



BLUE RECHARGE

Blue credits for water aquifers recharge and sustainability

Activity 3.3

Deliverable 3.3.1 Training toolkit of the workshop for technicians and policy makers





Purpose and Target Audience

The BLUE RECHARGE Training Toolkit was jointly developed by the Italian and Croatian partners as part of the workshops and capacity-building activities foreseen under Activity 3.3 of the project. Its primary objective is to facilitate the transfer of knowledge generated by the pilot cases and support the dissemination of Managed Aquifer Recharge (MAR) and Blue Credits approaches among technical and institutional stakeholders.

The toolkit is specifically addressed to water utility managers, irrigation and reclamation consortia hydraulic and environmental specialists, water infrastructure companies, public authorities, policy makers, irrigation and reclamation boards, researchers, and professionals involved in the planning, management and protection of water resources. By addressing both technical experts and decision makers, the toolkit bridges scientific and operational knowledge with policy development and strategic planning needs, fostering a shared understanding of innovative groundwater management solutions.

Joint Development and Structure

The toolkit was developed through a coordinated and collaborative process involving both Italian and Croatian partners. A common structure, designed by CER and agreed upon during technical meetings, was adopted to ensure consistency while allowing each pilot site to present its specific environmental and hydrogeological characteristics.

The resulting product combines technical information, explanatory diagrams, monitoring results and practical examples in a concise and highly visual format. This approach allows complex technical concepts to be communicated effectively to audiences with different levels of expertise and professional backgrounds. Rather than serving merely as a collection of project results, the toolkit was conceived as an operational training resource capable of supporting workshops, facilitating stakeholder dialogue and connecting theoretical concepts with practical experiences developed in the pilot areas.

The shared structure also enables a direct comparison between the Italian and Croatian pilot cases, highlighting both common principles and site-specific solutions adopted within different hydrogeological settings.

The Italian Pilot Case

The toolkit section dedicated to the Italian pilot case presents the experience developed in the Mezzano Valley, Province of Ferrara, where the project assessed the contribution of agricultural wetlands to shallow aquifer recharge through Managed Aquifer Recharge techniques. The materials explain the key requirements for a recharge wetland, including suitable soil permeability, water availability, hydraulic connection with the aquifer and the presence of hydrophilic vegetation capable of supporting ecosystem stability and biodiversity. The toolkit presents the main results achieved through monitoring activities, including groundwater recharge performance, aquifer response, salinity reduction and environmental co-benefits. In particular, the Italian pilot demonstrated an estimated infiltration of approximately 10,100 m³ over 112 days, an average groundwater level increase of 20-30 cm and salinity reductions of up to 500-600 µS/cm.





The material also illustrates the broader project framework, showing how wetlands, groundwater recharge and environmental monitoring can contribute to climate adaptation, water resilience and sustainable water resource management. Blue Credits are presented as innovative instruments capable of recognising and valorising measurable environmental benefits generated through aquifer recharge interventions.

The Croatian Pilot Case

The Croatian toolkit presents the pilot developed in Southern Istria, where MAR solutions were tested within a karstic aquifer environment using treated wastewater originating from the Lobarika treatment plant. Particular emphasis is placed on the conditions required to guarantee recharge safety and effectiveness, including tracer testing, assessment of underground hydraulic connections, identification of suitable infiltration fields and continuous water quality monitoring.

The comparison between the Italian and Croatian experiences demonstrates how the same groundwater stewardship principles can be successfully applied under different environmental and hydrogeological conditions, adopting solutions specifically tailored to local needs and constraints.

Use During Workshops and Training Activities

The toolkit was extensively used during both classroom-based and field-based training activities organised within Activity 3.3. During workshop presentations, it supported the explanation of project objectives, MAR principles, groundwater quality monitoring methods and environmental benefits achieved through the pilot cases.

Its visual structure facilitated communication between trainers and participants and provided a common reference framework for discussions concerning technical, environmental and governance-related aspects of aquifer recharge. During field visits, the toolkit acted as a practical guide, helping participants identify and understand the infrastructure, monitoring systems and management practices observed on site. The integration of classroom sessions with direct observation of pilot interventions significantly enhanced the effectiveness of the training process, allowing participants to relate theoretical concepts to real-world applications and implementation challenges.

Awareness Raising and Replicability

The toolkit played an important role in raising awareness about water conservation, sustainable resource use and groundwater rebalancing. By presenting measurable results from both pilot sites, it demonstrated how MAR solutions can contribute to increasing water availability, improving groundwater quality and strengthening territorial resilience to climate change impacts.

Particular attention was devoted to explaining the relationship between recharge interventions and Blue Credits. Through practical examples and pilot results, the toolkit illustrates how measurable environmental benefits, such as increased groundwater availability, improved water quality and wetland enhancement, can potentially be recognised within environmental incentive and stewardship





schemes. This helps stakeholders understand the link between environmental sustainability, water governance and innovative financing mechanisms.

The toolkit was produced in English and translated into Italian for dissemination purposes. It was complemented by project posters and roll-up banners used during workshops, training sessions and site visits to increase project visibility and support stakeholder engagement activities. Thanks to its flexible and transferable structure, the toolkit represents a durable knowledge-transfer resource that can continue to be used beyond the project lifetime for training, awareness-raising and stakeholder engagement initiatives in other territories interested in implementing Managed Aquifer Recharge solutions.





Annexes

Aquifer Recharge

The recharge system tested in Croatia-Hungary

Managed Aquifer Recharge (MAR) includes a range of techniques used to store water underground and make it available during periods of scarcity. The main methods are divided into two categories. Infiltration systems take advantage of the natural capacity of the soil to absorb water for example through wetlands, canals, or small barriers in watercourses, promoting the recharge of shallow aquifers.

Some solutions, such as Soil Aquifer Treatment, also make it possible to improve water quality during the process. Injection methods, on the other hand, use wells to introduce water directly into deeper aquifers, with the possibility of recovering it later.

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BLUE RECHARGE

BLUE-RECHARGE

BLUE CREDITS FOR AQUIFER RECHARGE AND SUSTAINABILITY

Version for the Italian Pilot site

What are Blue Credits

Blue Credits are instruments that recognize and enhance interventions capable of improving aquifer recharge. When a project generates a measurable benefit - such as aquifer recharge, improved water quality, or the creation of wetlands - this value is quantified and made visible. Managed aquifer recharge, in fact, consists of the intentional introduction of water into aquifers for subsequent use or environmental benefit. Blue Credits therefore link environmental sustainability with economic value, incentivizing practices that increase water availability and strengthen territorial resilience.

BLUE-RECHARGE is a project funded under the INTERREG Italy-Croatia Programme and is aimed at the sustainable management of water resources through nature-based solutions and innovative technologies to:

- improve aquifer recharge
- increase resilience to climate change
- enhance ecosystems such as wetlands
- integrate agriculture, the environment, and water management

The project is based on an integrated approach that combines:

- natural infrastructure (Nature-Based Solutions)
- managed aquifer recharge techniques
- environmental monitoring

ITALIAN PILOT SITE

The BLUE-RECHARGE pilot site is located in the Mecenate Valley (Trentino), an agricultural area in the Po Delta characterized by high water pressure and a risk of salinization. The Baldassarri farm was selected, covering approximately 8 hectares with three interconnected basins, as it is representative of the area and suitable for managed aquifer recharge.

WETLAND 1 WETLAND 2 WETLAND 3

THREE STEPS FOR A WETLAND:

- Water availability**
continuous or seasonal connection with the aquifer
- Suitable soil**
permeable yet capable of retaining water, with the presence of sediments and organic matter
- Typical vegetation**
hydrophilic plants (reeds, rushes, etc.) biodiversity that stabilizes the ecosystem

Results

Salinity reduction up to -500-600 µS/cm

Average increase in aquifer level: ~20-30 cm

Estimated infiltration: ~10.100 m³ at 112 days

Version for the Croatian Pilot site

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CROATIAN PILOT SITE

The BLUE-RECHARGE pilot site is located in the south Istria region where the aquifer is at risk of failing to achieve good quantitative status and is having a poor chemical status due to increased concentrations of nitrates and periodically use water intrusion. For these reasons, the water is not used for human consumption but has potential for some technical use and irrigation. In the settlement (Lipovci) new WWTP was constructed where the treated wastewater is indirectly discharged in the underground, that represents managed aquifer recharge.

Infiltration field at WWTP Tivoli well

THREE STEPS FOR A CARST AQUIFER:

- Tracer test**
based on previous research, it is necessary to determine the monitoring points for the tracer test.
- Optimal infiltration field**
Based on the absorbency test and expert calculations, it is necessary to construct a functional absorption field, for improved WWTP effluent quality.
- Monitoring**
while MAR is applied constant monitoring of water quality at determined points is essential.

Results

The tracer test shows an underground connection to only one of the observed locations - the Tivoli well.

On the basis of isotope analysis, suitability for MAR has been established: long retention time for natural purification.

Tertiary treatment of waste water necessary to prevent any negative impact on the aquifer.