

Reflexive Monitoring and Impact Assessment of Nature-Based Solutions: Advancing Climate Adaptation and Stakeholder Engagement through Living Labs

A. Malamakis¹, C. Karkanias¹, K. Devlioti¹, M. Batsioulas¹, T. Patsakidou¹, G. Banias¹

¹Environmental Engineering and Sustainability Laboratory, Institute for Bioeconomy and Agri-Technology, Centre for Research and Technology-Hellas, 57001 Thermi, Thessaloniki, Greece
Presenting author email: a.malamakis@certh.gr

Introduction

As the effects of climate change become increasingly tangible, Nature-Based Solutions (NBS) have emerged as a critical strategy for enhancing ecosystem resilience and societal adaptation. The eNaBIS project aims to foster biodiversity-positive transformations in education and professional practice, leveraging Living Labs (LLs) as participatory structures for co-designing and evaluating NBS interventions. In this context, robust, dynamic, and participatory impact assessment becomes essential—not only to demonstrate effectiveness but also to enable real-time adaptation and learning.

This paper presents the reflexive monitoring and impact assessment framework developed within the eNaBIS project. It reflects on the methodological integration of systemic monitoring tools, the design of impact monitoring indicators (IMIs), and the strategic use of LLs to enhance climate adaptation and stakeholder engagement. Reflexive monitoring—a cyclic, feedback-oriented method - lies at the core of the approach, ensuring alignment with evolving project realities and stakeholder insights. By linking ecological, educational, and societal outcomes through a dynamic monitoring architecture, the framework supports evidence-based decision-making and deeper system innovation.

Materials and methods

The methodology developed for eNaBIS integrates system innovation theory with reflexive monitoring practices. Impact monitoring is defined as the systematic tracking of changes across biodiversity knowledge, practices, and policy adoption, especially within educational and community systems. The project employs a dual-layer approach, aligning pre-defined Key Performance Indicators (KPIs) with more adaptive and context-sensitive Impact Monitoring Indicators (IMIs).

The logical framework consists of eight stages: (1) KPI definition, (2) tool design, (3) stakeholder mapping, (4) training, (5) data collection, (6) analysis, (7) feedback and revision, and (8) documentation. This structured sequence enables flexible adaptation while maintaining strategic coherence. At the time of writing, the project completed initial stages, with stakeholder mapping, IMI finalisation, and feedback mechanisms operationalized.



Figure 1: Logical framework for implementing Impact Monitoring in the eNaBIS Project.

Reflexive Monitoring Methodology (RMA)

The core methodology is based in an iterative process of observation, analysis, reflection, and adjustment, as described by Lodder et al. (2020). In contrast to conventional linear evaluation approaches, RMA embeds learning within the monitoring process itself, enabling project teams to adapt as they progress (Van Mierlo et al., 2010). This methodology employs a range of tools to support continuous learning and stakeholder engagement. These include system and actor analysis to identify key leverage points and clarify the roles of different stakeholders, and dynamic learning agendas that help track emerging challenges and learning needs over time. It also involves the use of tailored indicators that differentiate between effect metrics and process metrics. To capture experiential

knowledge, audiovisual learning histories are created, documenting how participants experience the project in practice. Additionally, structured feedback forms are used to encourage systematic reflection among partners, supporting ongoing adjustments to the implementation process.

Data Collection and Analysis

The data collection strategy uses a mixed-methods approach that blends quantitative and qualitative techniques to assess project outcomes. Quantitative tools include surveys, performance metrics such as participant numbers and training completion rates, and trend analyses. These are complemented by qualitative tools like semi-structured interviews, open feedback, field observations, and stakeholder workshops (Creswell et al., 2017). Implementation partners collect data for each activity using harmonised templates to ensure consistency. A central monitoring team leads the analysis and synthesis, supporting system-wide learning and adaptation through continuous feedback loops that respond to emerging challenges and evolving project realities.

Indicator Design and Stakeholder Engagement

Twenty IMIs have been designed to complement KPIs, covering thematic domains such as curriculum integration, transdisciplinary education, NBS experimentation, and policy influence. IMIs are selected based on their relevance to biodiversity-NBS outcomes, feasibility of measurement, stakeholder legitimacy, and capacity for continuous improvement. Stakeholders are engaged through interviews, feedback forms, and LL co-design processes, ensuring ownership and validation of monitoring insights.

Results

LLs provide real-world environments for testing NBS across educational institutions and communities. They serve as both action and reflection spaces, where stakeholder interactions generate observable, analyzable, and adjustable insights. Planned activities include integration of biodiversity modules into Technical and Vocational Education and Training (TVET) curricula, peer-to-peer learning among interdisciplinary students and, among others, policy workshops and exhibitions in collaboration with local institutions. Through LLs, reflexive monitoring enables stakeholder empowerment and context-sensitive assessment. The selected tools have begun to reveal meaningful early-stage patterns: - Surveys indicate increased awareness of biodiversity topics among participants; - Open feedback forms highlight institutional constraints in curriculum integration; - Audiovisual documentation captures emotional and behavioural engagement from LL participants; - System analysis identifies structural inertia in policy adoption, guiding targeted advocacy workshops.

Indicators such as IMI3 (TVET module implementation) and IMI10 (local info-days) have proven effective in measuring both outcome and process dimensions. Stakeholder feedback has been instrumental in refining implementation strategies, demonstrating the utility of reflexivity in adaptive project management.

Conclusions

The impact monitoring and reflexive assessment framework developed under eNaBIS offers an innovative way to evaluate NBS in education and societal transformation. By embedding stakeholder engagement and reflexivity into the process, it shifts from conventional monitoring to a tool for learning, adaptation, and change. The framework uses mixed methods and participatory tools to capture a wide range of impacts, from curriculum development to behavioural change. Living Labs serve as dynamic spaces for implementation and evaluation, grounding assessment in real-world experience. Iterative feedback loops, ongoing stakeholder engagement, and alignment with emerging project realities ensure the system remains relevant and responsive. This approach positions eNaBIS as a model for integrating NBS into education and community practice and contributes to broader debates on how reflexive monitoring can drive transitions toward nature-positive, climate-resilient societies.

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Acknowledgements

This research study was funded by the European Union's Horizon Europe programme under eNaBIS project (GA No 101135035)