civil society. The session was structured around three sequential exercises. The first, *Hazards*, invited participants to identify and discuss the climate hazards perceived as most relevant to the case study. The second, *Challenges*, focused on mapping the political, social, economic and operational challenges that must be addressed to ensure sound NBS implementation and stakeholder ownership. The third, *Co-creation Brainstorm*, engaged participants in identifying potential solutions to the challenges raised, in the form of co-creation ideas and actions for further development. Notes taken during the session, together with the boards produced, informed a report from which the extracts for this study were drawn.

Transformation Lab 2 was held on 24 June 2025 and brought together 21 participants with a similar sectoral representation. The session comprised three exercises of a more prospective and planning-oriented nature. The *Vision* exercise invited participants to sketch a collective vision for the demonstration site in relation to climate change adaptation by 2050, using an online interactive polling platform (Mentimeter) for contributions. The *Co-creation Action Prioritisation* exercise asked participants to select up to two co-creation actions requiring most urgent implementation, facilitated through a projected Miro Board. The *Planning* exercise concluded the session with the elaboration of two co-creation action plans, equally facilitated through a projected online collaborative whiteboard platform (Miro Board). As with the first Transformation Lab, notes and boards produced during the session were compiled into a report from which the extracts for this study were drawn.

The Citizen Science event was held on 13 and 14 March 2026, having the presence of 26 participants from academia, public institutions and civil society. The data considered for this study were drawn from discussion sessions conducted following hands-on activities on the NBS site field and an artistic activity centred on nature. The discussions were held in small round-table groups, recorded in full, and subsequently transcribed. Extracts for this study were taken directly from these transcriptions.

Table 03
Empirical NATALIE project activities analysed.

Empirical NATALIE project activities analysed			
Activity	**Date**	**Stakeholders**	**Description**
Focus group farmers	3 July 2023	12 participants from agricultural stakeholder organisations	- Round-table discussion
Transformation Lab 1	6 October 2024	23 participants from academia, the business sector, public institutions, and civil society	- Identifying and discussing the climate hazards perceived as most relevant to the case study (Hazard wheel). - Mapping the political, social, economic and operational challenges that must be addressed to ensure sound NBS implementation and stakeholder ownership - Identifying potential solutions to the challenges raised, in the form of co-creation ideas and actions for further development.
Transformation Lab 2	24 June 2025	21 participants from academia, the business sector, public institutions, and civil society	- Sketching a collective vision for the demonstration site in relation to climate change adaptation by 2050 (Mentimeter) - Selecting up to two co-creation actions requiring most urgent implementation (Miro Board) - Elaborating two co-creation action plans (Miro Board)
Citizen science event	13 and 14 March 2026	26 participants from academia, public institutions and civil society	- Discussion sessions conducted following hands-on activities on the NBS site field and an artistic activity centred on nature

The findings from both the literature review and the empirical inputs were classified according to their relationship to design and intent dimensions, corresponding to the deep leverage points framework.

In the discussion session, the two corpora were subsequently cross-referenced to produce integrated guidelines to inform an institutional framework for upscaling Nature-based Solutions. The theoretical framework served as a conductive thread to reflect upon the ground approach of the NATALIE case study, emerging enablers and barriers from both the literature review and the practice-based experiences. As this study employed a qualitative thematic analysis approach, no statistical analysis or power calculation was applicable.

Results

Considering the theoretical framework, the results were separated into two overarching themes: Design and Intent. Based on the results emerged from the literature review, eight sub-themes were inductively delimited. The sub-themes under the design theme were four: Information & Knowledge Flows; Institutional Structure & Power; Planning Incentives & Constraints; Policy & Legal Frameworks, relating to the structure of information flows, rules, power and self-organisation addressed by Abson et al. (2016). Intent-related leverage points operate at the level of the norms, values and goals underpinning dominant paradigms. The four sub-themes identified from the literature review were: Capacity & Awareness; Community Norms & Values; Political Will & Trust; Stakeholder Engagement & Equity.

These sub-themes then deductively categorised the inputs from the empirical analysis from practitioners of the NATALIE case study. The contributions from the practitioners came from the Agriculture focus group, Transformation Labs 1 and 2 and the Citizen Science event.

The results demonstrated that enablers and barriers often addressed very similar themes with different wordings. For example, while an enabler is “education about NBS”, the barrier would be “lack of education about NBS”. On that account, the analysis is presented thematically rather than through a conventional enabler–barrier dichotomy.

Literature review: Systematic analysis of NBS enablers and barriers

From the seven inputs collected from the systematic literature reviews, 194 extracts in total were compiled, of which 91 were enablers and 103 were barriers. The main topics reviewed were allocated in the sub-theme “Policy & Legal Framework” with 32 contributions, “Stakeholder Engagement & Equity” with 27 contributions, as well as “Institutional Structure & Power” along with “Information & Knowledge Flows” both with 26 inputs each. Then comes “Planning Incentives & Constraints” with 24 inputs, “Capacity & Awareness” (22); Political Will & Trust (19); and lastly Community Norms & Values (18).

Then, in each theme, it was delimited main topics that emerged. Figure 04 presents a synthesis of the results from the literature review, putting together the different themes in size according to their frequency, main topics and an extract example to each sub-theme.

Information & Knowledge Flows

The literature consistently identifies knowledge deficits as one of the most structurally significant barriers to NBS governance. These deficits operate at multiple levels: insufficient technical expertise within local administrations (Martin et al., 2021, 2025; Castaldo et al., 2025), lack of quantitative evidence on NBS performance (Aza et al., 2026), missing baseline data on existing NBS infrastructure (Aza et al., 2026), and a broader insufficiency in the comprehensive understanding of local ecological,

climatic, and socio-cultural conditions required for effective NBS planning (Zarei & Shahab, 2025; Castaldo et al., 2025). Compounding these gaps, the reliance on external consultants risks perpetuating long-term capacity deficits within local governments rather than building durable institutional knowledge (Castaldo et al., 2025). The problem is not only one of generation, but also of circulation: unclear communication of NBS objectives and benefits to both policymakers and the public (Aza et al., 2026; Castaldo et al., 2025), limited cross-sectoral and international knowledge-sharing mechanisms (Sarabi et al., 2019; Recalde Aza et al., 2026; Zarei & Shahab, 2025), and barriers to academic-practitioner collaboration further constrain the diffusion of available knowledge into governance practice. Table 04 presents the full results.

Institutional Structure & Power

The literature consistently highlights institutional fragmentation and rigid hierarchical arrangements as primary structural barriers to NBS governance, including bureaucratic obstacles in planning and approval processes, path dependency (Sarabi et al., 2019; Martin et al., 2025), centralized governance regimes disregarding local priorities (Aza et al., 2026), and persistent administrative silos with unclear roles and responsibilities across departments and implementing bodies (Castaldo et al., 2025; Recalde Aza et al., 2026). Fragmentation is identified across administrative, regulatory, and ecological dimensions further compounded by poor inter-institutional communication and the difficulty of coordinating actors with different jurisdictions and political agendas (Venuti, 2025; Recalde Aza et al., 2026; Castaldo et al., 2025). On the enabling side, clear mandate and authority, the presence of a single coordinating organization, cross-scale collaboration, and polycentric and cross-sectoral arrangements are identified as key structural conditions (Martin et al., 2021; Castaldo et al., 2025; Martin et al., 2025), alongside institutional flexibility, enhanced policy coordination across governance tiers, and the facilitation of intermediary organizations (Martin et al., 2025; Zarei & Shahab, 2025). Table 05 presents the full results.

Planning Incentives & Constraints

The literature identifies a range of planning-level barriers that hinder NBS integration into urban governance, including incoherent urban strategies, confusing existing frameworks, lack of appropriate design guidelines and tools or enforcement mechanisms as well as uncertainty in the implementation process. There are conflicts between executive policies and urban development objectives (Zarei & Shahab, 2025), having discrepancies between urban plans and actual urban form (Castaldo et al., 2025) and the absence of clear design standards and guidelines incorporating ecological criteria (Aza et al., 2026; Castaldo et al., 2025). Disorganized urban growth, implementation vacuums in urban green plans, insufficient enforcement, and uncertainty regarding the effectiveness of solutions further constrain planning practice (Aza et al., 2026; Castaldo et al., 2025; Sarabi et al., 2019). On the enabling side, the literature points to the importance of strategic alignment of NBS with existing urban frameworks, the development of tailored planning instruments and design guidelines, and the incorporation of environmental assessments and ecological suitability criteria into urban design (Zarei & Shahab, 2025;

Castaldo et al., 2025). Piloting NBS at smaller scales before broader implementation, robust monitoring and evaluation processes, and the use of planning support tools are also highlighted as key enabling conditions (Zarei & Shahab, 2025; Castaldo et al., 2025). Table 06 presents the full results.

Policy & Legal Frameworks

The literature identifies the absence of clear, consistent, and supportive regulatory frameworks as a foundational barrier to NBS governance, spanning national, regional, and municipal levels (Zarei & Shahab, 2025; Recalde Aza et al., 2026; Castaldo et al., 2025; Martin et al., 2025; Sarabi et al., 2019). A particularly recurring issue is the disconnect between national legal frameworks and their practical applicability at the local level, compounded by institutional difficulties in enforcing NBS-related regulations (Castaldo et al., 2025). Land ownership and property rights constitute an additional layer of constraint, with restrictive zoning laws, enclosures on urban green spaces, expropriation resistance, and evolving notions of property rights all limiting the availability and accessibility of land for NBS implementation (Martin et al., 2025; Venuti, 2025; Castaldo et al., 2025; Recalde Aza et al., 2026; Zarei & Shahab, 2025). On the enabling side, the presence of national policy frameworks providing support for local implementation, regional policy umbrellas, supportive legal systems for NBS integration, and innovative incentive structures are consistently highlighted (Castaldo et al., 2025; Martin et al., 2021; Zarei & Shahab, 2025; Sarabi et al., 2019), alongside favorable public property rights and mechanisms to regulate private land developers (Martin et al., 2021; Castaldo et al., 2025). Table 07 presents the full results.

Capacity & Awareness

The literature identifies insufficient technical capacity and limited environmental education as core barriers to NBS governance, including the absence of NBS-focused training in engineering curricula, failure to integrate traditional knowledge, and a widespread lack of awareness among both officials and the public regarding the benefits of NBS over conventional gray solutions (Aza et al., 2026; Castaldo et al., 2025). On the enabling side, education and training programs, the transmission of NBS competencies to new generations of professionals, and targeted public awareness campaigns are consistently highlighted (Sarabi et al., 2019; Zarei & Shahab, 2025; Castaldo et al., 2025). Risk awareness raised by extreme events, modeling, or prior risk management experience is also identified as a key enabler, capable of mobilizing civil society and generating political support for NBS development (Martin et al., 2021; Castaldo et al., 2025). Table 08 presents the full results.

Community Norms & Values

The literature identifies community norms, values, and cultural context as significant mediating factors in NBS governance. Barriers include social resistance to urban configuration changes, public distrust rooted in perceived health risks, preference for conventional infrastructure, mismatches between technical solutions and public expectations, and opposition to NBS funding (Aza et al., 2026; Zarei & Shahab, 2025). Colonial legacy is also noted as a structural cultural barrier in certain contexts (Castaldo et al., 2025). Conversely, shared social norms, aesthetic appreciation, alignment between citizens' and

decision-makers' preferences, and the incorporation of local values and attitudes into NBS design are identified as enabling conditions (Martin et al., 2021; Zarei & Shahab, 2025; Castaldo et al., 2025), with risk awareness raised by extreme events further capable of shifting community dispositions toward NBS acceptance (Martin et al., 2021). Table 09 presents the full results.

Political Will & Trust

Political will and institutional stability emerge as critical enabling conditions in the literature, with the presence of committed political leadership, local champions, and clearly defined goals identified as key drivers of NBS governance (Martin et al., 2021, 2025). Conversely, unstable political environments, frequent shifts in priorities, government instability across governance levels, and a general lack of long-term political commitment constitute recurring barriers (Zarei & Shahab, 2025; Recalde Aza et al., 2026; Castaldo et al., 2025; Martin et al., 2025). Corruption, clientelism, risk aversion, and the prioritization of developer economic interests over community needs further erode the political and institutional conditions necessary for effective NBS implementation (Castaldo et al., 2025; Recalde Aza et al., 2026; Martin et al., 2025), while trust relationships between actors are identified as a foundational enabling condition (Martin et al., 2021). Table 10 presents the full results.

Stakeholder Engagement & Equity

The literature identifies meaningful and continuous stakeholder engagement as a key enabler of NBS governance, encompassing community participation in design and implementation, involvement of community gatekeepers, and broad multi-stakeholder partnerships including the private sector (Castaldo et al., 2025; Zarei & Shahab, 2025; Sarabi et al., 2019; Martin et al., 2021, 2025). Barriers include lack of consultation during planning and decision-making, conflicts of interest among stakeholder groups, limited private sector engagement, and restricted participatory rights in planning and environmental decision-making (Aza et al., 2026; Zarei & Shahab, 2025; Venuti, 2025; Castaldo et al., 2025). Equity dimensions are also prominent, with the risk of exacerbating social inequalities in access to green infrastructure identified alongside calls for integrating environmental justice principles, empowering underrepresented groups, and ensuring equitable access to NBS benefits (Zarei & Shahab, 2025; Recalde Aza et al., 2026, 2026). Table 11 presents the full results.

Empirical review: Italian Case Study experience from the NATALIE project

From the seven inputs collected from the empirical review, 59 extracts in total were compiled. The main topics reviewed were allocated in the sub-theme “Information & Knowledge Flows” with 13 inputs and Community Norms & Values (12) and “Capacity & Awareness” (10). Then comes “Planning Incentives & Constraints”, “Policy & Legal Framework” and Political Will & Trust, all with 6 contributions each. Lastly, “Stakeholder Engagement & Equity” with 4 contributions as well as “Institutional Structure & Power” (2).

Also for the empirical review, each theme, it was delimited main topics that emerged in a deductive way. Figure 05 presents a synthesis of the results from the literature review, putting together the different

themes in size according to their frequency, main topics and an extract example to each sub-theme.

Information & Knowledge Flows

Empirical findings underscore the importance of knowledge integration and accessibility as foundational conditions for NBS governance. Participants emphasized the value of interdisciplinary collaboration and the need to avoid reliance on single disciplinary perspectives. Farmers were recognized as holders of critical biodiversity knowledge that should be formally valued and transmitted. The importance of conducting systemic, multi-scale and multi-disciplinary analysis during the investigative phases of NBS planning was also stressed, alongside the need for simple, dynamic, and accessible tools that engage local entities and align with territorial priorities, including the selection of the area based on the water dimension. More broadly, participants identified multiple co-benefits of NBS such as water filtration, cooling, air quality improvement, recreation, and biodiversity support as important dimensions that remain largely invisible to the public, reinforcing the need to make territorial data and ecological processes more legible to non-expert audiences.

Institutional Structure & Power

Participants noted that quantifying and comparing the benefits of NBS against conventional management approaches was identified as a key mechanism for influencing political decision-making, in particular on economic and safety terms. Effective NBS governance was also associated with the capacity to integrate knowledge and expertise across multiple disciplines and thematic areas, fostering cross-sectoral collaboration as a structural condition for implementation.

Planning Incentives & Constraints

Participants highlighted several planning-level tensions shaping NBS implementation. A key concern was undervaluing comprehensive urban planning instruments, with many decisions increasingly taken through ad-hoc development plans. On the other hand, stakeholders highlighted emerging possibilities for NBS planning, such as incentives, innovative projects and ground-based eco-schemes. An interesting thought emerged was the possibility of having NBS as win-win solutions, not resulting in productivity loss for farmers, hence, reducing opposition from the sector. An insight emerged from the focus group with farmers, was the possibility of implementation of NBS on curved parts of the plot, which in general are non-productive parts of their land. Participants also pointed to the potential of building regulation reform as a lever for incentivizing adaptation measures and discouraging maladaptive urban features such as underground garages and basements.

Policy & Legal Frameworks

Participants consistently identified regulatory frameworks as a significant barrier, noting that existing rules are often unclear to non-experts and do not adequately support the implementation of nature-based actions. Specific tensions emerged around the alignment between the Regional Complement for

Rural Development of Veneto and local expropriation and compensation processes managed by the Land Reclamation Consortium. Regulatory obstacles were broadly acknowledged, while the Common Agricultural Policy (PAC) eco-schemes were identified as a potential policy opportunity to support farmer engagement with NBS. Other relevant frameworks raised as possible entry points for NBS were the Development and Cohesion Plan (PSC), the Municipal Water Plan and the Regional Complement for Rural Development (CSR) although this latter was critiqued, as it was stated that the interventions from the CSR are rarely implemented, and innovative projects, such as NATALIE, are necessary to counteract this lack.

Capacity & Awareness

Participants emphasised the role of direct experience and environmental education in building NBS awareness and acceptance. A recurring theme was perceptual factors, in which from the lack of contact and targeted experience, negative impacts, including climate change are not raised aware. The invisibility of ecological processes, such as underground soil life or small urban biodiversity, and the consequent tendency to neglect what cannot be readily observed. Environmental education, particularly when conducted at a young age and through physical contact with nature, was identified as leaving lasting impressions. Collective learning and shared discovery were framed as part of a broader process of caring for common goods, while the challenge of continuously updating professional knowledge and keeping pace with evolving NBS solutions was also acknowledged as a capacity constraint.

Community Norms & Values

Cultural factors emerged as a significant and slow-moving barrier to NBS adoption, characterized by long inertia and a declining sense of collective territorial identity. Participants noted that the introduction of NBS in new territories often encounters cultural resistance, compounded by the erosion of shared place-based values and collective stewardship practices. Stakeholder needs and priorities were recognized as highly context-dependent, varying according to crop type, production systems, and the relative weight given to quantitative versus qualitative outcomes. Conversely, participants identified several cultural enablers: bringing citizens into natural environments, showcasing operational examples of successful NBS, actively integrating the perceptions and lived experiences of inhabitants alongside technical knowledge and offering recognized contributions to land allocation. Promoting a broader culture of Nature-based Solutions and connecting citizens with local landscape heritage were framed as long-term enabling conditions.

Political Will & Trust

Participants identified economic interests and capitalist pressures as structural barriers to political commitment to NBS. Institutional awareness was nonetheless perceived as growing, as signaled by indicators such as the presence of local political figures at NBS-related events. On the enabling side, the willingness of regional bodies such as Veneto Agricoltura to share experimental research results and

operational manuals developed in collaboration with local water management consortia was highlighted as a positive signal of emerging institutional trust and knowledge-sharing disposition.

Stakeholder Engagement & Equity

Participants emphasized the capacity of NBS to generate community cohesion and produce positive effects at multiple scales, with post-intervention areas identified as spaces for reconnecting citizens with nature and recovering lost knowledge of local landscapes. Collective action and group cohesion were recognized as amplifying the positive outcomes of NBS interventions. A key challenge identified was the difficulty of initially engaging people with natural contexts, even when the experience itself tends to be perceived positively once undertaken.

Discussion

The results show that enablers and barriers rarely operate as opposites. In most sub-themes they describe the same governance condition observed from two directions, so that what obstructs a process also indicates where it might be acted upon. Reading the two corpora against one another therefore produces less a list of obstacles than a map of where territorial governance is currently under tension.

The dialogue between the systematic literature and the empirical material also makes visible how an exogenous, externally designed experimental framework such as the Italian NATALIE case study interacts with an existing institutional setting. Rather than producing immediate structural change, it introduces practices that are tested locally and progressively translated, or not translated, into territorial governance dynamics.

This section is organised accordingly: it first reconstructs the position of the Italian case study within the territorial governance cycle described by Janin Rivolin (2012); then, it examines an asymmetry in how the two corpora distribute their attention across the design and intent dimensions of the deep leverage points framework (Abson et al., 2017). Lastly, four domains in which the confrontation between literature and practice is most generative are discussed in turn: knowledge flows, planning and policy coherence, participation, and trust.

Territorial governance pathways in the Italian case study

Following Janin Rivolin (2012), the mainstreaming of NBS can be read as a territorial governance systems evolving iterative cycles. In the Italian case study, the cycle begins with the confrontation between conventional maintenance of the hydrographic network and the NBS *practices* introduced at the Pianton canal. This confrontation generates a territorial reaction, influenced by information and knowledge flows that *evaluate* the practice. *Discourse* is then constructed from these different processes along with confrontations between stakeholders and dissemination of good practices and impacts of NBS.

The intended trajectory is that collective and individual opinion leaders converge in orienting the selection of preferred governance frameworks. Over time, this selective process *legitimises* substantive and procedural choices, modifies the codified *structure* of the governance system, and supports the propagation and persistence of rules and *tools* favourable to NBS. The adoption of new tools in turn generates further practices and innovative approaches, triggering subsequent rounds of institutional change.

This orientation constitutes one of the intended legacies of the project: rather than remaining a point intervention, the ambition is for the experience to generate a lasting political framework capable of scaling similar solutions to other contexts, drawing on the positive reception and outcomes achieved in the territory. The adoption of new *tools* continuously generates new practices and innovative approaches, triggering further rounds of institutional change - and long-term scalability of NBS. Two pathways are already visible: the interest expressed by the Municipality of Mogliano Veneto in supporting analogous projects elsewhere, and the possibility for the Consorzio di Bonifica Acque Risorgive, as land manager, to incorporate NBS-oriented activities into its operational planning.

The territorial governance activities carried out so far were deliberately positioned at the deep leverage points (Abson et al., 2016), since they focus on social and cultural paradigm shift towards awareness and political willingness, rather than on technical parameters. This positioning is what makes them relevant to upscaling, because it is at this level that long-term change is produced.

First of all, the focus group with farmers and landowners opened a dialogue with the actors who control the key resource for NBS implementation in an agricultural context. It allowed concerns to be surfaced, possibilities for avoiding productivity losses to be negotiated, and the planning incentives that matter for the agricultural sector to be identified.

The Transformation Labs performed a different function. By bringing together stakeholders from different institutions, sectors and levels of expertise in a shared discussion space, they enabled the mapping of a diversity of perspectives, power positions and degrees of familiarity with NBS within the same territory. Most participants already held some engagement with or experience of NBS, but approached them from different standpoints. The sequenced guiding questions across the two sessions allowed for a progressive account of the NBS implementation process as perceived and experienced by local actors, moving from the identification of hazards and challenges, to the articulation of co-creation priorities and planning actions. In doing so, the Transformation Labs generated insight into the information and institutional capacity available across organisations, the values and cultural dispositions that different actors bring to NBS, and the political dynamics of trust and regulatory constraint that shape their engagement. They also revealed differing expectations regarding transparency, information access, and the recognition of situated knowledge.

The Citizen Science event extended engagement beyond the mapped stakeholder groups. As a public activity grounded in hands-on engagement with the natural environment, it produced a form of engagement that desk-based or purely informational formats achieve less readily. Participants

themselves reflected that environmental education activities carried out at a young age and in direct physical contact with nature leave more lasting impressions than theoretical study alone. The event also opened space for discussing NBS from multiple observational perspectives, including dimensions such as underground ecosystems that are less commonly foregrounded. Through group work, the presence of children, and a varied sequence of engagement formats, the event fostered a sense of community among participants. This aligns with the broader NBS governance literature, which highlights the importance of understanding community perspectives (Zarei & Shahab, 2025) and incorporating local understanding and attitudes towards NBS as a means of promoting social acceptability (Castaldo et al., 2025).

Shallow leverage points, including financial, technical, materials, remain necessary for NBS implementation. In this case study, they were relatively easy to address, considering the availability of EU funds and an established project consortium. The observation that follows is that the sequence of dialogue and practice constructs a more solid basis for scalability than the physical works alone, and that strengthening deep leverage points creates the conditions under which shallow ones can be addressed. This was supported, for example, when participants addressed their positive experience and changing of perspective related to NBS during the citizen science event. The social experience gathered in the transformation labs and citizen science helped to increment creative sources as suggested by (Cotella & Janin Rivolin, 2025), and can become permanent only through continuity.

The territory already offers evidence of such continuity. A comparable NBS experience was previously implemented at the nearby Vernise river, and its technical results informed the selection of the Pianton canal as the NATALIE demonstration study. This progression illustrates what practitioners have emphasised about the value of demonstration sites, and indicates that the present intervention is itself a contribution to an accumulating regional culture of NBS adoption.

Guiding principles towards an institutional framework for upscaling Nature-based Solutions

Asymmetries between literature and practice

Reading the two corpora side by side reveals an asymmetry in the distribution of the themes of the analysis. In the literature, the four design-related sub-themes account for a slight majority of coded extracts, with Policy and Legal Frameworks the single most represented sub-theme. In the empirical framework, intent-related sub-themes predominate, and Community Norms and Values together with Capacity and Awareness rank immediately after Information and Knowledge Flows. From this scope, the analysis articulates that literature is oriented towards the rules, instruments and structures that would make NBS governable, while the practitioners of the case study are oriented towards the awareness, culture and trust that would make NBS wanted.

The sharpest divergence concerns Institutional Structure and Power. It is among the most represented sub-themes in the literature and the least represented in the empirical framework. This unlikely indicates

that institutional fragmentation is absent from the Veneto context, but rather that the project format renders it temporarily undetectable. NATALIE assembled a consortium with a defined mandate, a single coordinating partner and dedicated funding, and therefore supplied from outside precisely the structural conditions whose absence the literature identifies as a barrier. Participants engaged in the project activities from the perspective in which a coordination arrangement had already been resolved.

The governance conditions that made the intervention possible are project conditions, being limited to its timescope. What the case study does test, and what it generates evidence about, are the intent-related conditions of awareness, cultural disposition, political will and trust. This is consistent with the design of the engagement project activities, which were deliberately positioned at that level, but it also delimits what the case can claim. It offers evidence on how a territory comes to accept and want NBS. It does not yet offer evidence on how an institution comes to codify them.

Cooperative knowledge flows between expertise and institutions

Effective NBS implementation rests on expertise, data and their circulation. Both corpora converge on the same barriers: limited technical expertise within local institutions, insufficient quantitative evidence of NBS performance relative to conventional grey infrastructure, and restricted circulation of information across sectors (Martin et al., 2021, 2025). In relation to the technical expertise, the NATALIE case study demonstrates it in a specific form. While NATALIE mobilised expertise from thirteen European countries to plan and facilitate the project, which resolved the immediate capacity constraint while reproducing the risk identified by Castaldo et al. (2025), that reliance on external expertise perpetuates organisational and technical capacity deficits within local government. The project's long-term sustainability relies on leaving a transferable legacy, equipping local practitioners with the knowledge and tools to continue and upscale the work independently.

The empirical material also indicates that the knowledge base at stake is plural. Practitioners valued professional expertise (Transformation Lab 1) alongside traditional and experiential knowledge, and identified farmers as holding some of the most grounded understanding of local biodiversity (Citizen Science event). Another important issue within the knowledge theme is data. Stakeholders agreed that territorial data must be shared and accessible, and the literature confirms data scarcity as a significant barrier to NBS governance (Castaldo et al., 2025), particularly regarding evidence of NBS benefits relative to conventional approaches (Aza et al., 2026). Practitioners also expressed a claim to contribute to the data and to have that contribution recognised. One participant observed that quantifying and comparing NBS benefits against conventional management is the exercise that ultimately influences political decisions (Citizen Science event). This connects evidence production to political uptake, and directly addresses what the literature describes as an insufficient link between the science, society and policy spheres (Aza et al., 2026).

The practical form this can be addressed is through knowledge-sharing mechanisms and accessible technologies (Sarabi et al., 2019). Stakeholders suggested developing simple, dynamic and legible tools

that engage local entities and respond to their territorial needs (Transformation Lab 1), which resonates with the concern in the literature for data usability in practice (Castaldo et al., 2025). In an agricultural landscape this translated into demands for soil analysis, biodiversity monitoring and more ecological farming practices (Citizen Science event). Farmers demonstrated a climate sensitivity rooted in direct field experience, noting for instance the narrowing of planting windows under a changing climate (Transformation Lab 2), consistent with the finding that risk awareness is heightened by exposure to extreme events (Martin et al., 2021).

Scale is a further condition. Even where a pilot operates on a limited site, system-scale analysis remains necessary for an adequate territorial diagnosis (Transformation Lab 1), consistent with the call for a comprehensive understanding of local ecological conditions (Zarei and Shahab, 2025). This is reinforced by cross-scale (Martin et al., 2021) and cross-sectoral collaboration (Martin et al., 2025), including multidisciplinary teams that bring together complementary expertise, such as the collaboration between agronomists and architects cited by practitioners (Transformation Lab 1). Such arrangements nonetheless operate against persistent institutional constraints: hierarchies and administrative silos that restrict collaboration across sectors (Martin et al., 2021, 2025; Castaldo et al., 2025; Venuti, 2025; Recalde Aza et al., 2026), bureaucratic inertia that anchors institutions to conventional approaches and limits space for innovation (Zarei and Shahab, 2025), and the difficulty of keeping solutions current as knowledge and conditions evolve (Transformation Lab 1).

The NATALIE process itself created space for inter-sectoral dialogue and generated new ideas and cross-disciplinary connections. This demonstrates that practice-based experience can work against fragmentation and, following Janin Rivolin (2012), this is the kind of practice that, once recognised and legitimised, feeds back into the evolution of the governance system. Its continuation depends, as the literature affirms, on political support for sustained NBS development and learning (Castaldo et al., 2025).

Coherence between planning and policy frameworks

Across both corpora, the regulatory and planning environment is decisive for NBS implementation. The Italian case study is illustrative in this regard, as the pilot was directly enabled by an EU ´project, which offered a more direct path to implementation than formal national or regional planning processes would have allowed. That path is also a diagnosis: the ordinary planning system was not the mechanism through which the intervention became possible.

Practitioners described a broader erosion of the weight and coherence of urban planning instruments, with decisions increasingly taken through ad hoc development plans rather than comprehensive planning frameworks (Transformation Lab 1). This fragmentation of the planning environment is itself a governance barrier, and one that the formal regulatory framework has not yet addressed in relation to NBS specifically.

The form and effectiveness of regulation vary across territories, but what the evidence consistently shows is that its presence or absence is decisive. Where regulatory frameworks are clear, consistent and supportive, they function as enablers; where they are absent, contradictory or poorly integrated across scales, they become barriers (Martin et al., 2021, 2025; Sarabi et al., 2019; Zarei and Shahab, 2025; Castaldo et al., 2025). NATALIE practitioners confirmed the existence of regulatory obstacles (Transformation Lab 2), which the literature situates within broader structural problems: bureaucratic barriers in the approval and implementation of NBS (Zarei and Shahab, 2025), path dependency that anchors institutions to established practices (Sarabi et al., 2019; Martin et al., 2025), and sectoral and administrative silos, including between the science, society and policy spheres, that undermine the effectiveness of legal frameworks (Martin et al., 2025; Castaldo et al., 2025; Recalde Aza et al., 2026). A further practical barrier identified by practitioners is the clarity of regulatory frameworks to non-experts (Transformation Lab 1), which the literature confirms through the documented absence of clear and consistent regulation (Zarei and Shahab, 2025; Castaldo et al., 2025) and of supportive policy and legal instruments (Recalde Aza et al., 2026; Martin et al., 2025).

The case study identified specific entry points and specific frictions within the Italian and Venetian instrument set. The Regional Complement for Rural Development (CSR), which defines how the national CAP strategic plan 2023 to 2027 is applied in Veneto, proved difficult to align with the expropriation and compensation procedures used by the Consorzio di Bonifica (Transformation Lab 2). CAP eco-schemes and their relation to farm organisation, including land design and crop rotation, were nonetheless identified as a potential opportunity to support agricultural engagement with NBS, alongside the Development and Cohesion Plan (PSC) and the Municipal Water Plan (Transformation Lab 1 and 2). Practitioners noted that interventions foreseen by the Municipal Water Plans are rarely implemented, and that innovative projects are currently compensating for that gap rather than correcting it. Building regulation reform was raised as a further lever, capable of incentivising adaptation measures and discouraging maladaptive features such as basements and underground garages (Transformation Lab 1).

Following Janin Rivolin (2012), for governance practices generated through project experience to translate into coherent planning instruments, the discourse and evidence produced during implementation must first be progressively legitimised and absorbed into the institutional structure. Therefore, the institutional translation that upscaling requires is that NBS-specific provisions need to find their way into planning tools and not as exceptional measures enabled by project funding, but as codified and durable components of territorial planning frameworks. This is the institutional translation that upscaling ultimately requires.

Participation as a mechanism of perceptual and cultural change

Culture and social acceptance emerged as one of the most consistently raised themes across both corpora. Practitioners were explicit about the difficulty of introducing NBS into territories where they

have no precedent. Both the project experience and the literature describe this as a long-standing inertia that takes time to shift (Transformation Lab; Zarei and Shahab, 2025; Recalde Aza et al., 2026), reflecting deeper sociocultural forces and the absence of a shared vision (Martin et al., 2021; Zarei and Shahab, 2025). The empirical material suggests that what moves this inertia is not information alone but sustained participatory processes that incorporate perspectives and lived experience into project design and governance.

Practitioners emphasised the importance of lowering barriers to first contact as a prerequisite for broader engagement. Resistance to participating in an activity such as a citizen science event is itself a barrier that must be crossed before deeper involvement becomes possible (Citizen Science event). Once crossed, the evidence from the case study indicates that participatory formats grounded in direct, physical engagement with the territory are particularly effective. Incorporating local perceptions and lived experience complements technical knowledge with situated understanding (Transformation Lab 1), and the literature confirms that this kind of community perspective is essential to NBS governance (Zarei and Shahab, 2025), with local understanding and attitudes directly influencing NBS acceptability (Castaldo et al., 2025).

One of the more generative insights from the citizen science event reframes the relationship between NBS and community. Rather than positioning community participation solely as an instrument for better NBS implementation, practitioners proposed that NBS itself has the capacity to generate community, producing multi-scale positive effects and reinforcing collective action and group cohesion (Citizen Science event). This perspective inverts the more common framing in the literature, where community participation (Zarei and Shahab, 2025) and stakeholder engagement (Martin et al., 2021) appear as enablers of NBS implementation. Positioned in this way, the NBS process becomes an active source of social cohesion which, if strengthened through partnership among stakeholders (Sarabi et al., 2019), in turn improves the conditions for implementation.

The case study also made visible that participation must also make space for critical perspectives. Hearing and genuinely addressing negative views is what distinguishes a participatory process from one that legitimises only the voices already aligned with project objectives. Over time, as perspectives are heard and incorporated into the co-construction of governance, cultural attitudes shift. This process can and tends to be accelerated by climate change, as people develop awareness through the direct experience of risk (Martin et al., 2021) and by the growth of an active and engaged citizenship around environmental concerns (Wassenhoven, 2008). In the terms of Janin Rivolin (2012), this gradual accumulation of participatory practice is the mechanism through which opinion is formed, discourse is shaped, and the conditions for institutional change are created.

Trust as a relational condition for legitimation

Trust between civil society and government institutions functions in both corpora as a precondition rather than an outcome. The NATALIE experience offered evidence of how project-based processes

begin to build trust. During the focus group with agricultural stakeholders, institutions demonstrated willingness to engage their expertise in collaborative terms, drawing on experience from previous projects. The literature identifies this disposition as characteristic of champions and advocates, recognised as key enablers of NBS governance (Martin et al., 2021, 2025). At the citizen science event, participants read the presence of the local Mayor as a signal of growing institutional awareness and of political will, another factor consistently identified as essential to NBS uptake (Martin et al., 2021, 2025). These are the relational conditions that upscaling requires, and their emergence is among the more tangible results of the governance pathway.

At the same time, the experience surfaced a significant structural barrier: the weight of economic interests and private pressures on governance decisions.. Practitioners raised concerns about activities that are more economically profitable but environmentally unsustainable being favoured over NBS alternatives (Transformation Lab 1), consistent with the identification of developer economic interests as a barrier to NBS governance (Castaldo et al., 2025). Where private economic pressure intersects with political agendas and lobbying, the result is a misalignment between political decisions and actual community needs (Zarei and Shahab, 2025). Notably, political instability and frequent shifts in political direction did not emerge as concerns in this case, unlike in much of the reviewed literature (Zarei and Shahab, 2025; Castaldo et al., 2025). This represents a comparatively favourable governance condition, and one that should be read as context-specific rather than generalisable.

Participation and cooperation can therefore be understood as mechanisms through which the command capacity of the governance system is maintained in the face of competing pressures (Wassenhoven, 2008). By introducing diverse perspectives into governance processes, participatory structures challenge established assumptions and counterbalance the influence of economic and other forms of power, creating conditions for decisions more genuinely responsive to community needs and long-term territorial sustainability. In this sense each participatory exchange contributes to the iterative cycle described by Janin Rivolin (2012), in which practices accumulate into the discursive and political conditions that eventually reshape the codified structure of governance.

Limitations of the study

This study is not without limitations. Informal governance exchanges, including spontaneous conversations and internal project interactions, were not systematically recorded and therefore remain underexplored as evidentiary material, representing a layer of governance practice that future work could capture through more deliberate documentation protocols. The four empirical activities also drew on different methodological formats by design of the broader NATALIE project, meaning their outputs are interpretive rather than strictly comparable, and the frequency counts reported here should be read as indications of emphasis rather than as measurements. Similarly, the systematic literature review was intentionally scoped and does not claim a global overview of NBS governance. The study is finally a single case in a specific institutional setting, and the comparatively favourable political stability observed in Veneto is not generalisable to contexts where instability is itself a primary barrier.

Conclusion

This study set out to bridge theory and practice in NBS governance by confronting the enablers and barriers established in the systematic literature with the empirical experience of the Italian NATALIE case study, in order to inform an institutional framework conducive to NBS upscaling. Three main findings follow from that confrontation.

The first is analytical. Enablers and barriers in NBS governance are largely not distinct objects. Across both corpora they describe similar conditions observed from opposite directions, in which the diagnosis offers a path of possible intervention. Presenting the results thematically rather than through an enabler and barrier dichotomy reflects the structure of the phenomenon.

The second is empirical. The literature and the case study distribute their attention differently across the deep leverage points framework. The reviewed literature concentrates on design-related conditions, above all policy and legal frameworks, institutional structure and planning instruments. The practitioners of the Italian case study concentrated on intent-related conditions: awareness, cultural disposition, knowledge circulation and trust. The most pronounced divergence concerns institutional structure and power, prominent in the literature and almost absent from the empirical material. This is interpreted as due to the project format, instead of evidence that institutional fragmentation is absent in Veneto. NATALIE supplied, from outside the ordinary governance system, the coordination mandate, the dedicated funding and the cross-sectoral arrangement whose absence the literature identifies as a barrier. The bypassing of this structural obstacle is one of the central cautions the case study offers to pilot-based approaches to NBS upscaling.

The third is theoretical. Janin Rivolin's (2012) diachronic account of territorial governance, in which practices generate discourses, discourses are selectively legitimised into structure, and structure produces the tools within which new practices emerge, describes what a demonstration project can and cannot do. A Horizon Europe demonstration site can act with unusual speed on the first phase of that cycle. It introduces practices, accelerates their circulation, and constructs discourse through stakeholder confrontation and dissemination through required and delimited project activities. It cannot, on its own, perform the legitimation that converts discourse into codified structure, because that step belongs to institutions operating on their own timescales and through their own instruments. The contribution of the case study is therefore located precisely between implementation and legitimation, which is where its evidence is strongest and where its claims must be most careful.

Practically, the case study leaves the territory with results that extend beyond the intervention site. The Municipality of Mogliano Veneto has expressed interest in supporting comparable projects elsewhere. The Consorzio di Bonifica Acque Risorgive, as manager of the minor hydrographic network, is positioned to incorporate NBS-oriented activities into its operational planning. Specific instruments were identified both as entry points and as sources of friction through which codification may occur: CAP eco-schemes and the Regional Complement for Rural Development, the Development and Cohesion Plan, and the Municipal Water Plans.

These findings sit within a wider context. NATALIE operates under the EU Mission on Adaptation to Climate Change, in a region where annual temperatures are rising faster than the global average and precipitation regimes are becoming less stable (ARPAV, 2023). Under those conditions the operative question is not whether NBS work, but whether governance systems can absorb them at the rate that adaptation requires. The evidence assembled here suggests that the binding constraint in the Venice Lagoon drainage basin is not technical feasibility or funding, both of which the project resolved, but the institutional translation of demonstrated practice into ordinary planning, addressing in particular cooperative knowledge flows between expertise and institutions, coherence between planning and policy frameworks, participation as a mechanism of perceptual and cultural change, and trust as a relational condition for legitimation, so that the experience can generate a lasting political framework beyond a single point intervention. Addressing that constraint is where the next phase of work lies.

Future research could build on the thematic areas identified here, particularly through deeper examination of the normative and strategic instruments relevant to policy and legal frameworks and to planning incentives, where the specificity of the Italian and Veneto regulatory context warrants dedicated study. A second direction would be returning to the same territory after the conclusion of the project to establish whether the discourse constructed during implementation has in fact been legitimised, and whether the structural conditions that the project supplied from outside have since been reproduced from within.

Abbreviations

ARPAV
Agenzia Regionale per la Prevenzione e Protezione Ambientale del Veneto
CBAR
Consorzio di Bonifica Acque Risorgive
CdB
Consorzio di Bonifica
CIA
Confederazione Italiana Agricoltori (Venezia)
CSR
Complemento di Sviluppo Rurale (Regional Complement for Rural Development)
EU
European Union
INBS
International Union for Conservation of Nature Nature–based Solutions (Global NBS Standard body)
IUAV
Istituto Universitario di Architettura di Venezia
NBS / NbS
Nature–based Solutions
NGO

Non–Governmental Organisation
PAC
Politica Agricola Comune (Common Agricultural Policy / CAP)
PSC
Piani Sviluppo e Coesione (Development and cohesion plan)
TL
Transformation Lab
UN
United Nations
UNGC
United Nations Global Compact

Declarations

Provided directly in the platform.

Author Contribution

Conceptualization and methodology were developed collaboratively by all authors. GDM conducted the formal analysis, figures and tables preparation. All authors reviewed and approved the manuscript.

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Figures

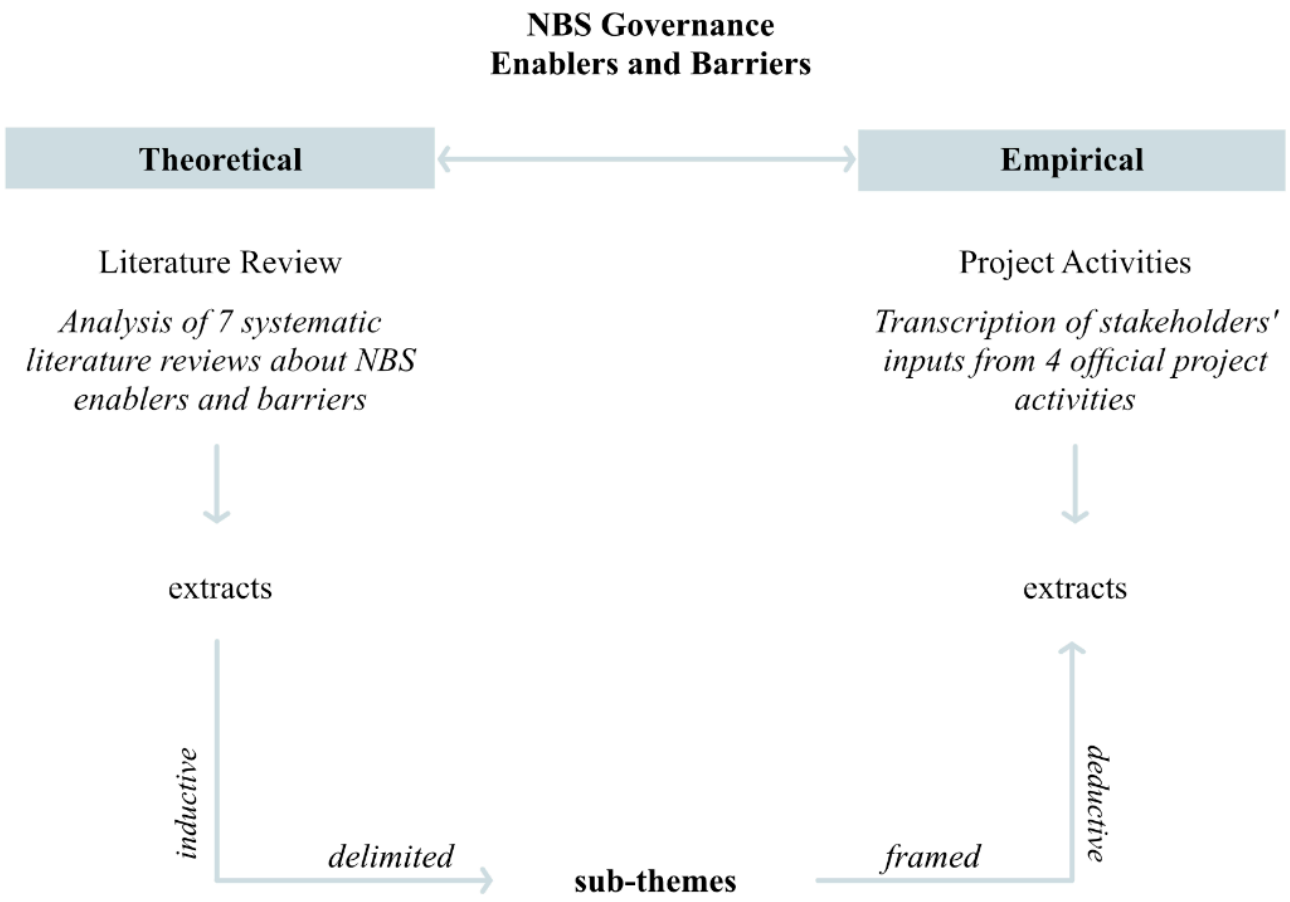


Figure 1

Territorial governance scheme

Source: Authors' elaboration (2026), adapted from Rivolin (2012).

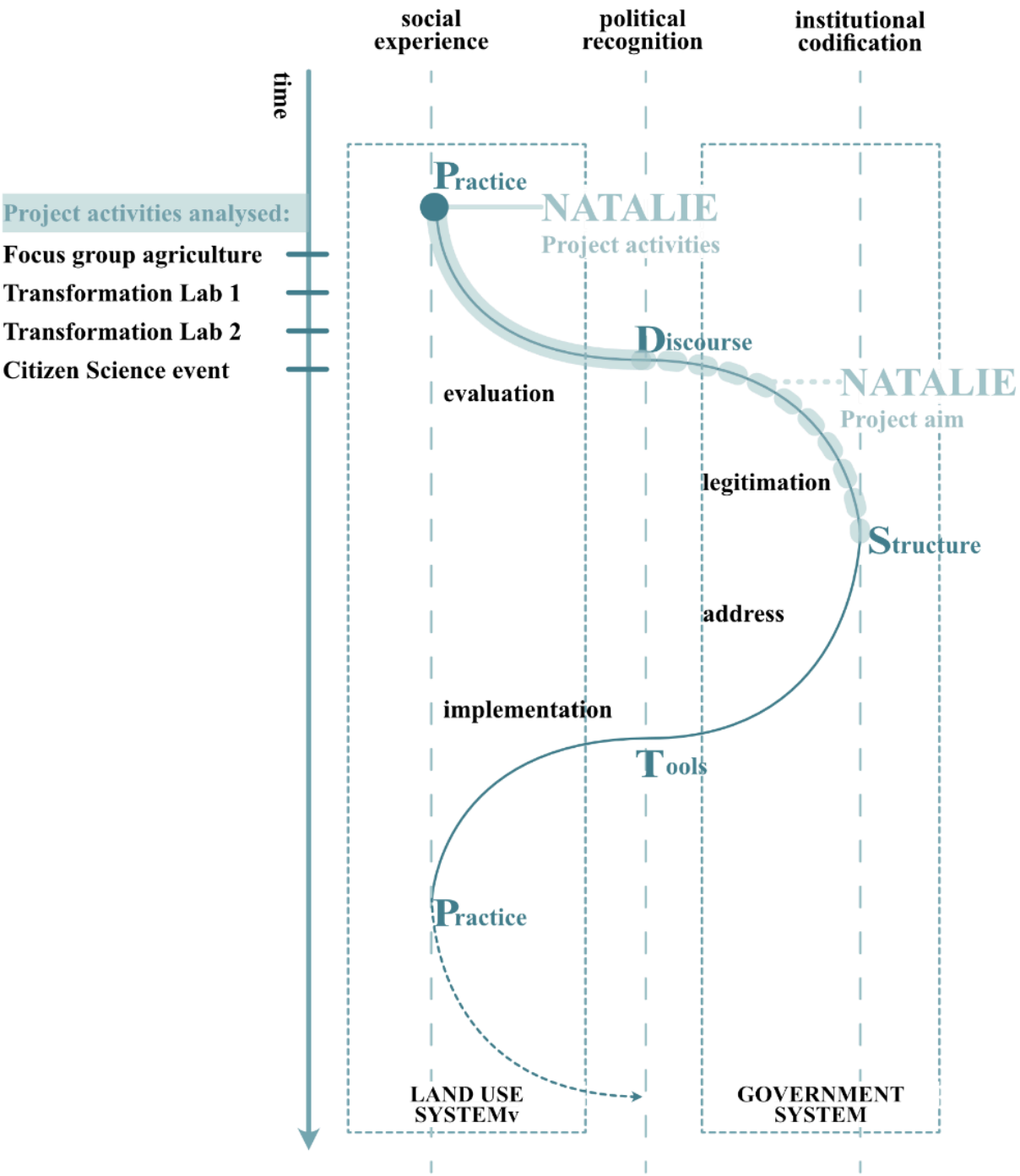


Figure 2

Territorial governance scheme incorporated in the case study project.

Source: Authors' elaboration (2026), adapted from Rivolin (2012).

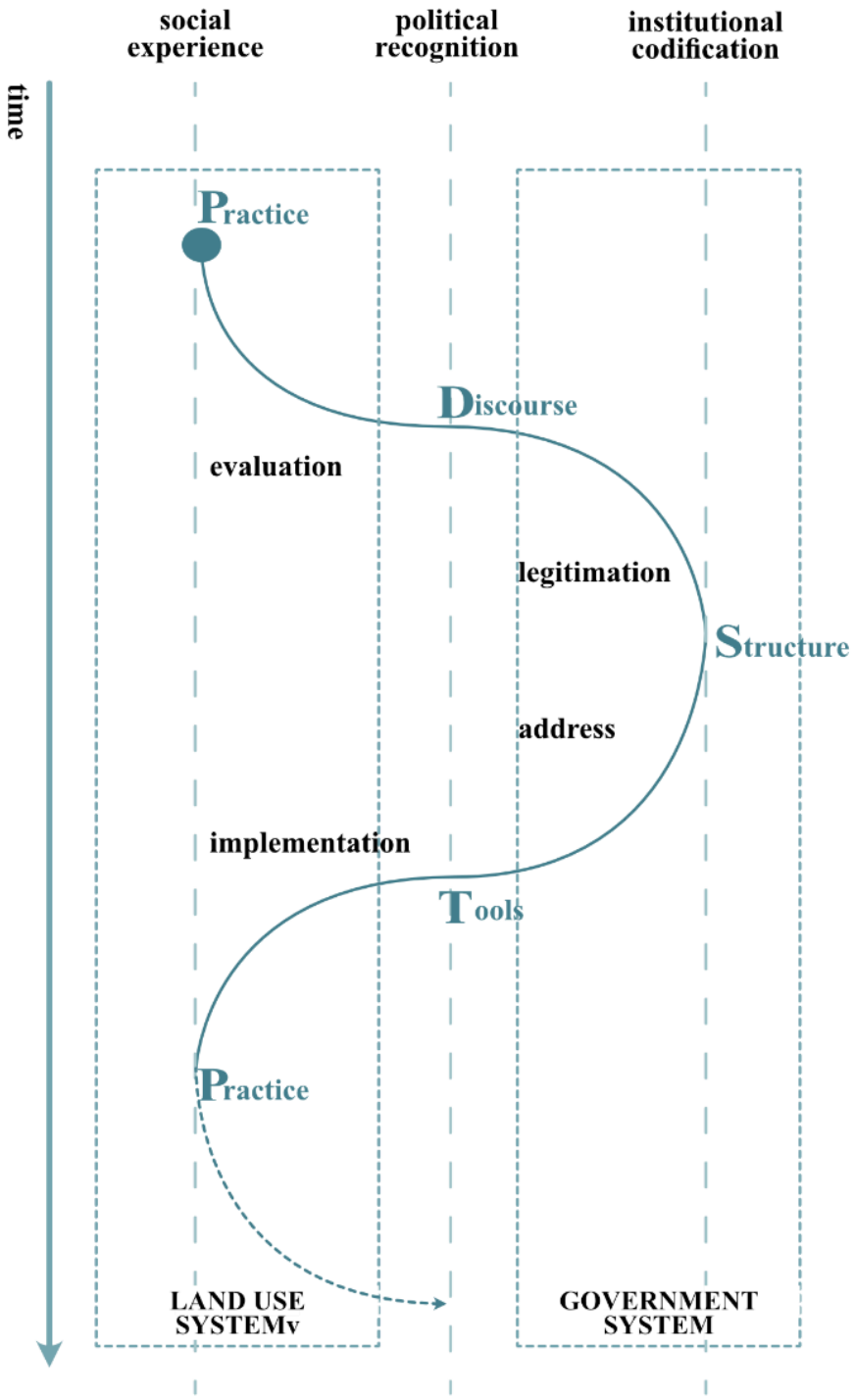


Figure 3

Synthesis of the method process

Source: Authors' elaboration (2026).

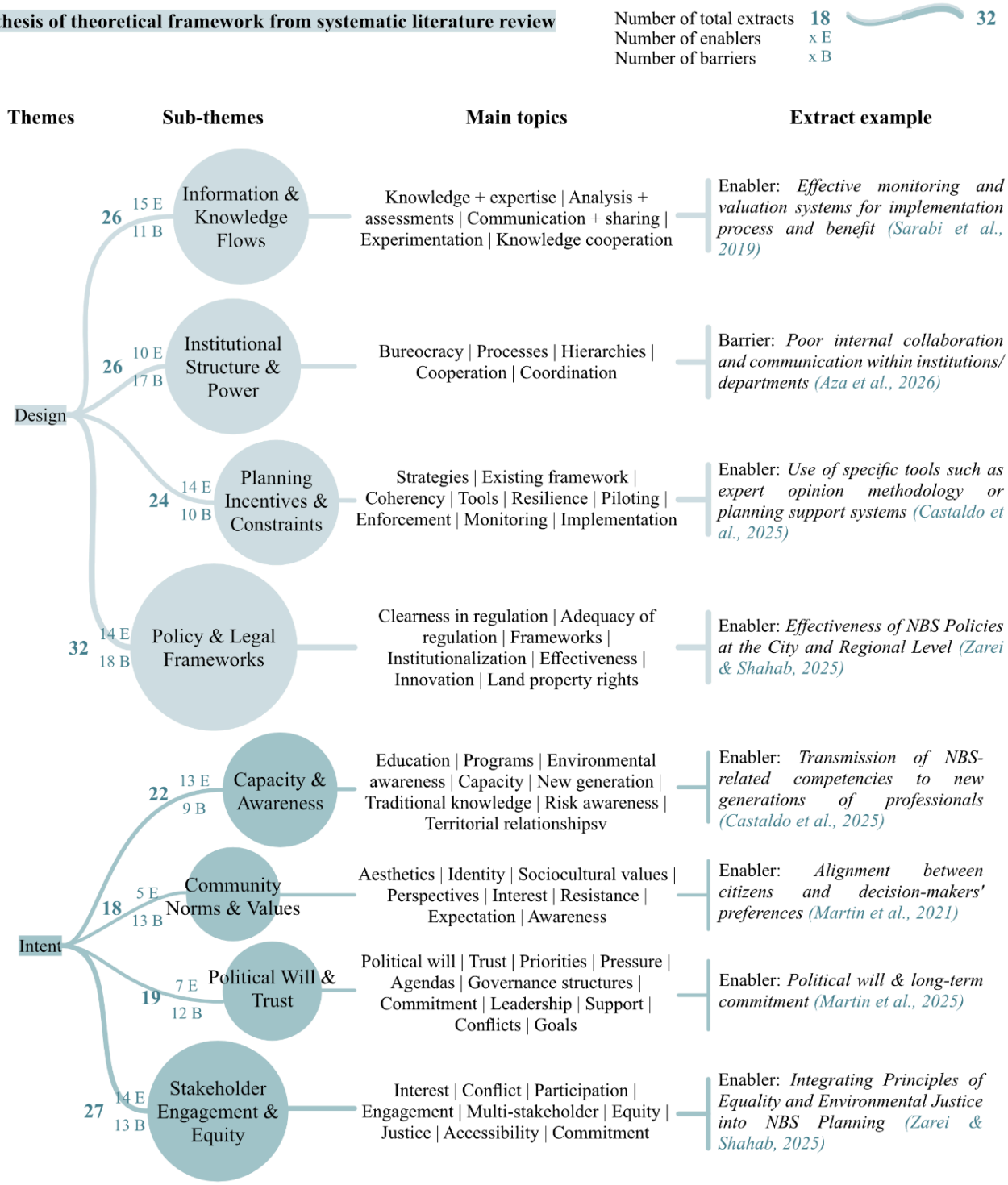


Figure 4

Synthesis of theoretical framework from systematic literature review

Source: Authors' elaboration (2026).

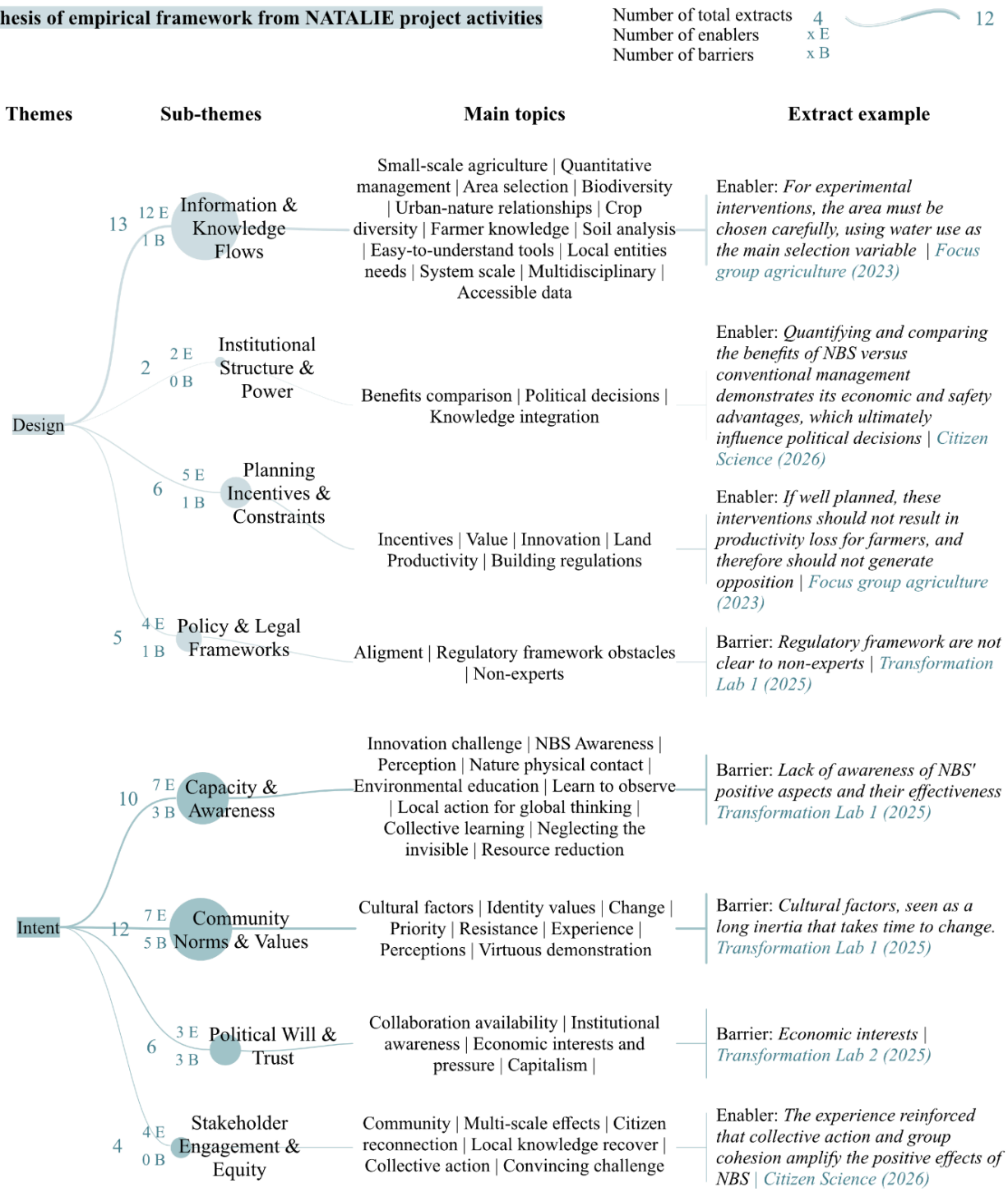


Figure 5

Synthesis results from empirical practice of NATALIE

Source: Authors' elaboration (2026).