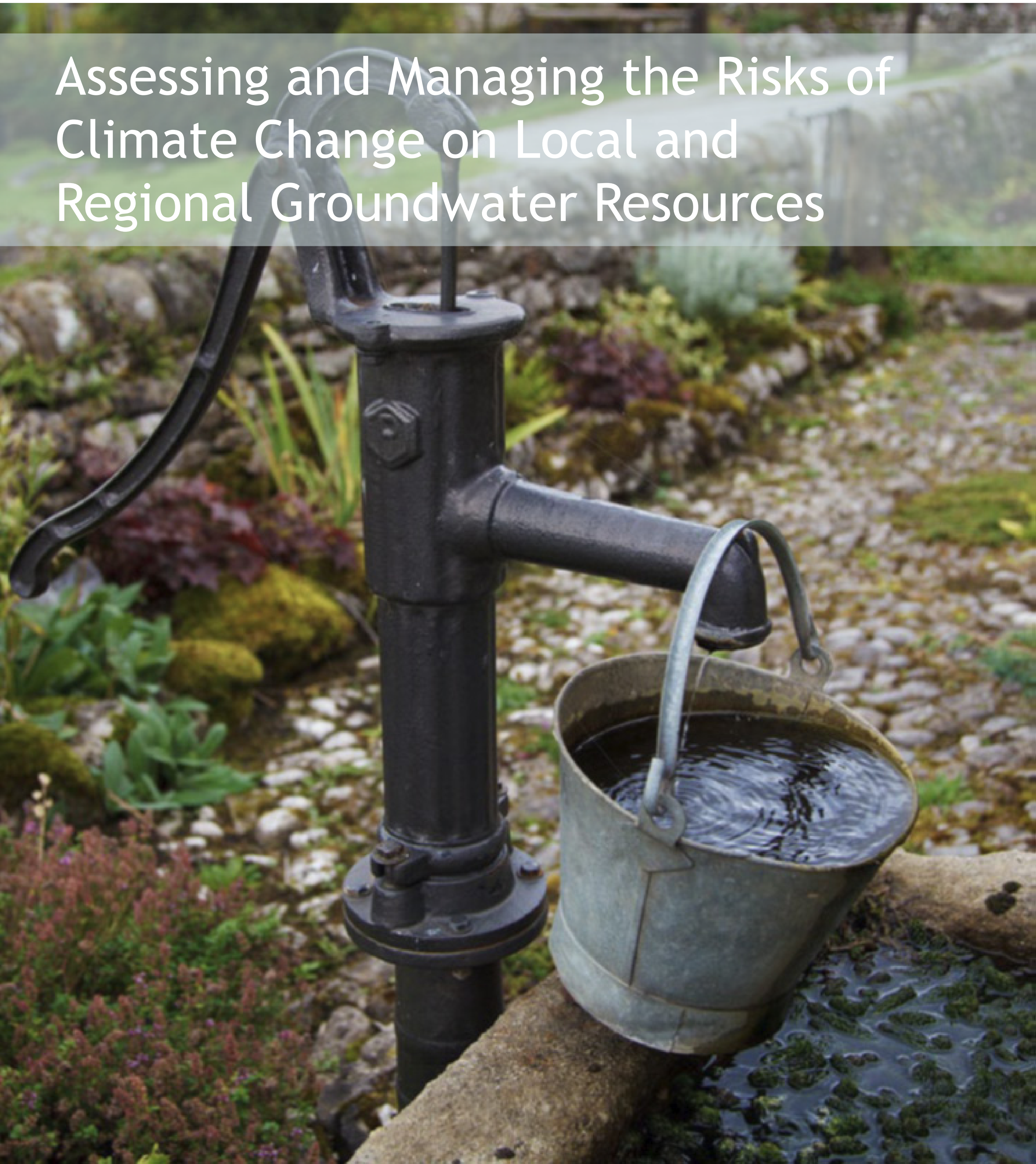
Interreg CENTRAL EUROPE

Co-funded by the European Union

MAURICE

Assessing and Managing the Risks of Climate Change on Local and Regional Groundwater Resources



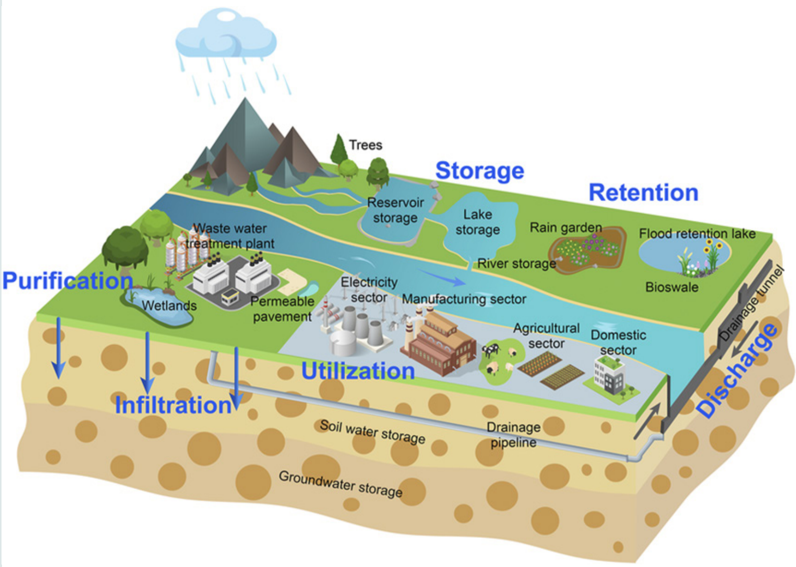
CONTENT

1. The sponge city concept

The MAURICE project, which stands for "Management of Urban Water Resources in Central Europe Facing Climate Change," is a transnational initiative aimed at increasing the resilience of urban water systems to climate change-related pressures. The MAURICE project aligns closely with the principles of the sponge city concept by incorporating nature-based solutions and blue-green infrastructure into its urban water management strategies. The project aimed to enhance the resilience of urban water systems to climate change-related pressures, such as declining groundwater levels and excessive water accumulation during short periods. By leveraging sponge city principles, MAURICE focused on sustainable water management practices that mimic natural hydrological processes to address these challenges.

Key sponge city principles of the MAURICE project:

Blue-Green Infrastructure:
The MAURICE project emphasized the implementation of blue-green infrastructure (BGI), which is a core element of the sponge city concept. BGI is a strategic, nature-based planning approach that combines water management ("blue") and green space ("green") to enhance urban resilience and sustainability.



The six hydrological processes in sponge city design[1]

For example, in Jaworzno, the project targeted urban development by delineating vulnerability zones and providing guidelines for constructing and operating blue-green infrastructure to enhance groundwater recharge and mitigate flooding.

Rainwater Reuse and Infiltration:
Sponge cities aim to capture, store, and reuse rainwater effectively. Similarly, MAURICE promoted rainwater reuse in Novy Bydzov to reduce drinking water consumption and rainwater runoff, addressing water scarcity caused by urban sealing and reduced precipitation.

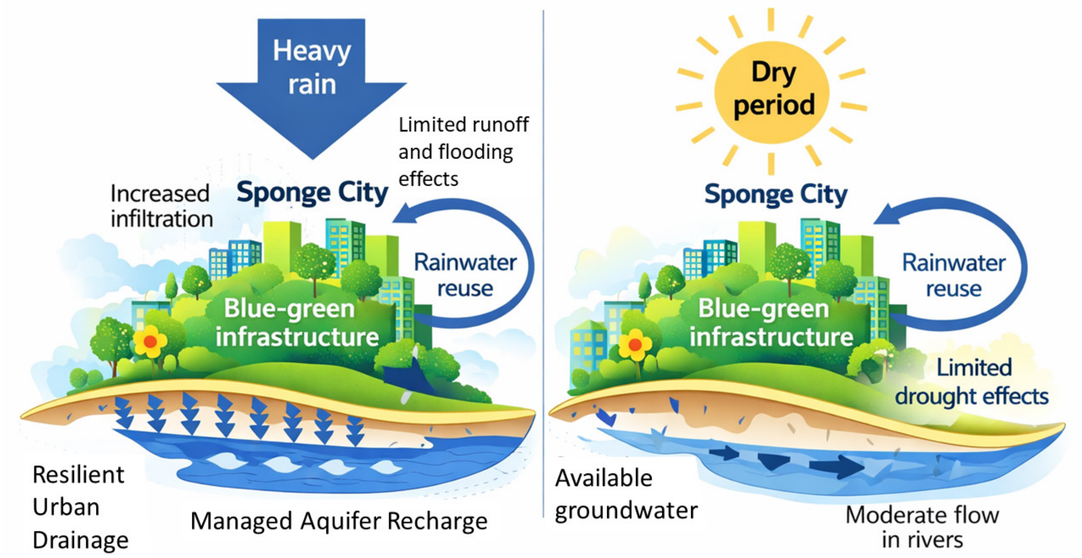
[1]Liu, Qianhui & Cui, Wenhui & Tian, Zhan & Tang, Yingdong & Tillotson, Martin & Liu, Junguo. (2022). Stormwater Management Modeling in "Sponge City" Construction: Current State and Future Directions. Frontiers in Environmental Science. 9. 10.3389/fenvs.2021.816093.

Managed Aquifer Recharge (MAR):
The project incorporated MAR techniques, which are integral to sponge city strategies. For instance, in Milan, the heritage irrigation canal network is used to circulate water during autumn and winter, allowing it to infiltrate agricultural fields and recharge underlying aquifers. This transforms the region into a sponge that absorbs and retains water, reducing evaporation and improving soil conditions.

Urban Drainage and Resilient Design:
Sponge cities focus on enhancing urban drainage systems to manage storm water effectively. In Ljubljana, MAURICE developed technical design solutions for resilient urban drainage systems to improve storm water management and groundwater quality.

Monitoring and Data/Model-Driven Adaptation:
The MAURICE project employed advanced monitoring systems and data-driven approaches to evaluate the effectiveness of sponge city-inspired measures. For example, pilots in Stuttgart and Varaždin used comprehensive measurement networks to assess various hydrological parameters enabling prognostic modeling for various climate and groundwater quality and quantity management scenarios.

By integrating sponge city principles into its action plans, the MAURICE project demonstrated how urban areas can adopt innovative water management strategies to enhance resilience to climate change impacts. This approach not only addresses immediate water-related challenges but also contributes to long-term sustainability and ecological balance.



Sponge city (Image created by MAURICE with Copilot)

2. From strategy to action

The MAURICE project followed a structured process, based on the Urban Adaptation Support Tool (UAST) recommendations from the European Climate Change Adaptation Platform, enabling transition from strategic planning to actionable implementation of climate adaptation measures for urban water management.

MAURICE operated in an interdisciplinary and multi-sectoral way by bringing together scientific research, technical expertise, policy makers, local authorities, and diverse stakeholders across sectors such as urban planning, water management, agriculture, and environmental protection to collaboratively develop, implement, and monitor climate adaptation strategies and action plans for urban water resilience.

Key steps:

1. Define Core Questions:

Identify climate challenges and goals, secure political support, form a core team, review legal obligations, collect initial data, and engage stakeholders.

2. Assess Risks and Vulnerabilities:

Develop a conceptual model, conduct investigations and pilot actions, and update models for decision-making.

3. Identify Adaptation Options:

Develop locally applicable adaptation options.

4. Assess and Select Options:

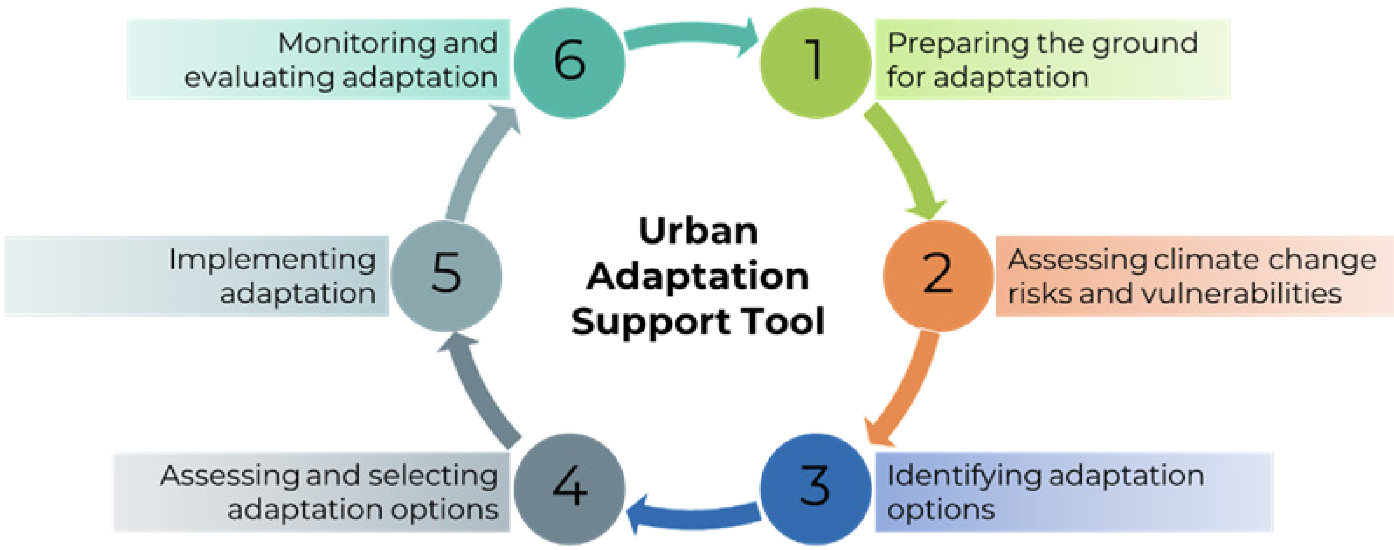
Simulate scenarios, set assessment criteria (cost, urgency, socio-economic, environmental), and prioritize options.

5. Develop and Implement Action Plans:

Create detailed plans (measures, roles, timelines, finances, monitoring), involve stakeholders, and secure funding.

6. Monitoring and Evaluation:

Set targets and KPIs, establish monitoring and evaluation, and refine strategies based on results.



Urban Adaptation Support Tool
(https://climate-adapt.eea.europa.eu/en/metadata/tools/urban-adaptation-support-tool)

Examples of Implementation by MAURICE pilot actions

The MAURICE project has applied these steps in its pilot cities:

Milan: Agricultural case - Winter irrigation for groundwater recharge using heritage irrigation canal networks.

Jaworzno: Embedding blue-green infrastructure (BGI) in the municipal urban development plans - Implementation of BGI to mitigate flooding and improve water management.

Novy Bydzov: Rainwater reuse in public infrastructure - to address drinking water shortages caused by urban sealing and reduced precipitation.

Ljubljana: Optimizing the city sponge - Development of resilient urban drainage systems to enhance storm water management and groundwater quality.

Stuttgart: Mitigation Strategies to counteract declining groundwater levels.

Varaždin: Groundwater quality restoration – Managing urban groundwater artificially influenced by hydropower plants.

3. Finding solutions in transnational cooperation

The MAURICE project adopted a collaborative and co-creative approach to address climate change-related challenges in urban water management across Central Europe. The transnational cooperation was structured to ensure that solutions were tailored to the specific needs of each participating city or region while leveraging shared knowledge and expertise. Hence an action plan for each of the 6 cities involved has been achieved, based on a joint management strategy.
The process was informed by pilot actions conducted in participating cities and regions, ensuring that solutions and the implementation of innovative approaches and technologies were grounded in real-world challenges and opportunities.

This co-creation process is characterised by the following key elements:

- Knowledge Sharing and Capacity Building
- Integration of Local and Regional Contexts
- Use of Advanced Tools and Models
- Pilot Actions and Best Practices

This enabled the development of the partnership's sponge city action plans in transnational cooperation.

5. Knowledge Sharing and Capacity Building

MAURICE leveraged existing research, technical tools, and methods from local and regional universities and external service providers. The project also built adaptive capacity by raising awareness, conducting further research, and creating supportive institutional frameworks.

2. Integration of Local and Regional Contexts

The project recognized that climate change impacts vary significantly based on geographical position, topography, and local climate conditions. Adaptation measures were tailored to address specific challenges, such as droughts, flooding, water scarcity, and groundwater depletion, in each region.

MAURICE project partners

3. Use of Advanced Tools and Models

MAURICE utilized advanced climate models, conceptual and numerical models, and monitoring systems to assess risks, simulate future scenarios, and evaluate the effectiveness of adaptation measures. The project also employed the Urban Adaptation Support Tool (UAST) to guide cities and regions in developing, implementing, and monitoring adaptation plans.

4. Pilot Actions and Best Practices

Pilot actions were conducted in six cities (Stuttgart, Milan, Jaworzno, Novy Bydzov, Varaždin, and Ljubljana) to test and refine technical solutions for urban water management. The results of these pilots were synthesized into best practices and shared across the transnational partnership to inform the development of action plans.

5. Development of Action Plans

The project created detailed action plans that included specific measures, roles and responsibilities, timelines, financial plans, and monitoring concepts. These plans were designed to be binding and sustainable, ensuring long-term implementation of climate adaptation measures.

4. Our local way to sponge city

4.1. Ljubljana, Slovenia: Optimising the city sponge

Ljubljana's approach to the sponge city concept aims to manage storm water smartly, preserve green spaces, and support the natural water cycle. The city must avoid passing environmental problems to its neighbours. Storm water retention and infiltration help break down pollutants like nitrogen, heavy metals, and synthetic chemicals. To protect downstream cities, Ljubljana needs to cut nitrogen losses by 18% and reduce chromium and benzotriazole by 75%. Soil permeability is key: more permeable soils need smaller retention basins. Increasing natural ground cover and using permeable pavements lowers surface runoff, so more water soaks into the ground. Clean roof runoff can be infiltrated directly, while paved surfaces need treatment first. Redirecting roof water from sewers to infiltration strengthens natural water circulation and reduces sewer loads, helping the city cope with droughts and heavy rain. This strategy makes Ljubljana more resilient to climate change and supports sustainable water management.

Infiltration basins on soils with lower permeability to prevent storm water runoff

4.2. Varaždin, Croatia: Groundwater Quality Restoration

Varaždin's sponge city approach focuses on understanding how the Drava River and its hydropower plants affect local groundwater.

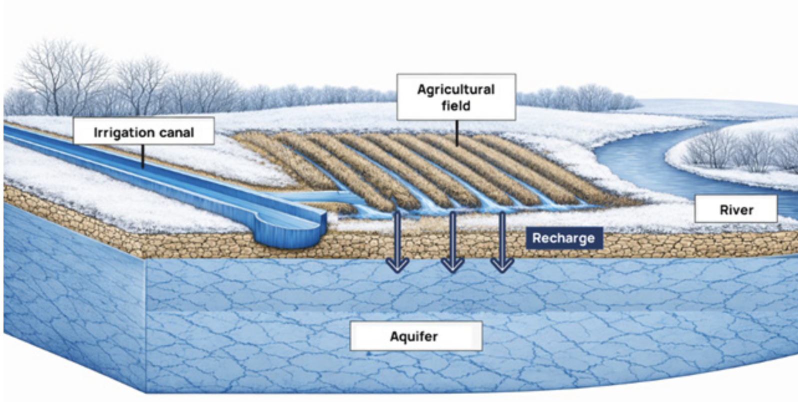
Comprehensive monitoring activities of hydraulic and chemical parameters in Varaždin

Instead of building new infrastructure, the city uses existing monitoring wells with sensors to track groundwater levels, temperature, and quality in real time. This helps city planners see how the aquifer reacts to changes in reservoir levels, rainfall, and farming activities. Nitrate pollution from agriculture is a main concern, so regular checks for nitrates and other pollutants are done. The data helps identify vulnerable areas, plan retention zones, and act quickly if pollution rises or water levels drop. These insights are used in city planning and have been adopted by local leaders. Early warning tools help protect water quality and ensure a safe, reliable drinking water supply.

Varaždin’s strategy builds resilience by combining scientific monitoring, pollution prevention, and smart planning based on how the aquifer naturally behaves.

4.3. Lombardy Region, Italy: Agricultural Case

To help Lombardy's agricultural sector prepare for future droughts in spring and summer, Milan's pilot action tested the use of heritage irrigation canals to spread water over fields in autumn and winter. The water infiltrates the soil and refills underground aquifers that store water naturally. During droughts, when surface water is limited, emergency wells can supply groundwater to help meet irrigation demand. This approach avoids building costly reservoirs, reduces evaporation, prevents frost damage, and improves irrigation efficiency.
The project brought together universities, an irrigation consortium, farmer associations, water service experts and regional authorities. It also relied on the collaboration of farmers who tested the solution by irrigating their fields over two consecutive winters. This teamwork ensured that the solution is practical and could be mainstreamed into regional policies.
Milan's strategy uses farmland and aquifers to infiltrate and store water, combining natural features and existing infrastructure for better climate adaptation and drought protection.



Distributing water via irrigation canals to store water in the aquifer in winter. Image created with Copilot based on the original at groundwaterexchange.org

Irrigation fields flooded, fed by the canal system

4.4. Stuttgart, Germany: Mitigation Strategies to counteract declining groundwater levels

Public spaces with permeable surfaces, Schützenplatz Stuttgart

Showcasing options for the funding scheme "Incentives for Urban Green"

The pilot area Stuttgart Feuerbach has faced sharply declining groundwater levels over the past 10–15 years, with major impacts on non-potable water resources, vegetation, and building stability. The City of Stuttgart therefore focused on mitigation strategies to counteract this trend. By analyzing long-term groundwater monitoring data with a numerical groundwater model, key insights into possible causes were gained. Besides climate change as the main driver, additional factors such as vertical leakage may also contribute.

The model was further used to assess targeted artificial groundwater recharge measures.

The strategy addresses technical constraints and user conflicts in a densely populated industrial district by promoting cooperation among city departments implementing initial demonstration measures. These include permeable public spaces with high recreational quality, combined with the municipal small-scale funding program "Incentives for Urban Green."

4.5. Jaworzno, Poland: Embedding BGI in the Municipal Urban Development Plans

To make Jaworzno more climate-resilient, the city is integrating blue-green infrastructure (BGI) into its urban development plans. BGI includes features like rain gardens and permeable surfaces that help manage rainwater and recharge groundwater. The city created BGI Guidelines and an interactive catalogue to help planners and investors choose the right solutions, especially in sensitive post-mining areas where ground stability is a concern. These tools will be officially adopted through a mayoral regulation. Jaworzno also promotes BGI to private investors with a clear step-by-step pathway, ensuring safe and effective rainwater management

Blue-green infrastructure pilot investment in Jaworzno

Demonstration sites at the GEOsfera Ecological and Geological Education Centre in Jaworzno show residents and investors how BGI works, raising awareness and encouraging adoption. Information is shared through education and stakeholder meetings, supporting long-term use of BGI for better water retention, safer urban development, and greater resilience to climate change.

4.6. Novy Bydzov, Czech Republic: Rainwater Reuse in Public Infrastructure

The City of Novy Bydzov is striving to gradually introduce efficient rainwater management to reduce climate change impacts on the city's water management infrastructure. A water management study assessed how much rainwater unnecessarily flows away through the sewage system from built-up areas (roofs of houses, parking lots, roads, etc.) and what proportion of this water flows through relief channels directly into the Cidlina River. The study also strongly recommended various combinations of water sources and smart solutions to reduce drinking water consumption in municipal facilities and buildings, proposing 2 promising locations – the Municipal Swimming Pool and the Winter Stadium.

The Municipal Swimming Pool in Novy Bydzov uses approximately 20 m^3 of water per day. By MAURICE project, a pool water treatment plant designed in the complete technical documentation, enables to save up to 70% of drinking water during the operation of the pool. Additionally, rainwater collected from the operational buildings is also cleaned by this treatment plant to swimming pool quality.

A swimming pool water treatment plant saves up to 70% drinking water

Rain water use in ice stadium – saving 100 % drinking water

The large roof area of the Winter Stadium building allows for the collection of a sufficient volume of rainwater - after minimal treatment used to produce ice for the ice rink. In extremely dry periods supplemented by groundwater from a well, this completely replaces drinking water.

5. MAURICE Sponge City Network

Further on, MAURICE established its Sponge City Network, a powerful transnational network linked to national institutions and stakeholders in participating countries. It enables support and knowledge exchange within the project community and bundling the available technical, research, management and administrative expertise. By its main feature, the online format “Sponge City Talk” held every 2-3 months, fostering awareness and establishing a knowledge base for public decision makers has been already achieved and will be made permanent.

Organized and led by the Central Mining Institute – National Research Institute (GIG-PIB) in Katowice, the Sponge City Network will be established as a well-known and recognized cluster organisation for CENTRAL EUROPE and beyond, focused on groundwater issues.

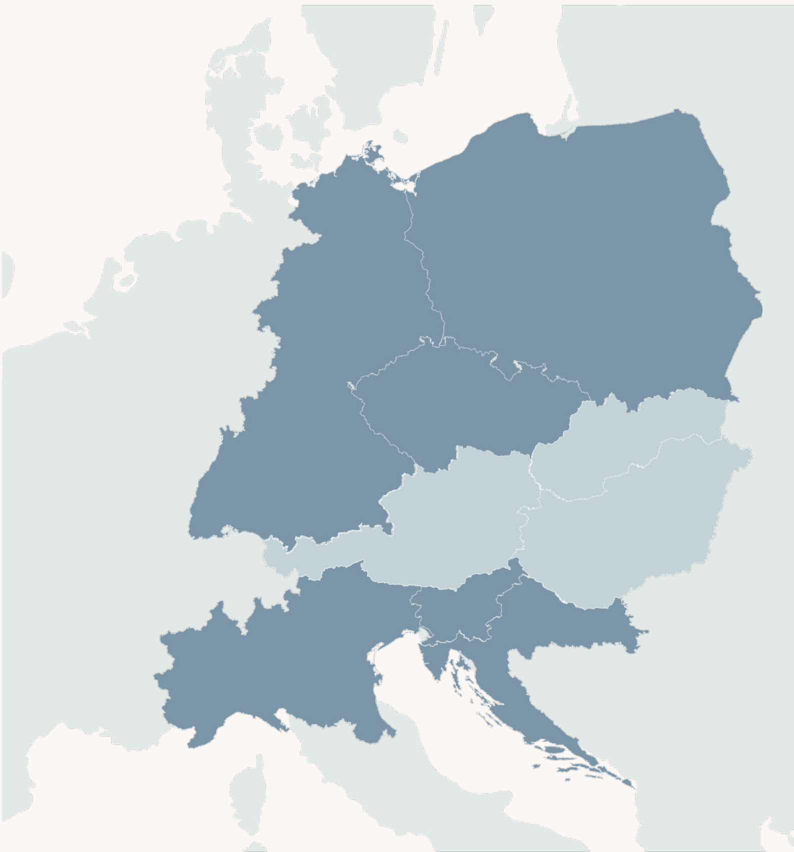
Acting as a flexible networking platform it will reach out to the wider Interreg community, which includes projects and their related main actors from INTERREG Central, Danube, North-West Europe and EUROPE and is linked to the LIFE and HORIZON programmes too.

MAURICE in a Nutshell

The MAURICE project promoted sustainable urban water management in Central and Eastern Europe by applying the sponge city concept. It integrated nature-based solutions and blue-green infrastructure to address climate change impacts such as groundwater depletion, flooding, and water scarcity. Six pilot cities — Ljubljana, Varaždin, Milan, Stuttgart, Jaworzno, and Novy Bydzov — implemented tailored strategies like rainwater reuse, managed aquifer recharge, and permeable surfaces. The project followed a structured process from risk assessment to action plan development, emphasizing stakeholder collaboration, advanced monitoring, and adaptive planning. MAURICE established a transnational Sponge City Network to facilitate ongoing knowledge exchange and capacity building, demonstrating how coordinated, innovative water management could enhance urban resilience and sustainability.

MAURICE Project Partners

- Central Mining Institute – National Research Institute, Poland
- Municipality of Jaworzno, Poland
- State Capital of Stuttgart, Germany
- The City of Novy Bydzov, Czech Republic
- Technical University of Liberec, Czech Republic
- Polytechnic University of Milan, Italy
- East Ticino Villoresi Reclamation and Irrigation Consortium, Italy
- Geological Survey of Slovenia, Slovenia
- Ljubljana Waterworks and Sewerage, Slovenia
- Faculty of Geotechnical Engineering, University of Zagreb, Croatia
- City Municipality Varaždin, Croatia



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