

Nature-Based Solutions for Demonstrating Climate-Resilient Critical Infrastructure



Deliverable 3.1:
NbS conceptual design for each demonstrator



NATURE-DEMO



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The Cover Photo (by Mohamed Eldessouki) shows one of NATURE-DEMO's demonstrator sites in Austria.

Contacts

You can get more details about the project and reach out to us through the project's website www.nature-demo.eu

You can also contact the Project's Coordinating Organisation:

DigInnoCent s.r.o.
Matoušova 48/4,
460 07 Liberec, Czech Republic
Website: www.diginnocent.com

NATURE-DEMO's Coordinator is Dr. Mohamed Eldessouki, and his email is: mohamed@diginnocent.com

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Author(s)	Andrea Majlingova [TUZVO], Radovan Hilbert [TUZVO], Dominik Gretsches [TUZVO], Alfred Strauss [BOKU], Florentina D. Ionescu [BOKU], Sérgio Fernandes [BOKU], Renate Cornici-Dan [PPK], Tiberiu Chiriches [PPK], Matjaž Mikoš [UL], Tamara Kuzmanić [UL], Mark Bryan Alivio [UL], Klaudija Lebar [UL], Igor Gjorgjiev [IZIIS], Marija Vitanova [IZIIS], Borjan Petreski [IZIIS], Ana Nanevska [IZIIS], Dušan Hancko [DHZ], Michal Vasil [DHZ]
Reviewer(s)	Tiberiu Chiriches [PPK], Chloe Treger [DML]
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Executive Summary

Deliverable D3.1: "Demonstration Sites: Baseline Description and NbS Implementation Framework" represents a core milestone within the NATURE-DEMO project, funded under the Horizon Europe Mission "Adaptation to Climate Change". The objective of this deliverable is to operationalize the methodological frameworks developed within Work Packages 1 and 2 into practical, site-specific applications across the five European demonstration sites. It establishes the analytical baseline for implementing, testing, and validating Nature-based Solutions (NbS) designed to enhance the resilience of critical infrastructures under current and future climate conditions.

Climate change is increasingly affecting Europe's critical infrastructures through intensified natural hazards such as floods, landslides, heatwaves, droughts, and erosion. These hazards jeopardize essential services, economic stability, and the safety of local communities. The NATURE-DEMO project responds to this challenge by demonstrating how NbS can be systematically integrated into infrastructure planning, maintenance, and risk management processes. Through real-life implementation, monitoring, and digital replication, the project seeks to build a solid evidence base supporting the large-scale adoption of NbS for resilient infrastructure across Europe.

The project is structured around four strategic pillars: *Create, Validate, Scale, and Sustain*, guiding the development and implementation of NbS-based adaptation measures. Within this framework, Deliverable D3.1 contributes to the Validate phase, providing harmonized baseline data and risk assessments to inform NbS implementation and performance monitoring at each demonstration site. The methodological structure integrates multi-hazard risk analysis with physical, economic, and ecological indicators, enabling a standardized evaluation of NbS effectiveness while accounting for local specificities.

The deliverable follows the integrated risk assessment and NbS evaluation methodology developed in Deliverable D2.1, which combines three analytical levels:

- **Level 1 – Screening:** Identification of key climate hazards and vulnerabilities for each infrastructure sector.
- **Level 2 – Semi-quantitative assessment:** Evaluation of hazard, exposure, and vulnerability indices using harmonized indicators and climate projections (RCP4.5 and RCP8.5 scenarios).
- **Level 3 – Quantitative assessment:** High-resolution modelling of risk components and evaluation of NbS performance in economic and structural terms.

Each demonstration site underwent a systematic assessment covering:

- Environmental and infrastructural baseline characterization;
- Analysis of relevant climate projections based on EURO-CORDEX datasets;
- Calculation of Hazard (HI), Exposure (EI), and Vulnerability (VI) indices, leading to the Potential Risk Index (PRI);

- Selection and specification of NbS types in alignment with the WP1 NbS Catalogue;
- Integration of stakeholder feedback and institutional considerations.

This harmonized approach ensures comparability between sites while allowing flexibility for adaptation to national contexts, regulatory frameworks, and data availability.

The NATURE-DEMO project includes five demonstration sites across Europe, each representing distinct climatic zones and infrastructure typologies:

- **Austria (Lattenbach, Brunntal, Gschliefgraben)**
Focuses on Alpine flood and landslide risk mitigation through vegetated retention structures, slope stabilization using soil bioengineering, and floodplain restoration. These sites test hybrid NbS–GPI systems and provide a framework for integrating ecological functions into national flood-protection strategies.
- **Romania (Braşov Urban Demonstration)**
Targets urban resilience challenges such as heat stress and stormwater management. The interventions include soil mulching, biodiverse hedgerows, and urban green corridors to improve microclimatic conditions, biodiversity, and air quality. The case provides valuable insights into NbS for urban adaptation and supports the Braşov Local Climate Action and Green Infrastructure Strategy.
- **Slovenia (Gradaščica River)**
Demonstrates NbS in fluvial systems, combining river re-naturalisation, re-vegetation of embankments, and side-channel reactivation. These measures reduce flood risk and sediment transport while restoring ecological connectivity. The site benefits from advanced monitoring technologies, including LiDAR, UAVs, and IoT-based sensors.
- **Slovakia (Zvolen municipality)**
Addresses compound hydro-meteorological and geomorphological hazards, including landslides and flash floods. The interventions integrate NbS for slope stabilization, small-scale retention, and landscape connectivity enhancement, aiming to strengthen local adaptation capacity and ecological coherence.
- **North Macedonia (Globocica Dam)**
Focuses on slope stabilization and erosion control in a hydropower context. Bioengineering and reforestation techniques are applied to reduce sediment inflow and protect energy infrastructure. The demonstration fosters collaboration between researchers, hydropower operators, and local authorities, providing a model for NbS application in energy-critical environments.

Deliverable D3.1 provides a methodological basis and coherent data structure that will serve as input for digital modelling, decision-support tools, and monitoring protocols in Work Packages 4 and 5. It establishes:

- A validated baseline for NbS implementation across five diverse contexts;
- A framework for multi-level risk assessment (hazard–exposure–vulnerability);
- A set of indicators for NbS effectiveness, including environmental, technical, and socio-economic metrics;
- A foundation for comparative evaluation of hybrid (NbS–GPI) infrastructure solutions.

The outputs of this deliverable will feed directly into the digital twin development and decision-support system, enabling simulation of NbS performance and facilitating transferability to other European regions. The results also provide practical evidence for policy integration within the EU Strategy on Adaptation to Climate Change, the Nature Restoration Law, and the EU Green Deal objectives.

Deliverable D3.1 lays the technical and conceptual foundation for the validation and scaling of Nature-based Solutions in critical infrastructure systems. By translating scientific methodologies into practical implementation pathways, it demonstrates how NbS can complement and, in some cases, replace traditional grey infrastructure approaches. The deliverable confirms that well-designed NbS can reduce climate-related risks while delivering multiple environmental and societal benefits, including enhanced biodiversity, improved water management, and strengthened community resilience.

Through its harmonized framework, D3.1 ensures that NATURE-DEMO demonstration sites act as living laboratories—generating data, knowledge, and policy insights that will inform future European strategies for climate-resilient infrastructure. The findings of this deliverable form the cornerstone for upcoming implementation, monitoring, and upscaling activities, advancing the overarching mission of NATURE-DEMO: to mainstream NbS as measurable, reliable, and scalable solutions for climate adaptation and risk reduction across Europe.

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