The Benefits of Nature-based Solutions: evidence using a systemic monitoring approach

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Scaling up Nature-based Solutions (NbS) is central to the societal transformation required to tackle interconnected challenges such as climate impacts, water risks, and biodiversity loss. Yet implementation remains constrained by limited, robust evidence on how NbS deliver the societal benefits they promise—especially improvements in climate resilience to floods and droughts, and measurable gains in biodiversity.

This Policy Brief presents a systemic monitoring approach for NbS that captures their environmental and socio-economic performance across broad sustainable-development objectives and major economic sectors. Applying this framework to 18 freshwater restoration case studies across Europe—each guided by the IUCN Global Standard for NbS—we demonstrate how diverse and heterogeneous data can be synthesised into coherent, actionable evidence. The results show how consistent monitoring strengthens confidence in the effectiveness, co-benefits, and upscaling potential of NbS.

Key messages

- Monitoring of freshwater and wetland restoration projects should cover environmental, economic and social criteria in a balanced way.
- An objective monitoring approach should provide with consistence in the assessment of the indicators, data confidence and a comprehensible visual synthesis.
- Well-designed freshwater and wetland restoration integrated into NbS can provide significant environmental and social benefits, support economic development, and contribute to the EGD objectives.
- The presented systemic monitoring approach provides decision-makers with the evidence needed to adjust interventions, allocate resources strategically, and ensure long-term effectiveness.

The MERLIN project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101036337.

1 Introduction

Implementing Nature-based Solutions (NbS) is central to EU and global policy goals, as they address both the biodiversity crisis and wider societal challenges such as climate adaptation and mitigation. Yet a key barrier remains: limited confidence in how effectively NbS deliver their primary objectives and wider co-benefits. Monitoring is often narrow in scope, focusing mainly on primary outcomes (e.g. flood resilience), while social and economic indicators are rarely included. Existing NbS data are frequently diverse, heterogeneous, and hard to compare.

To address this, MERLIN developed a consistent, systemic monitoring approach that captures the environmental, economic, and social impacts of NbS. This briefing introduces the approach, tested across 18 freshwater and wetland restoration case studies guided by the IUCN Global Standard for NbS, and provides recommendations for strengthening its application.

2 How to cover all relevant aspects affected by NbS?

NbS are intended to address societal challenges such as climate resilience and biodiversity loss, while also contributing to wider sustainable-development goals, including public health and a greener economy. Within MERLIN, a systemic monitoring framework was developed covering 13 environmental, social, and economic policy criteria aligned with the European Green Deal (EGD) (Carvalho et al., 2022).

To collect structured information, specific indicators were defined for each criterion. For example, changes in water-storage capacity or areas of rewetted wetlands serve as indicators for Flood Resilience, with several indicators further subdivided where appropriate. Standardised guidance and reporting templates (MERLIN Deliverable D1.6) ensured consistency. Indicator selection will, however, vary across restoration programmes depending on regional contexts and policy priorities. A Theory of Change (ToC) was used in all 18 case studies to identify primary and secondary NbS goals (Pott et al., 2025).

The standardised indicators were applied by the 18 freshwater and wetland case studies over two years. Case-study diversity meant that not all criteria were equally relevant to all projects. Although a Before-After-Control-Intervention (BACI) design is recommended, control sites were rarely available, so impact assessment mostly relied on before–after comparisons.

Appropriate spatial and temporal scales are indicator-specific. Some impacts occur at the habitat scale (e.g. carbon fluxes), others at the catchment scale (e.g. migratory fish). Social and economic outcomes, such as downstream flood or drought resilience, often materialise far from the intervention site. Indicators also respond over different timeframes—ranging from immediate pollution reductions to ecological changes that may take years or decades—requiring modelling approaches to estimate long-term effects where direct measurement is not yet feasible.

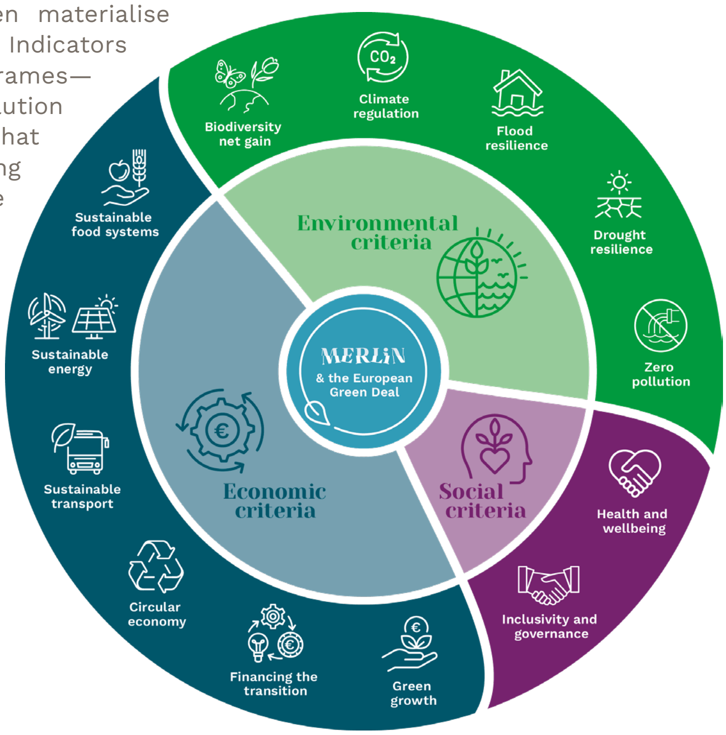

Figure 1 - Systemic monitoring framework developed within MERLIN to assess the impacts of freshwater restoration measures in alignment with the European Green Deal.

3 How to objectively assess NbS impacts?

Within the MERLIN Horizon 2020 project, a scoring approach for interpreting monitoring results was developed (Schwerk et al., 2025). The method followed two steps: first, individual indicators were scored within each policy criterion; second, these were aggregated into a single score for each of the 13 European Green Deal criteria. The analysis assessed both the direction of impact (positive, negative, or no change) and the strength of the supporting evidence. A clear visual synthesis was produced to support rapid decision-making and performance tracking (Box 1). The scoring system was peer-reviewed by experts from all 18 case studies, who provided revisions and accompanying justification.

Box 1: "Traffic light system" for assessing the impact of restoration measures

Negative impact:

Clear evidence of deterioration.

Indications of deterioration, but data are ambiguous (e.g. fluctuating trends).

No impact/irrelevant impact:

No detectable change, with stable data or narratives confirming the absence of change.

No significant change, but less precise evidence.

Positive impact:

Clear evidence of improvement, supported by consistent data or positive narratives.

Indications of improvement, but data are ambiguous (e.g. fluctuating trends)

The aggregated score for each of the 13 Green Deal policy criteria was calculated as follows: when all indicators within a criterion showed the same result, the criterion score matched that shared assessment. When indicators differed, a numerical scoring system was applied to compute an average value (see Schwerk et al., 2025, for details). The resulting aggregated scores were then reviewed by case-study experts, who provided feedback and validation.

4. Example application

Interactions inferred from the monitoring results of the Tisza Floodplain Rewetting Project in Hungary (MERLIN case study 9) demonstrate the practical value of the monitoring approach. The analysis shows that stable funding is crucial for sustaining multiple benefits (interaction 1); that combined measures can generate simultaneous co-benefits (interaction 2); that bringing people closer to nature enhances inclusivity and strengthens restoration outcomes (interaction 3); that flood, drought, and climate-regulation impacts interact (interaction 4); and that land-use change may create risks of stakeholder dissatisfaction (interaction 5) (Figure 2).

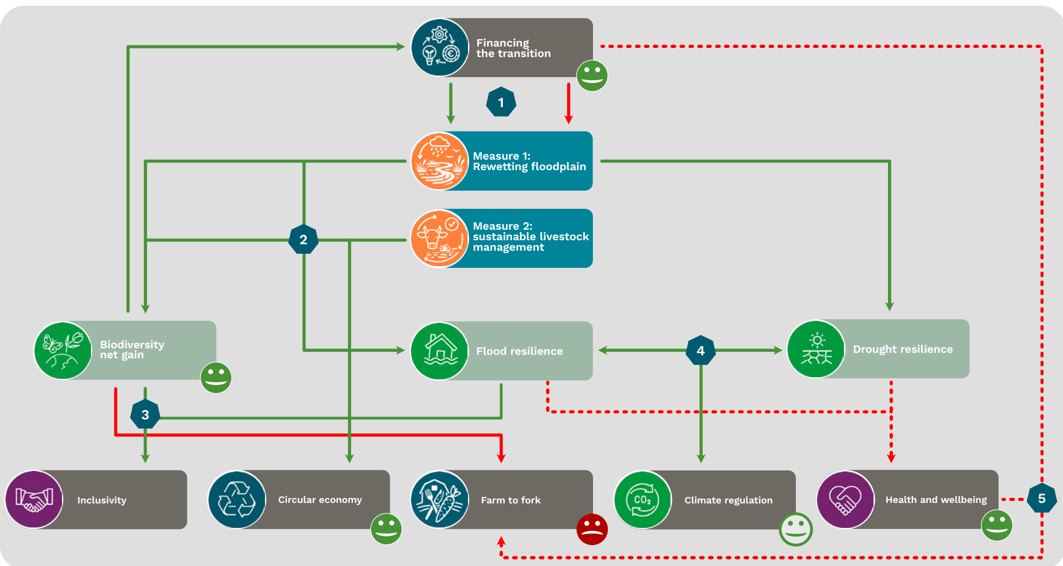

Figure 2 - Schematic diagram of the interactions inferred from available evidence for the Tisza Floodplain Rewetting Project, Hungary. The diagram displays the two main measures implemented and their links to the primary Green Deal policy criteria associated with the restoration objective (green boxes), alongside secondary Green Deal criteria (grey boxes). Arrows indicate positive (green) or negative (red) interactions, with dashed arrows marking interactions of low confidence. Numbered heptagons correspond to the interactions referenced in the text.

5. Key conclusions

Environmental results strongest; socio-economic gaps remain

Environmental outcomes were the most robustly reported across the case studies, particularly for Biodiversity Net Gain and Climate Regulation. In contrast, socio-economic criteria were less consistently assessed, highlighting the need to integrate these dimensions more strongly into monitoring and planning. Indicators relating to economic sectors were often not relevant to project goals, which were primarily environmental.

Confidence varies across criteria

High-confidence results were achieved for Biodiversity Net Gain, supported by quantitative data. Lower confidence for Zero Pollution and economic-sector indicators points to priorities for improved data collection and methodological refinement. In several case studies, narrative insights complemented quantitative data, adding depth in complex contexts and supporting more tailored adaptation.

Recognising trade-offs is essential

Some disbenefits were also reported, including temporary increases in water pollution and loss of agricultural land. Transparent identification of such trade-offs is essential for managing conflicts and aligning ecological restoration with socio-economic needs, including approaches for compensation where relevant.

Systemic monitoring adds explanatory power

The systemic monitoring approach enabled MERLIN case studies to assess the multiple benefits of freshwater and wetland restoration in a consistent and practical way. This helped determine not only whether ecological improvements occurred, but also whether they translated into enhanced ecosystem services. To fully understand why change does or does not occur, benchmark information (e.g., cost, effort) and contextual data (e.g., land use, governance) are needed alongside impact monitoring.

NbS deliver value – but scaling requires stronger monitoring

In conclusion, the MERLIN monitoring results show that well-designed NbS can deliver substantial environmental and social benefits, support local economic development, and contribute directly to European Green Deal objectives. Strengthening and further standardising the systemic monitoring approach will be crucial for scaling up NbS and maximising their contribution to sustainability goals—particularly climate and biodiversity targets. The MERLIN approach provides decision-makers with the evidence required to adjust interventions, allocate resources strategically, and enhance long-term effectiveness.

Acknowledgements

This briefing draws on research funded by H2020 MERLIN (grant agreement No 101036337).

References

Carvalho, L., Schwerk, A., Matthews, K., Blackstock, K., Okruszko, T., Anzaldua, G., Baattrup-Pedersen, A., Buijse, T., Colls, M., Ecke, F., Elosegi, A., Evans, C., Gerner, N., Rodríguez González, P., Grondard, N., Grygoruk, M., Hein, L., Hering, D., Hernandez Herrero, E., Hoffman, C.C., Hopkins, J., Ibrahim, A., Rouillard, J., Scholl, L., Spears, B., Williamson, J., & Birk, S. (2022). New framework for monitoring systemic impacts of freshwater and wetland restoration actions. EU H2020 research and innovation project MERLIN deliverable 1.2. 75 pp. https://project-merlin.eu/outcomes/deliverables.html.

Pott, L., Hershkovitz, Y. & Birk, S. (2025). Mapping multiple benefits in large-scale freshwater restoration: A theory of change approach. Nature-Based Solutions 8, 100240. DOI: 10.1016/j.nbsj.2025.100240

Schwerk, A., Carvalho, L., Spears, B., Williamson, J., Pott, L., Kajner, P., Okruszko, T., Ádám, S., Baattrup-Pedersen, A., Balogh, P., Bañares, I., Barbosa, H., Beranen, L. L., Boets, P., Cardoso, S., Colls, M., Duarte, G., Ecke, F., Ecker, T., Elosegi, A., Eklöf, K., Erős, T., Ferreira, M. T., Forio, M. A., Fuchs, F., Gerisch, M., Gerner, N., Goethals, P., Grossman, M., Grygoruk, M., Henriques, V., Hershkovitz, Y., Ibrahim, A., Jarak, M., Karnatz, S., Katz, A., Kelderman, S., Kempter, I., Lourenço, F., Michelitsch, S.-S., Mutinova, P., Olszewska, J., Ónodi, G., Parada-Santiago, N., Payne, R., Peponi, A., Pickard, A., Portela-Pereira, E., Provan, N., Puiu, I., Rankinen, K., Ratner, T., Rodríguez-González, P. M., Ronkainen, T., Ronkanen, A.-K., Santos, L., Schneider, A., Scrieciu, A., Segurado, P., Tallósi, B., Trandziuk, P., Udklit, L., & Birk, S. (2025). Manuscript and policy briefing evaluating success of large landscape-scale restoration. EU H2020 research and innovation project MERLIN Deliverable D1.6. 135 pp. https://project-merlin.eu/outcomes/deliverables.html.