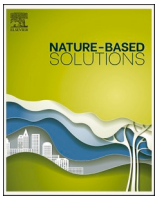
Nature-Based Solutions 9 (2026) 100341

Contents lists available at ScienceDirect

Nature-Based Solutions

journal homepage: www.elsevier.com/locate/nbsj



Social capital and the financing of nature-based solutions: Evidence from financial institutions and rural cooperatives in Colombia

Judith Vergara-Garavito [a,*], Rosa Carvajal Barrera [a], Doris Arévalo Ordoñez [a], Luis Farak -Flórez [b], Gloria Calderón Peña [c], Melani Díaz Moya [c], Sergio Prieto Mosquera [c]

[a] School of Finance, Economics and Government, Universidad EAFIT., Medellín, Colombia
[b] Universidad Cooperativa de Colombia, Colombia
[c] SolNatura Project Coordinator, Fondo Acción, Colombia

ARTICLE INFO

Keywords:
Capacity development
Cooperative banking
Climate finance
Institutional learning
Rural development finance
Environmental investment
Mixed methods
Latin America

ABSTRACT

Nature-based Solutions (NbS), defined as actions that protect, manage, and restore ecosystems while addressing societal challenges, are increasingly promoted as mechanisms to advance climate adaptation, biodiversity conservation, and rural development. Despite growing policy support, the operationalization of NbS within rural financial systems remains limited, particularly in emerging economies. This study examines how social capital and institutional capacity-building processes influence the design and adoption of NbS-oriented financial instruments by local financial institutions and rural cooperatives in Colombia. The research applies a mixed-methods embedded case study of the SolNatura project, which engaged nine financial institutions across two rural departments; qualitative evidence from semi-structured interviews, collaborative workshops, and technical validation sessions was triangulated with quantitative institutional diagnostics and training assessments to analyze changes in organizational capacities, trust dynamics, and financial innovation outcomes. The results demonstrate that technical training alone is insufficient to enable NbS financing: the successful development of nine NbS-aligned financial instruments and a catalog of 112 eligible activities (spanning silvopastoral systems, shade-grown coffee, agroforestry, nature-based tourism, and clean energy technologies) depended on the sequential activation of three complementary forms of social capital: bonding social capital through internal coordination across institutional units; bridging social capital through horizontal peer learning among financial institutions; and linking social capital through structured engagement with climate finance actors. The study concludes that social capital functions as a dynamic organizational capability that enables financial institutions to translate NbS principles into operational financial instruments, offering replicable insights for scaling NbS finance in rural and emerging economy contexts.

1. Introduction

The global climate emergency and the accelerated loss of biodiversity have positioned Nature-based Solutions (NbS) as fundamental strategies for simultaneously addressing the environmental and socio-economic challenges of the 21st century [1–3]. NbS are defined as actions to protect, conserve, restore, manage, or sustainably use natural or modified ecosystems that address social, economic, and environmental challenges while simultaneously providing human well-being, ecosystem services, resilience, and biodiversity benefits [4]. Realizing this potential requires innovative financing schemes that go beyond traditional financial-sector mechanisms. In this context, local financial institutions operating in rural and semi-rural territories play a strategic intermediary role in mobilizing capital toward NbS initiatives. By integrating environmental conservation objectives with sustainable development strategies, these institutions can align local productive systems, territorial financial stability, and long-term environmental goals [5,6].

However, the effective mobilization of financial resources for NbS faces multiple barriers that go beyond purely economic or technical considerations [7]. Recent literature on climate and sustainable finance has begun to recognize that social and institutional factors, particularly those related to trust and social capital, play a fundamental role in determining the success of green finance initiatives [8]. Trust in scientific and financial institutions, as well as in social capital networks within rural communities, is often an underestimated dimension of green finance. Yet they are essential for understanding why some

* Corresponding author.

https://doi.org/10.1016/j.nbsj.2026.100341
Received 3 March 2026; Received in revised form 16 May 2026; Accepted 16 May 2026
Available online 17 May 2026

sustainability-oriented financial instruments are adopted and scaled up while others encounter resistance or indifference [9].

The global study by Cologna et al. [10] on public trust in scientists across 68 countries identified four key dimensions: perceived competence, benevolence, integrity, and openness. Openness scored lowest across all countries, pointing to a critical need to strengthen two-way communication and public participation in evidence-based decision-making. This trust-building imperative extends to rural development, particularly in the relationship between farmers and financial institutions. According to Ping et al. [11], social capital dimensions, including social trust, social networks, and social participation, play a significant positive role in farmer households' access to credit. Similarly, institutional trust significantly shapes farmers' economic decision-making, with higher levels of trust directly correlated with investment in adopting agricultural technologies and sustainable innovations [12].

The adoption of green financial instruments by rural producers and small businesses depends not only on the availability of capital or favorable credit conditions, but also on the capacity of these producers and businesses to access capital and credit. It also depends on the trust these actors place in the financial institutions offering such products, as well as on the perceived credibility of the environmental and scientific arguments underpinning them [13]. When financial institutions operate in rural contexts where close personal relationships and dense social networks prevail, interpersonal and institutional trust become critical assets that can facilitate or impede financial innovation [14].

The concept of social capital, understood as resources derived from social networks, norms of reciprocity, and mutual trust that enhance economic efficiency through coordinated action [8], has gained increasing prominence in development economics. For this study, we adopt the three-dimensional typology most widely applied in rural finance and institutional contexts [15,16,18–20]. Bonding social capital refers to dense ties within homogeneous groups that generate internal cohesion; bridging social capital encompasses connections across diverse groups that enable information sharing and horizontal learning; and linking social capital involves vertical relationships with institutions of power that provide access to resources, legitimacy, and external financing. Recent work by Chetty et al. [15,16] empirically demonstrated that social capital, specifically economic connectivity, is one of the strongest predictors of upward economic mobility, underscoring that social relationships constitute a critical infrastructure that facilitates the flow of information, resources, and opportunities.

In rural and family farming contexts, social capital directly influences access to financing and the adoption of productive innovations. Empirical evidence from China shows that social capital promotes rural entrepreneurship through the exchange of financial knowledge [17]. Studies in Colombia and other Latin American countries have documented how social capital can both facilitate and hinder collective action and sustainable development, depending on the interaction between bonding and bridging capital [18–20]. The literature also recognizes the dark side of social capital, in which dense networks within groups can foster exclusion or reinforce norms that impede innovation [21].

In rural finance, this can manifest as resistance to new financial products or excessive dependence on informal credit systems [22]. Despite strong theoretical foundations, measuring social capital constructs within green finance adoption remains methodologically difficult. Conventional metrics were designed for community contexts and fall short of capturing the inter-organizational dynamics shaping capacity-building processes in financial institutions [23]. This recognition has led practitioners to adopt embedded relational approaches through participatory methodologies such as peer learning networks, thinking spaces, and collaborative technical validation, thereby simultaneously strengthening technical skills and building bridging and linking social capital [24].

Colombia offers a particularly relevant empirical context. As a megadiverse country with ambitious Paris Agreement commitments to reduce greenhouse gas emissions by 51% by 2030 and achieve carbon neutrality by 2050 [25], Colombia developed Latin America's first green taxonomy in 2022 [26], establishing regulatory standards for green financial instruments. National institutions such as FINAGRO, the Fund for Financing the Agricultural Sector, have begun greening agricultural credit across priority value chains [27], operating through rediscount mechanisms that channel concessional resources to rural intermediaries; these public instruments are complemented by private-sector biodiversity bonds that have mobilized over $120 million for environmental projects [28] and by blended finance arrangements co-structured by international technical cooperation agencies. Across Latin America, analogous architectures, combining multilateral development finance, national rediscount facilities, and local intermediaries, have emerged as the dominant model for NbS investment [5]; yet a critical gap persists between these national-level frameworks and their effective adoption by local financial actors in rural areas precisely where social capital and institutional trust play decisive roles [29,30].

Savings and credit cooperatives, microfinance foundations, and solidarity organizations constitute the financial infrastructure in many rural areas and have unique comparative advantages stemming from their proximity to communities, contextual knowledge, and decades-long relationships of trust [31]. However, these institutions also face multiple barriers to adopting NbS-oriented instruments. These include limited technical capacity to assess environmental and social risks, lack of robust monitoring systems, insufficient knowledge of international climate financing schemes, and tensions between their traditional social orientation and the professionalization demands of green financing [32–35]. Paradoxically, when strategically mobilized, their existing social capital structures can accelerate sustainable finance: cooperatives can serve as bridges between national policy frameworks, international climate finance, and local producers [36–39]. This bridging function, however, does not emerge spontaneously; it depends on the work of technical intermediaries capable of simultaneously translating international sustainability standards into locally legible instruments, facilitating multi-stakeholder coordination, and strengthening the institutional absorptive capacity of rural financial entities. With these situations, organizations operating at the interface of international climate cooperation and rural financial systems, including technical cooperation agencies, environmental foundations, and academic institutions, have increasingly assumed this intermediary role. Yet, the conditions under which such intermediation generates durable institutional transformation remain empirically underexplored [7,53].

In this context, the SolNatura project [40], implemented by GIZ in collaboration with Fondo Acción, Universidad EAFIT, and The Nature Conservancy (TNC) in Huila and Santander, constitutes a comprehensive effort to address these dynamics. Working with nine local financial institutions, the project applied Project-Based Learning (PBL) to treat capacity building as a socio-technical process that develops competencies while cultivating relational capital [41]. Unlike traditional training models, PBL situates learning in real-world problem-solving tasks, such as designing context-specific financial instruments, fostering peer exchange, enabling collaborative validation, and co-creating solutions.

Despite strong theoretical foundations in social capital and institutional trust, the specific role of these factors in enabling rural financial institutions in emerging economies to design and adopt NbS-oriented financial instruments remains empirically underexplored. Prior studies have examined social capital in agricultural credit access [11,14], farm innovation networks [66], and community NbS governance [60]. None, however, has systematically analyzed how social capital is cultivated through structured capacity-building programs within financial institutions, or how it mediates the translation of NbS principles into operational credit products. This is the research gap this study addresses.

The following question guided this research: How did the horizontal learning, technical validation, and multi-stakeholder coordination mechanisms implemented in the SolNatura project influence the

reduction of organizational, technical, and institutional barriers to the design of financial instruments oriented towards nature-based solutions? The study advances three contributions. Theoretically, it reconceptualizes bonding, bridging, and linking social capital as dynamic organizational capabilities within financial institutions. Methodologically, it operationalizes PBL as both an intervention framework and an analytical lens for observing institutional transformation. Empirically, it provides rare evidence from rural financial systems in the Global South on the conditions under which NbS financing capacity can be systematically developed.

1.1. Conceptual framework

The adoption of NbS in emerging territories depends on how institutional, financial, and governance factors intertwine to enable or hinder sustainable transitions [42]. In emerging economies, regulatory pressure has been a key driver for the adoption of green financial practices. Still, when environmental governance is weak, these pressures tend to lead to superficial adoption rather than structural transformation, underscoring the need for stronger institutional frameworks [43–45]. This challenge is compounded in rural areas of Latin America, where the relationship between financial and green innovation is modulated by local dynamics of governance, ownership, and organizational culture [46]. Financial innovation can catalyze environmental investment [47]. Still, its effectiveness depends on institutional capacities to integrate environmental criteria into investment decisions, which operate in an interdependent manner with environmental regulation as a decisive mediator [48]. In rural contexts dependent on natural resources, the volatility of these resources undermines the continuity of sustainable strategies [49].

The magnitude of financing required for sustainable transitions amplifies these tensions. Mobilizing capital for environmental projects requires technical intermediaries capable of structuring bankable initiatives that simultaneously meet financial and climate criteria [50], transforming not only financial instruments but also the institutional capacity of rural entities to formulate projects consistent with sustainability objectives [51]. The literature on biodiversity finance has identified promising mechanisms such as payments for ecosystem services, offsets, green bonds, and sustainable tourism [52]. Still, the gap between theory and practice persists, particularly because the lack of local actors' participation in the design of instruments results in financial products misaligned with territorial realities [53]. Even in Europe, contractors and consultants implementing NbS report recurring obstacles: limited specialized experience, a shortage of qualified personnel, reliance on gray infrastructure, and vague regulatory frameworks [54]. More than technical problems, these reflect the weak institutionalization of NbS within governance systems. When collaborative work, data sharing, and multidisciplinary teams are promoted, strategic opportunities emerge [55].

The need to strengthen governance is particularly evident where conceptual gaps persist between local and private actors and where uncertainty about long-term maintenance exists [56]. The co-production of NbS has shown that early stakeholder participation, professional facilitation, and the institutionalization of planning are key to success [57–61]. Yet, these processes still face limitations from the lack of formal participation spaces and the difficulty of adapting to specific territorial realities.

This evidence converges on a core conceptual proposition: without institutional trust, social legitimacy, and organizational capital, NbS financing struggles in fragile institutional contexts. Social capital, operationalized in this study through its three forms (bonding, bridging, linking), provides the analytical framework for understanding how these relational assets are built, activated, and translated into financial innovation. Bonding social capital supports internal cohesion and cross-departmental integration within financial institutions. Bridging social capital enables cross-sector connections and peer validation among institutions of heterogeneous maturity. Linking social capital enables relationships with powerful institutions such as funders, regulators, and technical cooperation agencies, providing access to resources, external legitimacy, and sustainable financing pathways. PBL provides such a framework by embedding learning in collaborative problem-solving and promoting peer exchange, co-creation, and joint validation. Crucially, it generates technical outputs, financial products and risk tools, and relational outcomes, trust and multi-stakeholder coordination, simultaneously, rather than treating them as sequential results.

2. Materials and methods

2.1. Methodological approach

The intervention was structured using PBL, a pedagogical strategy that anchors learning in authentic tasks that involve real problem-solving [62–64]. Rather than traditional training models where knowledge flows unidirectionally from experts to recipients, this approach engaged each financial institution in designing a specific applied project: the development of a financial instrument for nature-based solutions. In the field of green financial innovation, this methodology activates the three dimensions of social capital: bonding between internal teams, bridging between institutions, and linking with economic and policy actors [65]. Its emphasis on iterative prototyping builds performance-based trust, a type of trust that is essential in rural contexts where personal relationships mediate access to credit [66]. When financial institutions actively participate in the co-design of instruments and share their constraints transparently, the conditions are created for institutional trust, enabling the legitimate, collaborative, and sustainable adoption of green innovations [67,68].

PBL's effectiveness for organizational transformation is supported by research showing that learning anchored in authentic tasks yields higher knowledge transfer and retention than content-based approaches [69, 70]. In sustainable finance, implementing green instruments requires cross-area integration—risk, credit, and sustainability—rather than isolated technical training [71,72]. By mandating collaborative product design from the outset, PBL facilitates systemic institutional alignment and accelerates internal coordination dynamics. This study employs an embedded multiple case study design, situating nine financial institutions as units of analysis within the overarching SolNatura case. The research follows a sequential explanatory mixed-methods logic: quantitative institutional diagnostics were conducted first to establish baseline capacity profiles, and qualitative data from interviews, workshops, and tutoring notes were subsequently used to explain the observed patterns. This combination captures both objective dimensions, capacities, structures, and financial products, and subjective ones, including trust perceptions, social relationships, and institutional motivations shaping the adoption of NbS-aligned instruments.

A note on positionality is necessary. The authors of this study participated directly in the SolNatura project as members of the Universidad EAFIT team, in a consultancy capacity. This dual positioning, as practitioners involved in designing and implementing the capacity-building process and as researchers analyzing its outcomes, carries inherent interpretive risks, including the tendency to rationalize one's own professional judgments. We acknowledge this tension explicitly and treat it as a reason for greater methodological rigor rather than a disqualifying condition. Several analytical safeguards were applied to manage this risk. For example, the analysis does not exclude institutions that showed limited progress (FI3, FI5) or structural barriers that the intervention did not fully resolve. And the purpose of this article is not to validate the consultancy as successful, but to use it as an empirical site for examining how social capital mediates institutional transformation in NbS finance. This research question extends well beyond the project's immediate objectives.

2.2. Participants and institutional context

SolNatura Project engaged nine financial institutions and cooperatives operating across two Colombian departments: five entities in Huila and three in Santander, plus a fintech company with national reach. The participating entities included five community-based savings and credit cooperatives, two social microfinance foundations, one rural financial institution, and a single specialized fintech platform. Huila and Santander are agriculturally strategic regions exposed to climate variability, soil degradation, and production constraints. These pressures heighten the need for NbS-oriented investment and make both departments relevant laboratories for testing green financial innovation under real territorial conditions. Their economic structures—coffee, livestock, diversified rural production, and emerging nature-based tourism—make them relevant laboratories for testing green financial innovation under real territorial pressures.

2.3. Stages of the methodological process

The methodological sequence, its analytical logic, and associated instruments are synthesized in Table 1.

2.3.1. Theoretical arguments for data collection tools

Semi-structured interviews assessed institutional capacity by enabling comparison across entities while capturing context-specific constraints and opportunities [73,74]. Active training methodologies—including lectures, case studies, subgroup work, AHP, and prioritization exercises—combined theory with practical application, consistent with adult learning principles [75–77]. Entry-exit assessments supported adaptive content adjustment and monitoring of knowledge acquisition [78].

Participatory sticker-rating workshops enabled inclusive demand assessment across heterogeneous literacy contexts, ensuring that financial product design reflected producer priorities [79–83]. Horizontal learning spaces promoted peer exchange, collective problem-solving, and coalition-building among institutions of varying maturity [81,84]. Personalized technical tutoring supported the collaborative development of customized financial instruments, addressing diverse institutional capacities and regulatory constraints. Evidence shows that intensive technical accompaniment accelerates resolution of implementation bottlenecks [85–87].

Table 1
Stages, activities, and data collection tools.

Stage	Key Activity	Data Collection Tools
1. Institutional Capacity Assessment	Diagnostic evaluation of institutional readiness across five internal capacity dimensions (governance, risk management, instrument design, green finance access, sustainability metrics)	Semi-structured interviews with staff members; self-assessment questionnaries
2. Technical Training	Three 4-hour face-to-face modules covering NbS fundamentals, risk analysis, and financial instrument design using active pedagogies	Entry-exit diagnostic assessments; attendance records
3. Analysis of Financing Demand Using Participatory Methodologies	Participatory workshops with trade associations and producer groups across nine priority value chains to identify sustainable activities and territorial financing needs	Financial Needs Prioritization Matrix; territorial demand database
4. Horizontal Learning and Collaborative Technical Validation	Three thinking spaces for peer learning and refinement of credit analysis tools among participating institutions	Documented meeting minutes; consensus records
5. Tutoring Sessions	Six individual sessions per institution for designing customized theoretical financial instrument models tailored to their context and capacity	Collaborative validation notes; instrument design documents
6. Complementary Analysis of Demand and Access to Financing	Training workshops on green credit access featuring practical case simulations and barrier identification	Participatory workshop records; access checklist tool
7. Multi-Stakeholder Coordination and Linkages with Investors	Funding panel presenting designed instruments to eight climate finance actors; establishment of pilot implementation roadmap	Panel documentation; feedback records; implementation roadmap

2.4. Data analysis

Data analysis followed procedures specific to each typology. Qualitative materials (interviews, meeting minutes, and tutoring records) were coded using a primarily deductive approach aligned with the three social capital dimensions of the conceptual framework. Enabling factors were operationalized as observable evidence of social capital activation; institutional gaps as deficits in one or more dimensions; and coordination patterns as the relational mechanisms through which capacity evolved across stages. Where empirically emergent categories arose, inductive sub-categorization was applied (see Table 2). The institutional capacity assessment operationalized capacity across five equally weighted dimensions (20 points each), yielding a 0–100 composite score. This score was classified into four ordinal levels: Incipient (0–25), In Progress (26–50), Advanced (51–75), and Leader (76–100). The instrument drew on the PRB (Principles for Responsible Banking) and TCFD (Task Force on Climate-Related Disclosure) frameworks, adapted to the context of rural cooperatives and microfinance entities. Each dimension was scored through standardized per-item scales, aggregated and expressed as a percentage of the maximum; multi-source triangulation (interview data, institutional documentation, and sector benchmarks) and participatory team validation were applied to ensure representational accuracy.

Quantitative data were analyzed using a multi-case approach, applying this institutional capacity scale, descriptive statistics for learning assessments, and territorial demand classification aligned with international sustainability standards. Qualitative findings were used to interpret quantitative patterns in a sequential explanatory logic, capturing both objective aspects (capacities, structures, financial products) and subjective ones (trust perceptions, social relationships, motivations) shaping the adoption of NbS-aligned instruments.

3. Results

Overall, the capacity-building intervention generated substantive outcomes and demonstrated the institutional feasibility of advancing financing mechanisms for nature-based solutions in Colombian territories. This section introduces an overview of the results presented in Table 3, followed by a concise analysis organized by methodological stage, noting the social capital dimension activated and institutional outcomes generated at each stage.

3.1. Analysis of financing demand: establishing territorial demand as the foundation for instrument design

Demand analysis conducted in Huila and Santander from January through March 2025 established a foundational understanding of financing requirements across priority value chains. The methodology

Table 2
Institutional Capacity Assessment Instrument: Dimensions, Variables, and Items.

Dimension	Key Variables Assessed	Items	Max. Score
1. Institutional Context, Organizational Structure & Governance	Existence of a formal sustainability strategy/policy; presence of a dedicated sustainability unit or cross-functional committee; board-level recognition of ESG materiality; training of senior management on climate/environmental risks	5	20
2. Risk Management	Existence of a specialized function for E&S risk management; institutional recognition of E&S and climate risk materiality; approved and active process for E&S risk identification, assessment and monitoring; integration of E&S risk analysis in credit underwriting; portfolio coverage of risk assessment	5	20
3. Financial Instrument Design	Internal green/climate finance policies or guidelines; approved criteria for classifying NbS/green lending operations; active NbS-specific products in portfolio; green portfolio volume and delinquency behavior; institutional capacity to assess NbS-related risks	5	20
4. Green/Climate/ Environmental Resources	Access to concessional green funding from multilateral banks or international organizations; access to non-reimbursable resources or technical assistance for green portfolio development or institutional strengthening	2	20
5. Objectives & Metrics	Existence of commercial targets for green/NbS lending; information system capacity to tag, track and report green portfolio; alignment of targets with national and international sustainability commitments	2	20
Total		19	100

combined participatory workshops with producer and trade associations with secondary data sources—including the National Agricultural Survey, the National Administrative Department of Statistics of Colombia, and territorial studies. Together, these inputs served to identify sustainable activities with financing potential, determine market sizing, and estimate required investment volumes. A comparative synthesis of these territorial findings is presented in Table 4.

In Huila, 176 sustainable activities were identified (82% in primary production), with demand concentrated in silvopastoral systems, eco-efficient panela furnaces (≈COP 19.7B), and shade-grown coffee. Smaller-scale interventions averaged COP 4.6 M. In Santander, 126 activities were identified (69% primary), with higher capital intensity in nature-based tourism (≈COP 208.5M–1040 M). Across territories, barriers included documentary gaps, limited guarantees, low awareness of green finance, and weak technical assistance. These differentiated demand profiles directly informed subsequent instrument design: the types of activities identified, and the barriers documented, shaped the eligibility criteria, guarantee mechanisms, and sector focus embedded in each institution's financial instrument. This stage primarily activated linking social capital by aligning financial institutions with territorially articulated demand, reducing information asymmetries, and strengthening institutional legitimacy with producer communities.

Table 3
Outputs, key results, and social capital dimension activated by stage.

Methodological Stage	Primary Outputs	Key Results	Social Capital Dimension Activated
Analysis of Financing Demand	Comprehensive territorial demand assessments (Huila & Santander)	302 sustainable activities identified; 112 validated NbS activities prioritized	Linking
Institutional Diagnostic and Capacity Mapping	Multi-dimensional capacity assessments across five dimensions	9 institutions evaluated: environmental-social risk management averaging 15/100 across entities	Bonding
Training	Three modular training cycles with entry-exit assessments	100% attendance; demonstrated conceptual retention and practical competency development	Bonding+bridging
Thinking spaces and Technical Validation	Three thinking spaces with cross-institutional validation	302 activities filtered; 112 eligible NbS activities consolidated; Protocol for Green Portfolio Labeling	Bridging
Expert Tutoring for Green Finance Design	Six tutoring sessions per institution with customized accompaniment	Nine theoretical financial instrument models developed; risk management integrated across all products	Bonding
Demand-Side Gap Closure Workshops	Producer training on green finance access and anchor company linkages	Barrier identification and accessibility frameworks refined; producer-institution alignment strengthened	Linking
Multi-Stakeholder Coordination and Funder Linkages	Funding panel connecting climate finance actors	Eight funding partners engaged; pilot implementation roadmap established; partnership pathways activated	Linking

3.2. Institutional diagnostic and capacity mapping: baseline asymmetries that shaped differentiated capacity-building pathways

Institutional diagnostics conducted in January 2025, through semi-structured interviews and self-assessment exercises, established a baseline capacity across nine financial entities. The multidimensional diagnostic applied the PRB (Principles for Responsible Banking) and TCFD (Task Force on Climate-Related Disclosure) frameworks across five interrelated dimensions: institutional context and governance; environmental and social risk management; financial instrument design; access to climate/environmental resources; and sustainability objectives and metrics. Detailed diagnostic scores across institutions and dimensions are displayed in Table 5.

The diagnostic revealed strong asymmetries across institutions. While governance and instrument design capacities ranged from In Progress to Advanced (≈65/100), environmental and social risk management was uniformly Incipient (≈15/100). None of the entities had a

Table 4
Results of Financing Demand Analysis.

Territory	Value Chains	Sustainable Activities Identified	Primary Stage (%)	Investment Focus	Key Barriers
Huila	Cocoa, coffee, sugar cane (panela), nature tourism	176 activities	82%	Silvopastoral systems; eco-efficient furnaces (COP 19.7B); shade-grown coffee	Documentary gaps; limited guarantees; green finance knowledge; weak technical support
Santander	Cocoa, coffee, sugar cane (panela), palm oil, nature tourism	126 activities	69%	Nature-based tourism (COP 208.5M–1040 M); ecological trails; rural lodging	Geographic access; guarantee schemes; financial literacy; technical assistance

Table 5
Results of the institutional diagnostic.

Institution	Institutional Context	Environmental-Social Risk Mgmt.	Financial Instrument Design	Climate/Environmental Resources	Objectives & Metrics	Overall Status
FI1[1]	65/100 (In Progress)	8/100 (Incipient)	85/100 (Advanced)	23/100 (Incipient)	45/100 (In Progress)	In Progress
FI2	68/100 (In Progress)	8/100 (Incipient)	80/100 (Advanced)	73/100 (Advanced)	75/100 (Advanced)	Advanced
FI3	40/100 (Incipient)	4/100 (Incipient)	0/100 (Incipient)	23/100 (Incipient)	30/100 (In Progress)	Incipient
FI4	100/100 (Leader)	85/100 (Advanced)	50/100 (In Progress)	0/100 (Incipient)	100/100 (Leader)	Leader
FI5	58/100 (In Progress)	4/100 (Incipient)	0/100 (Incipient)	23/100 (Incipient)	30/100 (In Progress)	Incipient
FI6	80/100 (Advanced)	8/100 (Incipient)	80/100 (Advanced)	23/100 (Incipient)	95/100 (Advanced)	Advanced
FI7	63/100 (In Progress)	8/100 (Incipient)	30/100 (Incipient)	73/100 (Advanced)	45/100 (In Progress)	In Progress
FI8	85/100 (Advanced)	8/100 (Incipient)	30/100 (Incipient)	23/100 (Incipient)	60/100 (In Progress)	In Progress
FI9	65/100 (In Progress)	8/100 (Incipient)	25/100 (Incipient)	23/100 (Incipient)	30/100 (In Progress)	Incipient

[1] The names of all financial institutions and cooperatives have been anonymized under the acronym FI, distinguishing each one by a number that accompanies it.

formal Environmental and Social Risk Management System (SARAS, by its Spanish acronym) integrated into their credit analysis processes, and only three applied basic exclusion lists derived from prior technical assistance engagements. FI4 showed the highest institutional capacity, whereas FI5 and FI3 remained in the Incipient range. Resource mobilization capacity also varied, primarily reflecting prior exposure to green finance. This stratification was crucial for tailoring pedagogical and technical pathways to institutional needs rather than applying standardized approaches. More mature institutions (FI4, FI6) subsequently acted as peer references during thinking spaces, accelerating tool adoption across the network, a direct expression of bridging social capital at work.

3.3. Training: building bonding and bridging social capital through structured knowledge transfer

Three modular training cycles delivered between May and July 2025 addressed foundational concepts through advanced implementation topics: (1) NbS fundamentals and financing mechanisms; (2) environmental-social risk identification and monitoring frameworks; and (3) green financial instrument design and operationalization. Active pedagogical methodologies, such as integrating case studies, hierarchical analysis, subgroup work, and participatory prioritization exercises, maintained engagement across diverse institutional profiles. Entry-exit diagnostic assessments captured learning gains, confirming knowledge retention and demonstrated competency development in environmental criteria integration, climate risk identification in productive activities, and financial argumentation for sustainability investments. The pedagogical strategy activated bonding social capital internally within institutions and bridging capital through cross-institutional peer comparison, with 100% participant attendance across all three cycles conducted in both departments, Neiva (Huila) and Bucaramanga (Santander). Beyond knowledge acquisition, the training cycles served as early catalysts for building social capital, creating structured peer-comparison spaces in which institutions contrasted progress, constraints, and interpretations of NbS eligibility.

3.4. Thinking spaces and technical validation: operationalizing bridging social capital through peer consensus

Three thinking spaces (February, April, and June 2025) enabled peer exchange between Fondo Acción and the Universidad EAFIT while fostering horizontal learning among institutions. The first session showed that only 40% of entities included sustainability in their missions, leading to the co-creation of NbS eligibility tools. Later sessions validated 302 proposed activities, consolidating 112 NbS-eligible activities across priority value chains. Using this process and the Analytic Hierarchy Process (AHP), the team developed a catalog organizing these 112 fundable activities across 10 strategic chains: cocoa (18), tourism (15), fruits and vegetables (14), coffee (13), sugarcane (11), forestry and livestock (10 each), oil palm (9), poultry (7), and aquaculture (5). The final laboratory confirmed eligibility criteria, defined exclusion lists at three levels, and operationalized Green Labeling for financial products. These spaces built consensus on environmental indicators and portfolio-marking protocols, strengthening institutional environmental risk management. A key innovation is the catalog's three-tier monitoring system, which assigns each activity fundamental, medium, and high-complexity indicators based on institutional capacity. These thinking spaces operationalized bridging social capital through peer validation among institutions with heterogeneous maturity levels, while academic engagement reinforced technical legitimacy and strengthened linking dynamics.

3.5. Personalized technical support and tutoring: translating collective learning into institution-specific instruments

Six individualized tutoring sessions (March–September 2025) translated collective learning into institution-specific financial

instruments, addressing product structuring, eligibility criteria, risk integration, and pilot implementation pathways. Through this process, participants refined nine theoretical financial instrument models adapted to institutional capacities and territorial demand. These products targeted key value chains—sustainable livestock, coffee, cocoa, palm, sugar cane (panela), and nature-based tourism—and integrated environmental criteria, inclusion mechanisms, and market alignment. The intensive mentoring helped resolve institution-specific bottlenecks, producing instruments that operationalized green financial innovation into concrete credit architectures and pilot roadmaps. The core features of each designed instrument are outlined in Table 6.

At this stage, bonding social capital deepened within institutions as cross-functional teams collaborated to translate collective learning into context-specific products. The iterative mentoring process strengthened internal trust across departments and reduced resistance to integrating environmental criteria, transforming sustainability from an external requirement into an internally coordinated strategic objective.

3.6. Demand-Side gap closure workshops: strengthening the producer-institution relational infrastructure

Workshops with 32 producer representatives identified six barrier categories: documentary, financial, technical, institutional, geographic, and knowledge-related, and co-designed corresponding solutions. These barriers and the co-constructed solutions are structured in Table 7.

Anchor company sessions reduced information asymmetries and facilitated direct interaction with credit decision-makers, improving borrower readiness for green instruments. These workshops further consolidated linking social capital by connecting producer organizations directly with financial decision-makers, reducing vertical distrust, and clarifying procedural expectations. By addressing asymmetries in documentation, guarantees, and financial literacy, the intervention strengthened the relational infrastructure necessary for effective NbS credit uptake.

3.7. Multi-Stakeholder coordination and funder linkages: activating linking capital and piloting green instruments

The funding panel (October 2025) convened eight climate finance actors representing development banks, impact funds, technical cooperation agencies, and hybrid investment vehicles. Their institutional profiles and financing modalities are detailed in Table 8.

Participating institutions presented nine theoretical instruments, initiating bilateral follow-ups, due diligence processes, and co-funding discussions. Engagement outcomes included pilot roadmaps, feedback on monitoring systems, and exploration of blended finance arrangements. A consolidated view of funder engagement and institutional follow-up actions is provided in Table 9. This stage consolidated linking social capital by integrating local institutions into broader climate finance networks and reducing structural isolation.

Following the funding panel and subsequent bilateral engagements with participating financial actors, participating institutions operationalized the theoretical financial instruments into concrete pilot implementations. The operational characteristics of these instruments are described in Table 10. These seven green financial products, now deployed across the territories, represent the tangible institutional transformation catalyzed by the SolNatura capacity-building process. The instruments collectively demonstrate the transition from abstract technical knowledge to financial innovation ready for market piloting.

Collectively, the seven stages demonstrate that NbS financing capacity emerged through sequential activation of bonding, bridging, and linking social capital. The causal pathway can be explicitly traced across six sequential stages. First, demand analysis reduced information asymmetries and aligned institutional priorities with territorial financing needs, activating and linking social capital with producer communities. Second, diagnostics and training strengthened internal coordination (bonding capital) and created cross-institutional peer awareness (bridging capital), with 100% attendance confirming institutional commitment. Third, thinking spaces operationalized bridging capital through peer validation, with more advanced institutions accelerating capacity development among less mature peers. Fourth, tutoring translated collective learning into institution-specific financial architectures, deepening bonding capital across credit, risk, and sustainability departments. Fifth, demand-side workshops strengthened the relational infrastructure between institutions and producers, reducing barriers to credit uptake. Sixth, the funding panel connected institutions to international climate finance actors, establishing pilot financing pathways as the highest-order outcome linking capital. The nine financial instruments, the validated 112-activity catalog, and established funding pathways represent tangible evidence of strengthened relational

Table 6
Financial instruments designed through tutoring and their main characteristics.

Institution	Instrument Name	Target audience	Primary sectors chains
FI5	SolNatura Line	Micro and small producers	Aquaculture, cocoa, livestock, tourism
FI1	EcoCredit	Small and medium producers	Coffee, cocoa, sugar cane, livestock, poultry
FI6	NbS Women's Lines and NbS Green Credit	Small and medium coffee growers	Coffee focus
FI2	Green Line NbS by Chain	Producers	Coffee, cocoa, oil palm
FI3	Rate Compensation Line for NbS restoration	Agricultural producers	Multi-sector (through intermediaries)
FI7	Green NbS Line Eastern Colombia	Micro and small entrepreneurs	Agriculture, energy, tourism
FI8	NbS Green Credit Line	Coffee growers	Coffee, agroforestry
FI9	Green Credit Line	Urban and rural members	Coffee, cocoa, sugar cane, tourism
FI4	Sustainable Agro Rotating Fund	Meat and dairy producers	Sustainable dual-purpose livestock

Table 7
Barriers identified and co-designed solutions.

Barrier Type	Description	Proposed Solutions
Documentary	Lack of formalized property titles, unresolved succession processes, absence of accounting records or certified financial statements.	Simplify documentary processes; promote gradual land tenure formalization; provide legal and accounting support.
Financial	Insufficient guarantees; limited guarantee schemes; unstable payment capacity	Solidary/associative guarantees; local guarantee funds; flexible microfinance lines adapted to rural contexts
Technical	Lack of environmental certifications or Good Agricultural Practices (GAP)	Technical capacity-building in GAP; environmental certification programs; validation support for NbS projects
Institutional	Weak accompaniment from public and financial entities in document preparation	Strengthen institutional presence in rural territories; partnerships between financial entities and local governments; green project formulation pathways
Geographic & Connectivity	Distance from financial centers; transport and digital connectivity limitations	Mobile banking; virtual services with offline support; rural bank correspondents; digital connectivity improvements
Knowledge	Low financial literacy and lack of awareness about green financial instruments.	Strengthen rural financial education; train in NbS project formulation; disseminate green instruments.

Table 8
Characteristics of guest anchors at the funding panel.

Funder	Type of Organization	Geographic Scope	Financing Modality	Ticket Size	Impact Focus	Strategic Value
Funder 1	National development bank (Colombia)	Colombia	Rediscount & direct credit; 60-month terms	Flexible; FNG guarantees	Green value chains; sustainable MSMEs	National funding source & territorial leverage
Funder 2	International technical cooperation agency	Spain–Latin America	Technical assistance; partial project co-financing	Variable (by call)	Agricultural cooperation; rural capacity-building	Technical cooperation & institutional strengthening
Funder 3	Impact investment fund	Europe–Latin America	Debt or impact investment; 36-month terms	From USD 5 million	Social inclusion; environmental & social impact	Large-scale financing with ESG criteria
Funder 4	International development fund	Latin America & Caribbean	Senior debt; 24–60-month terms	From USD 500,000	Poverty reduction; rural livelihoods	Flexible & sustainable financing for rural IMF
Funder 5	Local financial intermediary	Colombia	Direct credit; FNG-backed guarantees; 60+ month terms	From USD 500,000	Social & environmental portfolios	Local intermediate operator or alliance partner
Funder 6	International microfinance platform	Global	Interest-free microloans; 4% fee model	Variable	Inclusive finance; local & sustainable economies	Low-cost credit diversification source
Funder 7	Hybrid investment & technical assistance fund	Latin America (Colombia included)	Seed capital; patient investment; technical assistance	From USD 200,000; flexible	Social enterprises; sustainable employment	Ideal for cooperatives with entrepreneurial & social models
Funder 8	Impact investment fund	International	Impact debt or investment; variable terms.	Tickets starting at USD 500,000.	Rural financial inclusion, women, and youth.	Co-financier of products with a social and territorial focus.

Table 9
Consolidated results by cooperative and financial institution after the funding panel.

FI/ cooperative	Funders Involved	Initial Comments & Agreements	Key Attractive Elements	Technical Adjustments & Identified Barriers
FI8	Funder 7, Funder 3, Funder 5, Funder 6, Funder 8, Funder 2	Interest in using Funder 6′s revolving credit line to expand offerings. Preparing information to deepen knowledge with Funder 7 and Funder 3.	In-kind credit model (coffee purchase at spot) with 43 buying points network; portfolio expansion potential. Funder 2 can advise on institutional strengthening.	Need to update credit regulations (expand portfolio/lines); external funding dependency; clarify intermediation conditions.
FI6	Funder 6, Funder 1, Funder 3, Funder 7	Opportunities identified with Funder 1, and Funder 3 ; scalability with Funder 6 depends on bilateral follow-ups.	Strong coffee market potential: coffee purchase, working capital, technical assistance. Opportunities with Funder 3 on energy efficiency.	Prioritize 1–2 funders with highest synergy; clarify platform costs; define strategy for low-synergy actors. FUNDECAFÉ blended financing option identified. Funder 6 works with MFIs with portfolios >5 M USD.
FI9	Funder 3, Funder 1, Funder 6, Funder 5	Rate, guarantee, and financeable activity adjustments; own funds available for execution; Funder 3 requested additional information.	Active line with Funder 1; rotating funding opportunity with Funder 6; updated instrument.	Funders may require more information on green portfolio monitoring and tracking; strengthen environmental and social monitoring systems.
FI1	Funder 6, Funder 1, Funder 2, Funder 5	Sought relationship-building over immediate funding. Initiated due diligence processes with Funder 6 and Funder 1.	Interest from Funder 6 (social impact) and Funder 1 (green lines); relations with producer associations (Fedecacao).	Requires support in due diligence and impact measurement mechanisms. Needs to strengthen financial products and value proposition aligned with funder sustainability criteria. Scalability depends on credit line expansion with FINAGRO and Banco Serfinanza. Opportunity to structure partnerships (e.g., with Almacenes Olímpica).
FI2	Funder 2, Funder 7, Funder 3, Funder 5	Funder 2 offers institutional strengthening and regional experience exchange. Funder 5 and local bank proposed as support partners for strategic funder alliances.	Sector alliances facilitating eligibility and monitoring; experience in productive agricultural credit. Funder 3 exploring: Senior Debt, Subordinated Debt (16% EA), and Subordinated Bonds.	Need for environmental and social risk plan (SARAS); prepare funding prospectus; compensation policy limitations. Funder 7 barrier: does not finance individuals; strategy is to identify associative schemes.
FI5	Funder 1, Funder 6, Funder 7, Funder 3	Funder 1 showed greater interest; pilot with sector associations proposed (livestock recommended). Funder 6 conditions and other green lines reviewed.	Funder 1 competitive green lines; sectoral pilots' opportunity. Potential in cacao, agroforestry, sustainable livestock, and generational transition.	Clear and relevant instrument (Funder 1). Viability and scalability with Funder 6 unclear due to portfolio size (<5 M USD).
FI7	Funder 6, Funder 5, Funder 2	Funder 6 interested in crowdfunding support; due diligence requirements and social indicators discussed. Digitalization advances (promissory note dematerialization planned Feb/2026).	Crowdfunding potential for micro-entrepreneurs; Funder 6 green line (climate credits 2026). Funder 2 offers capacity building for associative schemes client self-sufficiency.	High international wire costs and currency risks; need for staff training and document digitalization for traceability.
FI3	Funder 1, Funder 5, Funder 2, Funder 7 (local bank potential)	Funder 1: portfolio presentation and expert meetings on green lines and solar energy; part of Funder 1 network. Funder 5: interest in green lines exploration; coordinated Banco Serfinanza approach.	Renewable energy and green infrastructure interest; possibility of working with municipalities using allocated credit lines for territorial projects.	Define mechanisms for territorial entity credit application; clarify guarantees, timelines, and committee function segregation; lines restricted to specific sectors.
FI4	Funder 2, Funder 7, Funder 3, Funder 1	Funder 2 opportunity to strengthen associative scheme bankability; technical assistance in livestock productivity. Funder 7: second meeting to present Fondo Lirio pipeline and support producer associations grouped by Alquería.	Commitment for bilateral meetings; collaborative work through Alquería.	Follow-up bilateral meetings with Funder 3 post-panel discussion.

Table 10
Financial Instruments Designed and Operationalized for Pilot Implementation.

Institution	Description of Financial Instrument
FI9	FI9 Green Credit NbS finances micro and small producers in the adoption of sustainable practices. It offers amounts of 1 to 120 minimum monthly wages, terms up to 60 months, preferential rates (20–24% annual effective rate), and flexible guarantee and prepayment conditions.
FI5	FI5 Pilot offers credits with preferential rates, terms up to 36 months, and no prepayment penalties, for agroforestry projects, clean energy and efficient water management. It combines own capital with technical assistance and incorporates sustainability indicators, prioritizing rural women and youth.
FI7	FI7 finances sustainable investments from micro and small producers, with preferential rates, flexible terms, and post-credit technical support. Its innovation lies in an NbS eligibility checklist and an environmental validation process by credit committee ensuring traceability of each loan.
FI6	CaféVerde offers preferential credit to small coffee growers, prioritizing women and youth, for implementing clean technologies and sustainable practices. It is structured as its own credit line with SolNatura technical support, integrating environmental criteria and technical assistance to validate investment results.
FI1	EcoCredit finances sustainable projects with terms up to 60 months, competitive rates, and no prepayment penalties. It incorporates ESG criteria in credit evaluation and combines own resources with specialized technical assistance. Its innovation lies in an inclusive and adaptable financing model responsive to rural productive cycles.
FI3	SbN FI3 Pilot operates through agreements with cooperatives and microfinance institutions, compensating interest rates on sustainable projects. It combines own resources with technical cooperation to reduce credit risk and improve NbS profitability. Its innovation lies in applying a public incentive mechanism stimulating sustainable practice adoption.
FI2	SbN FI2 Pilot offers green credits with environmental criteria in credit analysis and digital monitoring tools. It combines own resources and technical assistance with rural trade associations, financing 100% of sustainable investments. Its innovation lies in a collaborative environmental and financial monitoring model for evaluating impact and profitability.

infrastructures within rural financial systems.

4. Discussion

The seven instruments developed constitute a locally adapted portfolio of green financial products supporting silvopastoral and agroforestry systems, watershed restoration, bioeconomy initiatives, nature-based tourism, clean energy, and water-efficient technologies. Their adoption across institutions in Huila and Santander demonstrates that funding panels not only mobilized early investment pathways but also catalyzed institutional transformation. This transformation can be understood through the lens of social capital.

Three conditions proved decisive and map directly onto the forms of social capital observed throughout the project. First, territorial knowledge (environmental, productive, and social) ensured contextual relevance and environmental integrity, reinforcing the internal cohesion that characterizes bonding social capital. Second, continuous technical assistance aligned financed activities with sustainability criteria throughout the credit cycle, while peer-to-peer exchange between institutions of varying size and capacity generated shared eligibility standards consistent with bridging social capital. Third, inter-institutional collaboration, anchored by technical validation spaces and coordination with international donors, strengthened governance, trust, and collective learning norms, reflecting both linking social capital and the institutional trust built through demonstrated outputs. Together, these dynamics illustrate how rural green finance, when structured around collaborative governance, generates not only financial returns but also durable relational infrastructure, as systematically mapped in Table 11.

Table 11
Parallels between concepts of social capital and phenomena observed in the SolNatura project.

Concept of Social Capital	Phenomenon Documented in SolNatura
Bonding social capital (internal links)	Integration of previously isolated areas (risks, credit, sustainability) generating greater internal cohesion across institutional departments
Bridging social capital (bridges between groups)	Peer-to-peer exchange between institutions with different levels of size and capacity to structuring and placing financial instruments in rural markets, generating trust and shared eligibility standards
Linking social capital (vertical links with power)	Funding panel with eight actors in international climate finance; initiation of due diligence processes and pilot implementation roadmaps; coordination with donors
Institutional trust based on performance	Technical validation through thinking spaces between Fondo Acción and the Universidad EAFIT as a mechanism for legitimization; iterative tutoring building credibility through demonstrated outputs
Collective learning and norms of reciprocity	Highly valued horizontal learning, comparing progress, sharing doubts, and recognizing good practices across institutions of heterogeneous maturity

These findings align with and extend the existing literature in important ways. The universal incidence of environmental-social risk management across all nine institutions confirms Biasin et al.'s [53] observation that local actor participation is systematically underrepresented in NbS instrument design. Still, our results go further, demonstrating that this gap is primarily relational rather than merely technical: institutions with prior exposure to inter-institutional networks progressed faster in instrument sophistication than technically similar peers. This supports Cofré-Bravo et al.'s [66] finding that combinations of bonding, bridging, and linking social capital are more predictive of innovation adoption than technical knowledge alone. The PBL methodology proved effective as an instrument for cultivating social capital in real time, consistent with Zhang & Ma's [64] meta-analytic finding that PBL produces significantly higher knowledge transfer and retention than content-based approaches, and with d'Escoffier et al.'s [67] evidence on PBL for sustainability education. Critically, our study adds a finding absent from prior PBL research: the relational outcomes of PBL were as analytically significant as the technical outputs.

Institutionalization nonetheless required addressing structural gaps. Most institutions lacked prior NbS experience and specialized environmental staff, relying instead on alliances and technical accompaniment, which previous studies identify as more effective than standardized training in heterogeneous institutional settings [23,78]. Most adapted existing products rather than creating new ones, but all stressed the need for information systems to identify and monitor NbS portfolios. A key limitation is that the capacity diagnostic was applied only at baseline, without standardized post-intervention reassessment; therefore, no measured institutional capacity gains can be claimed. Instead, the evidence shows differentiated trajectories: institutions with stronger pre-existing governance and resource-access conditions (FI4, FI6, FI2) progressed faster in instrument design and funder engagement than those starting from Incipient conditions (FI3, FI5), suggesting that minimum institutional capital may be a precondition for autonomous operationalization. This indicates that support intensity and duration should be calibrated to baseline institutional conditions. Sustainability also remains uncertain: the pilot roadmaps and funder commitments generated through SolNatura represent early relational foundations rather than demonstrated long-term performance [88].

Moreover, reframing bonding, bridging, and linking social capital as organizational capabilities extends the foundational typology [15,16,18–20] from community settings to financial institutions. Rather than static contextual attributes, our findings suggest these forms operate as dynamic capabilities that mediate the translation of external knowledge into organizational routines. Their effectiveness also depended on

sequencing: bonding capital had to precede bridging capital, and bridging capital had to precede linking capital, for technical knowledge to translate into operational financial instruments. This temporal dimension extends prior community-level theories. Although dense social capital networks can inhibit innovation [21], in this case, bonding capital facilitated openness because the PBL methodology oriented collaboration toward external challenges rather than reinforcing existing routines.

However, this study has several limitations worth noting. The case is limited to two regions within a single country, so generalizing the findings to other regulatory or institutional contexts requires caution. The diagnostic relied on self-reported assessments, which may be subject to social desirability bias. Without post-intervention longitudinal data, causal claims about financial or environmental outcomes remain limited. Institutional heterogeneity was also evident; FI3 and FI5 remained at an Incipient level in several capacity dimensions by the end of the intervention, suggesting that structural barriers may not be fully addressed through capacity-building alone. And the twelve-month timeframe makes it difficult to assess whether the observed social capital gains will hold beyond the project's active facilitation. Finally, the authors' dual role as both practitioners and researchers in this project introduces interpretive constraints that standard peer review cannot fully eliminate; findings should be read with this in mind, and future independent replications of this framework would be particularly valuable for validating the causal claims advanced here.

Future research should undertake longitudinal analyses to assess the medium- and long-term financial and environmental performance of NbS-aligned instruments, as well as comparative studies across territories and Global South countries to identify replicable patterns and critical contextual conditions. Additionally, further work is needed to develop standardized metrics for measuring organizational social capital and to examine its causal relationship with financial, climate, and biodiversity outcomes.

5. Conclusions

Building on these findings, the study advances three contributions to NbS, sustainable finance, and environmental governance scholarship. The first contribution is theoretical. By reconceptualizing bonding, bridging, and linking social capital as organizational capabilities embedded within financial institutions, this research demonstrates how internal coordination, peer validation, and structured engagement with climate finance actors mediate the operationalization of NbS principles. This reframing repositions social capital as a dynamic mechanism of institutional change and financial innovation, capable of overcoming static institutional attributes.

The second contribution is methodological. Project-Based Learning (PBL) is operationalized not merely as a training approach but also as an analytical lens for observing institutional transformation in real time. The co-design of financial instruments and iterative validation processes generated empirical evidence of how knowledge acquisition, trust-building, and coordination evolved simultaneously, offering a replicable framework for studying socio-technical change in NbS finance.

The third contribution is empirical and directly policy-relevant. By systematizing evidence on nine NbS-aligned financial instruments and 112 validated activities across Colombian rural territories, this study advances a granular characterization of financial intermediation dynamics within Global South contexts. Critically, this evidence base informed the formulation of Colombia's first national policy framework on the subject—the National Strategy for Nature-based Solutions (NbS) issued by Colombia's National Planning Department in March 2026 [88, 89], thereby exemplifying a robust process of evidence-based public policy design. This research-to-policy translation constitutes a substantive contribution, demonstrating the instrumental role of empirically grounded, territorially embedded analysis in shaping coherent and actionable policy architectures. Beyond the Colombian case, the study offers a transferable analytical and methodological framework for designing evidence-based NbS policies under conditions of institutional heterogeneity and fragility. The findings reinforce that scaling NbS finance is contingent not solely upon regulatory alignment and capital mobilization, but on sustained investments in institutional capabilities and multi-scalar relational governance. Accordingly, multilateral climate finance institutions and national development banks should incorporate structured peer-learning architectures that leverage institutional diversity to catalyze bridging social capital, while simultaneously strengthening linking social capital through formalized engagement mechanisms that embed rural financial actors within transnational climate finance ecosystems.

Funding

This research was derived from a consultancy project developed for the Universidad EAFIT and Fondo Acción. SolNatura is a project commissioned by the Federal Ministry for the Environment, Nuclear Safety and Consumer Protection of the Federal Republic of Germany (BMUV). It is part of the International Climate Initiative (IKI). However, this specific research article was not directly funded by such a project.

CRediT authorship contribution statement

Judith Vergara-Garavito: Writing – original draft, Validation, Project administration, Methodology, Investigation, Formal analysis, Conceptualization. **Rosa Carvajal Barrera:** Visualization, Software, Methodology, Formal analysis, Data curation. **Doris Arévalo Ordoñez:** Writing – review & editing, Methodology, Conceptualization. **Luis Farak -Flórez:** Writing – original draft, Validation, Software, Investigation, Data curation. **Gloria Calderón Peña:** Visualization, Supervision, Project administration, Funding acquisition. **Melani Díaz Moya:** Writing – review & editing, Validation, Investigation, Formal analysis. **Sergio Prieto Mosquera:** Writing – review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

References

[1] T. Dunlop, D. Khojasteh, E. Cohen-Shacham, W. Glamore, M. Haghani, M. Van Den Bosch, D. Rizzi, P. Greve, S. Felder, The evolution and future of research on nature-based solutions to address societal challenges, Commun. Earth. Environ. 5 (2024) 132, https://doi.org/10.1038/s43247-024-01308-8.

[2] I.B. Key, A.C. Smith, B. Turner, A. Chausson, C.A.J. Girardin, M. Macgillivray, N. Seddon, Biodiversity outcomes of nature-based solutions for climate change adaptation: characterising the evidence base, Front. Environ. Sci. 10 (2022) 905767, https://doi.org/10.3389/fenvs.2022.905767.

[3] N. Seddon, A. Chausson, P. Berry, C.A.J. Girardin, A. Smith, B. Turner, Understanding the value and limits of nature-based solutions to climate change and other global challenges, Phil. Trans. R. Soc. B 375 (2020) 20190120, https://doi.org/10.1098/rstb.2019.0120.

[4] IUCN, International Union for Conservation of Nature, IUCN Global Standard For Nature-based Solutions: a User-Friendly Framework For the verification, Design and Scaling Up of NbS: First Edition, 1st ed., IUCN, 2020 https://doi.org/10.2305/IUCN.CH.2020.08.en.

[5] L. Marsters, G. Morales, S. Ozment, M.C.S. Zuniga, G. Watson, M. Netto, G. L. Frisari, Nature-based Solutions in Latin America and the Caribbean: Financing Mechanisms For Regional Replication, IDB Publications, 2021, https://doi.org/10.18235/0003688.

[6] D. van Raalte, N. Ranger, Financing nature-based solutions for adaptation at scale. https://www.eci.ox.ac.uk/sites/default/files/2023-12/Financing_NbS_for_Adaptation-GCAOxford2023-finalv2.pdf, 2023.

[7] H.A. Sheikh, D. Narain, C. Bartlett, C. Christiaen, Unlocking private finance for nature: addressing barriers and reframing risk-return dynamics, iScience 28 (2025) 113669, https://doi.org/10.1016/j.isci.2025.113669.

[8] A. Haldane, D. Halpern, Social capital 2025: the hidden wealth of nations. https://apo.org.au/node/329440, 2025 (accessed October 26, 2025).

[9] F. Ubeda, A. Mendez, F.J. Forcadell, Sustainable banking and trust in the global South, Glob. Policy. 15 (2024) 34–44, https://doi.org/10.1111/1758-5899.13314.

[10] V. Cologna, N.G. Mede, S. Berger, J. Besley, C. Brick, M. Joubert, E.W. Maibach, S. Mihelj, N. Oreskes, M.S. Schäfer, S. van der Linden, et al., Trust in scientists and their role in society across 68 countries, Nat. Hum. Behav. 9 (2025) 713–730, https://doi.org/10.1038/s41562-024-02090-5.

[11] L. Ping, S. Xiaosong, L. Jinzhao, Research on farmers' households credit behavior and social capital acquisition, Front. Psychol. 13 (2022), https://doi.org/10.3389/fpsyg.2022.961862.

[12] H.Y. Nigus, Whom farmers trust the most? Institutional trust and economic decision makings: evidence from rural Ethiopia, SSRN J. (2022), https://doi.org/10.2139/ssrn.4270786.

[13] B. Mei, A.A. Khan, S.U. Khan, M.A.S. Ali, J. Luo, An estimation of the effect of green financial policies and constraints on agriculture investment: evidences of sustainable development achievement in Northwest China, Front. Public Health 10 (2022) 903431, https://doi.org/10.3389/fpubh.2022.903431.

[14] J. Salinas Vásquez, J.P. Sarmiento Jara, M.P. Urgilés Salinas, D.F. Oña Avendaño, Social capital and credit risk in a financial cooperative of Ecuador, J. Co-Oper. Organiz. Manage. 12 (2024) 100247, https://doi.org/10.1016/j.jcom.2024.100247.

[15] R. Chetty, M.O. Jackson, T. Kuchler, J. Stroebel, N. Hendren, R.B. Fluegge, S. Gong, F. Gonzalez, A. Grondin, M. Jacob, D. Johnston, M. Koenen, E. Laguna-Muggenburg, F. Mudekereza, T. Rutter, N. Thor, W. Townsend, R. Zhang, M. Bailey, P. Barberá, M. Bhole, N. Wernerfelt, Social capital I: measurement and associations with economic mobility, Nature 608 (2022) 108–121, https://doi.org/10.1038/s41586-022-04996-4.

[16] R. Chetty, M.O. Jackson, T. Kuchler, J. Stroebel, N. Hendren, R.B. Fluegge, S. Gong, F. Gonzalez, A. Grondin, M. Jacob, D. Johnston, M. Koenen, E. Laguna-Muggenburg, F. Mudekereza, T. Rutter, N. Thor, W. Townsend, R. Zhang, M. Bailey, P. Barberá, M. Bhole, N. Wernerfelt, Social capital II: determinants of economic connectedness, Nature 608 (2022) 122–134, https://doi.org/10.1038/s41586-022-04997-3.

[17] J. Zhao, T. Li, Social capital, financial literacy, and rural household entrepreneurship: a mediating effect analysis, Front. Psychol. 12 (2021), https://doi.org/10.3389/fpsyg.2021.724605.

[18] J. Sudarsky, The Measurement of Social Capital in Colombia and Its Development in Bogota, The International Scope Review, 2005. https://socialcapital.is/TISR/synopsis/the-measurement-of-social-capital-in-colombia-and-its-development-in-bogota/ (accessed October 26, 2025).

[19] G.D. Valencia Agudelo, D. Cuartas Celis, Trayectoria de los estudios sobre el capital social en América Latina, Ens. Econ. 30 (2020) 98–119, https://doi.org/10.15446/ede.v30n57.82502.

[20] Scott Whiteford, Capital social y reducción de la pobreza en América Latina y el Caribe: en busca de un nuevo paradigma, CEPAL (2003) s.l.

[21] M. Rubio, Perverse social capital: some evidence from Colombia, J. Econ. Issues. 31 (1997) 805–816.

[22] T. Dufhues, G. Buchenrieder, I. Fischer, Social capital and rural development: literature review and current state of the art, (2006). https://doi.org/10.22004/AG.ECON.92017.

[23] Kwaku Ofori, Innovative strategies for capacity building in financial institutions: lessons from successful microfinance models, Int. J. Sci. Res. Arch. 13 (2024) 1223–1226, https://doi.org/10.30574/ijsra.2024.13.2.2159.

[24] J.M. Chambers, C. Wyborn, M.E. Ryan, R.S. Reid, M. Riechers, A. Serban, N. J. Bennett, C. Cvitanovic, M.E. Fernández-Giménez, K.A. Galvin, B.E. Goldstein, N. L. Klenk, M. Tengö, R. Brennan, J.J. Cockburn, R. Hill, C. Munera, J.L. Nel, H. Österblom, A.T. Bednarek, E.M. Bennett, A. Brandeis, L. Charli-Joseph, P. Chatterton, K. Curran, P. Dumrongrojwatthana, A.P. Durán, S.J. Fada, J.-D. Gerber, J.M.H. Green, A.M. Guerrero, T. Haller, A.-I. Horcea-Milcu, B. Leimona, J. Montana, R. Rondeau, M. Spierenburg, P. Steyaert, J.G. Zaehringer, R. Gruby, J. Hutton, T. Pickering, Six modes of co-production for sustainability, Nat. Sustain. 4 (2021) 983–996, https://doi.org/10.1038/s41893-021-00755-x.

[25] Colombia | NDC Partnership, (n.d.). https://ndcpartnership.org/country/col (accessed October 26, 2025).

[26] A. Escobedo, Colombia's Green taxonomy: a first in Latin America. https://www.greenomy.io/blog/colombias-green-taxonomy, 2022 (accessed October 26, 2025).

[27] The Biodiversity Finance Initiative, Colombia Leads the Way in Greening Agricultural Finance to Protect Biodiversity, BIOFIN, 2025. https://www.biofin.org/news-and-media/colombia-leads-way-greening-agricultural-finance-protect-biodiversity (accessed October 26, 2025).

[28] R. Atwood, Financing Biodiversity in Colombia, IFC, 2025. https://www.ifc.org/en/stories/2025/financing-biodiversity-in-colombia (accessed October 26, 2025).

[29] OECD, Rural Policy Review of Colombia 2022, OECD Publishing, 2022, https://doi.org/10.1787/c26abeb4-en.

[30] L. Rojas-Suarez, L. Pacheco, An Index of regulatory practices for financial Inclusion in Latin America: enablers, promoters, and preventers, Working Paper 468, https://www.cgdev.org/publication/index-regulatory-practices-financial-inclusion-latin-america, 2017 (accessed October 26, 2025).

[31] E.M. Gutierrez, R. Rekha, Expanding Opportunities For Rural Finance in Colombia, World Bank, 2016. https://documentos.bancomundial.org/es/publication/documents-reports/documentdetail/102471467999687402 (accessed October 26, 2025).

[32] X.P.G. Espinoza, M.A.P. Silva, S.A.G. Silva, D.P.L. Freire, Sustainable development and credit unions in economic and social profitability: a bibliometric analysis, Herit. Sustain. Dev. 7 (2025) 269–288, https://doi.org/10.37868/hsd.v7i1.976.

[33] L. Nugroho, W. Utami, T. Akbar, W. Arafah, The challenges of microfinance institutions in empowering micro and small entrepreneur to implementating green activity, Int. J. Energy Econ. Policy 7 (2017) 66–73.

[34] M. Allet, Why do microfinance institutions go green? An exploratory study, J. Bus. Ethics 122 (2014) 405–424, https://doi.org/10.1007/s10551-013-1767-2.

[35] D. Berko, R. Rajaram, The perceived impact of green microfinance to influence micro, small and medium enterprises to implement green activities, Expert J. Bus. Manage. 12 (2024). https://business.expertjournals.com/23446781-1205/ (accessed October 26, 2025).

[36] V.S. Castillo, The contribution of rural social networks to the consolidation of social capital, AWARI 4 (2023), https://doi.org/10.47909/awari.52.

[37] J.E.S. Vélez, Capital social y empresas rurales: un estudio de caso, Criterio Libre 11 (2013) 143–161, https://doi.org/10.18041/1900-0642/criteriolibre.2013v11n19.1105.

[38] N.L. Johnson, R. Suarez, M. Lundy, The importance of social capital in Colombian rural agro-enterprises, (2002). https://doi.org/10.22004/AG.ECON.50059.

[39] C. Streck, G. Martínez, D. Landholm, F. Bravo, J. Castro, L. Cote, S. Mithra, M. Montaño, P. Pulido, Unlocking nature-based solutions through carbon markets in Colombia, Clim. Focus (2022). https://climatefocus.com/publications/unlocking-naturebasedsolutions-through-carbon-markets-in-colombia/ (accessed October 26, 2025).

[40] Promoting Nature-based Solutions for resilient, low carbon and biodiverse territorial development (SolNatura) – IKI Colombia, (n.d.). https://ikicolombia.com/en/proyectos/promoting-nature-based-solutions-for-resilient-low-carbon-and-biodiverse-territorial-development-solnatura/ (accessed October 26, 2025).

[41] C.K. Ansell, E. Sørensen, J. Torfing, Co-Creation For Sustainability: The UN SDGs and the Power of Local Partnerships, Emerald Publishing, Bingley, 2022.

[42] H. Ding, C.N. McLaren, Financial Sector Guidebook On Nature-Based Solutions Investment: Aligning Investment With Impacts and Showcasing Examples, WRIPUB, 2025, https://doi.org/10.46830/wrigb.24.00043.

[43] A.A. Alsmadi, K.S. Al-Omoush, Adoption of green banking innovations: drivers and outcomes, GF 7 (2025) 584–609, https://doi.org/10.3934/GF.2025022.

[44] S. Handoyo, Public governance and national environmental performance nexus: evidence from cross-country studies, Heliyon. 10 (2024) e40637, https://doi.org/10.1016/j.heliyon.2024.e40637.

[45] H. Muhammad, M. Aman, How environmental regulations influence ESG controversies: the role of climate governance and environmental decoupling, Corp. Soc. Responsib. Environ. 33 (2026) 1320–1338, https://doi.org/10.1002/csr.70235, csr.70235.

[46] T. Könnöla, P.D. Río González, J. Carrillo-Hermosilla, F.J. Díaz López, Innovación Verde En América Latina y El Caribe: Estudio De Casos Sobre La Gestión De Programas De Apoyo, Inter-American Development Bank, 2023, https://doi.org/10.18235/0004891.

[47] G. Maldonado-Guzmán, Green Innovation Mediates Between Financial Innovation and Business sustainability? Proof in the Mexican Manufacturing Industry, 6, GF, 2024, pp. 563–584, https://doi.org/10.3934/GF.2024021.

[48] N. Shafi, F. Wahid, U. Ullah, W.A. Shaheen, Unlocking green prosperity: how innovation, trade, finance and governance shape sustainable economic growth, Dev. Sustain. Econ. Finance 7 (2025) 100085, https://doi.org/10.1016/j.dsef.2025.100085.

[49] J. Ayala-García, S. Dall'erba, The natural resource curse: evidence from the Colombian municipalities, Papers Region. Sci. 100 (2021) 581–603, https://doi.org/10.1111/pirs.12577.

[50] J. Gorelick, N. Walmsley, The greening of municipal infrastructure investments: technical assistance, instruments, and city champions, Green Finance 2 (2020) 114–134, https://doi.org/10.3934/GF.2020007.

[51] Y. Yang, Z. Wang, R. Luo, Financial innovation and agricultural investment: drivers of sustainable growth in China's rural economy with regional variations, Int. Rev. Econ. Finance 101 (2025) 104230, https://doi.org/10.1016/j.iref.2025.104230.

[52] R. Chopra, H. Nobanee, D. Chakraborty, P.A. Hamill, Investing in nature: unpacking trends and gaps in biodiversity finance research, Dev. Sustain. Econ. Finance 2-4 (2024) 100023, https://doi.org/10.1016/j.dsef.2024.100023.

[53] A. Biasin, H. Toxopeus, D. Pettenella, F. Polzin, M. Masiero, Financing urban nature-based Solutions (NBS): a literature review from the perspective of funders, Nat.-Based Solut. 6 (2024) 100195, https://doi.org/10.1016/j.nbsj.2024.100195.

[54] J.J. Aguilera-Rodríguez, A. Scolobig, J.G.C. Martin, J. Linnerooth-Bayer, Implementing nature-based solutions: insights from private contractors and consultants, Nat.-Based Solut. 8 (2025) 100278, https://doi.org/10.1016/j.nbsj.2025.100278.

[55] J. Moodie, E. Salle, B. Zomer, R. Vilcu, I. Laurent, Empowering rural areas in multi-level governance processes, (2023). https://doi.org/10.5281/ZENODO.7504192.

[56] M.D. Marino, I.S. Furuseth, C. Enge, G.S. Solli, L.J. Barkved, Nature-based solutions for climate change adaptation in urban areas: a Norwegian planning perspective, Land. use policy. 157 (2025) 107678, https://doi.org/10.1016/j.landusepol.2025.107678.

[57] D. Roitsch, N. Da Schio, S.K. Ostoić, I. Zivojinovic, D. Vuletic, A. Armstrong, A. Czaplarska, F. Baró, I. Whitehead, A. Bujis, R. De Vreese, Co-production of urban forests as nature-based solutions: motivations and lessons-learnt from public officials, Environ. Sci. Policy. 157 (2024) 103764, https://doi.org/10.1016/j.envsci.2024.103764.

[58] K. Hölscher, N. Frantzeskaki, D. Kindlon, M.J. Collier, G. Dick, A. Dziubała, M. Lodder, A. Osipiuk, M. Quartier, S. Schepers, K.V. De Sijpe, C.V. Der Have, Embedding co-production of nature-based solutions in urban governance:

emerging co-production capacities in three European cities, Environ. Sci. Policy. 152 (2024) 103652, https://doi.org/10.1016/j.envsci.2023.103652.
[59] K. Soini, C.C. Anderson, A. Polderman, C. Teresa, D. Sisay, P. Kumar, M. Mannocchi, S. Mickovski, D. Panga, F. Pilla, S. Preuschmann, J. Sahani, H. Tuomenvirta, Context matters: co-creating nature-based solutions in rural living labs, Land. use policy. 133 (2023) 106839, https://doi.org/10.1016/j.landusepol.2023.106839.
[60] A. Ibrahim, K. Marshall, E. Carmen, K.L. Blackstock, K.A. Waylen, Raising standards for stakeholder engagement in nature-based solutions: navigating the why, when, who and how, Environ. Sci. Policy. 163 (2025) 103971, https://doi.org/10.1016/j.envsci.2024.103971.
[61] E. Van Wyk, L. Moore, E. Lecavalier, A. Berghöfer, R. Karutz, A. Kyessi, G. Maree, Mainstreaming nature-based solutions in Dar es Salaam, Tanzania: a capacity perspective on transformative change, Nat.-Based Solut. 8 (2025) 100261, https://doi.org/10.1016/j.nbsj.2025.100261.
[62] M.S. Knowles (Ed.), Andragogy in Action, 1. ed., Jossey-Bass, San Francisco, 1990, 3. print.
[63] J.W. Thomas, A review of research on project-based learning, (2000).
[64] L. Zhang, Y. Ma, A study of the impact of project-based learning on student learning effects: a meta-analysis study, Front. Psychol. 14 (2023) 1202728, https://doi.org/10.3389/fpsyg.2023.1202728.
[65] X. Gao, Does structural social capital lead to proactive green innovation? A three-part serial mediation model, PLoS. One 19 (2024) e0301286, https://doi.org/10.1371/journal.pone.0301286.
[66] G. Cofré-Bravo, L. Klerkx, A. Engler, Combinations of bonding, bridging, and linking social capital for farm innovation: how farmers configure different support networks, J. Rural. Stud. 69 (2019) 53–64, https://doi.org/10.1016/j.jrurstud.2019.04.004.
[67] L.N. d'Escoffier, A. Guerra, M. Braga, Problem-based learning and engineering education for sustainability: where we are and where could we go? J. Probl. Based Learn. High. Educ. 12 (2024) 18–45, https://doi.org/10.54337/ojs.jpblhe.v12i1.7799.
[68] L. Wyness, F. Dalton, The value of problem-based learning in learning for sustainability: undergraduate accounting student perspectives, J. Account. Educ. 45 (2018) 1–19, https://doi.org/10.1016/j.jaccedu.2018.09.001.
[69] C. Ansell, E. Sørensen, J. Torfing, Improving policy implementation through collaborative policymaking, Policy. Polit. 45 (2017) 467–486, https://doi.org/10.1332/030557317×14972799760260.
[70] S. Hajian, Transfer of learning and teaching: a review of Transfer theories and effective instructional practices, Ije 7 (2019), https://doi.org/10.22492/ije.7.1.06.
[71] E. Cohen-Shacham, G. Walters, C. Janzen, S. Maginnis, Nature-based Solutions to Address Global Societal Challenges, IUCN International Union for Conservation of Nature, 2016.
[72] NGFS, Synthesis report on the greening of the financial system – Insights for financial actors in advanced and emerging economies, Network Greening Financial System. https://www.ngfs.net/en/publications-and-statistics/publications/synthesis-report-greening-financial-system-insights-financial-actors-advanced-and-emerging-economies, 2024 (accessed November 3, 2025).
[73] M. DeJonckheere, L.M. Vaughn, Semistructured interviewing in primary care research: a balance of relationship and rigour, Fam. Med. Commun. Health 7 (2019) e000057, https://doi.org/10.1136/fmch-2018-000057.
[74] Finance in common, Technical assistance and capacity building for public development Banks (PDBs) mapping and qualitative benchmarking, Finance Common. (2025). https://financeincommon.org/technical-assistance-and-capacity-building-for-public-development-banks-pdbs-mapping-and (accessed November 3, 2025).
[75] A.G. Palis, P.A. Quiros, Adult learning principles and presentation pearls, Midd. East Afr. J. Ophthalmol. 21 (2014) 114, https://doi.org/10.4103/0974-9233.129748.
[76] J. Rogushina, A. Gladun, O. Anishchenko, S. Pryima, Matching criteria of andragogue profile components into the adult learning ecosystem model, (2025).
[77] J.C.C. Valverde, et al., Cinco estrategias andragógicas para una clase eficaz, RGSA 18 (2024) e09767, https://doi.org/10.24857/rgsa.v18n11-193.
[78] A.D.S. Nascimento, G.D.S. Abbad, Evaluation of a training program for credit Union counselors, Paidéia (Ribeirão Preto) 31 (2021) e3131, https://doi.org/10.1590/1982-4327e3131.
[79] Á. Macken-Walsh, M. Javornicky, A. Forde, A. Naughton, S. Quiédeville, R. Home, M. Bettoni, J.M. Díaz Puente, A.M. Augustyn, D.C. Repede, Impact assessment and evaluation tools | EvalForEarth, LIAISON. https://www.evalforearth.org/resources/impact-assessment-and-evaluation-tools, 2020 (accessed November 5, 2025).
[80] N. Narayanasamy, Participatory Rural Appraisal: Principles, Methods and Application, SAGE Publications India Pvt Ltd, New Delhi, 2009, https://doi.org/10.4135/9788132108382.
[81] B.D. Ratner, A.M. Larson, J.P.S. Barletti, H. ElDidi, D. Catacutan, F. Flintan, D. Suhardiman, T. Falk, R. Meinzen-Dick, Multistakeholder platforms for natural resource governance: lessons from eight landscape-level cases, Ecol. Soc. 27 (2022), https://doi.org/10.5751/ES-13168-270202.
[82] Banco ADOPEM, Promoting green credits as a financial inclusion strategy in rural areas of the Dominican Republic. https://www.ada-microfinance.org/en/our-resources/media-center/rural-financing-banco-adopem-promoting-green-credits-financial-inclusion, 2017 (accessed November 5, 2025).
[83] D. Forcella, D. Castellani, F. Huybrechs, M. Allet, Green Microfinance in Latin America and the Caribbean: An Analysis of Opportunities, Inter-American Development Bank, 2017, https://doi.org/10.18235/0001348.
[84] L. Pedersen, Building Long-Term Sustainability in Multi-Stakeholder platforms: Making Your Impact Last, UNDP, 2021. https://www.evidensia.eco/resources/1220/building-long-term-sustainability-in-multi-stakeholder-platforms-making-your-impact-last/ (accessed November 5, 2025).
[85] ACF, Capacity Building Service strategies: a review of the literature, (2022).
[86] M.W. Blokland, G.J. Alaerts, J.M. Kaspersma, M. Hare (Eds.), Capacity Development for Improved Water Management, 1st ed., CRC Press, 2019 https://doi.org/10.1201/b10532.
[87] Kwaku Ofori, Innovative strategies for capacity building in financial institutions: lessons from successful microfinance models, Int. J. Sci. Res. Arch. 13 (2024) 1223–1226, https://doi.org/10.30574/ijsra.2024.13.2.2159.
[88] A. Brasil-Leigh, R. Byrd, P. Käfer, G. Miao, M. Ruiz-Sierra, A. Vieira, W. Wallock, Toolbox On Financing Nature-Based Solutions - CPI, CPI, 2024. https://www.climatepolicyinitiative.org/publication/toolbox-on-financing-nature-based-solutions/ (accessed November 5, 2025).
[89] The National Strategy for nature-based Solutions (NbS) – Departamento Nacional de Planeación. https://colaboracion.dnp.gov.co/CDT/PublishingImages/La_Entidad/Directivos/Direcccciones/ambiente-y-desarrollo-sostenible/SbN/2026_Estrategia_Nacional_SbN_modificado.pdf, 2026 (accessed April 1, 2026).