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Restoring mussel habitats to strengthen climate resilience in Germany

A holistic strategy for nature conservation and flood resilience in Bavaria, Saxony and North Rhine-Westphalia

Restoring healthy freshwater pearl mussel populations – reliant on intact river systems and catchments – boosts regional climate resilience and supports more adaptable, sustainable water supply in the face of climate change.

Key Learnings

- **Restoring natural water bodies** – well connected to their floodplain and with higher water retention rates in the catchments – supports technical flood protection measures, reduces drought risks, and has a strongly positive effect on nature conservation and quality of life.
- **Cooperation:** Broad stakeholder participation and a well-informed public are a prerequisite for successful measure implementation. This requires a combination of classic public relations with individual consultancy and close personal contact. The latter is especially time-consuming and depends on long-term continuity of projects.
- **Species selection representative for an entire ecosystem:** The freshwater pearl mussel is a good indicator of river health due to its sensitivity to habitat quality. Protecting this species requires restoring entire ecosystems, making it an effective way to address multiple environmental objectives and stakeholder interests.

About the region

The mussel conservation and climate change adaptation actions cover the entire distribution range of the freshwater pearl mussel in Germany, meaning sites in Bavaria, Saxony and North Rhine-Westphalia. Local climate conditions like annual rain differ between the sites, but they mainly have similar freshwater conditions, located in low-lying, rural primary rock mountain areas. Agriculture and forestry in different intensities mainly dominates the land use. The areas are popular tourist destinations mainly for hiking, winter sports, and wellness.

Climate Hazards

Droughts, Extreme Heat, Flooding

Sector

Agriculture, Biodiversity Protection, Forestry, Water Management

Key system

Ecosystem and Nature Based Solutions, Water Management



Climate Threats

During the last decades, air temperatures have risen in Germany, with average annual mean temperatures already 1.8 °C warmer between 1991 and 2020 compared to 1961 and 1990. Predictions estimate that this trend will continue with more hot days threatening river ecosystems. In recent years, unprecedented regional droughts and severe floods have disrupted water cycles, with visible impacts, such as dry streams appearing even in some pearl mussel habitats – a phenomenon that only emerged in the late 20th century. Landscape features like narrow valleys and soils with low water storage capacity worsen the impacts of climate change in the regions. As a result, areas with small or even no permanent streams – previously unaffected – are now experiencing flooding, such as in the Ahr region near the North Rhine-Westphalian [project area](#).

The Freshwater Pearl Mussel as a Climate Change Indicator

The freshwater pearl mussel is a reliable indicator of river ecosystem health as it supports a healthy water cycle by filtering water, improving water quality, and maintaining ecological balance in freshwater ecosystems. Its poor conservation status reflects various external pressures, like elevated riverbeds, bank reinforcements, water quality issues and the growing impacts of climate change on water balance and temperature. During recent hot and dry summers, mussel larval production has declined or followed an unusual pattern, reducing reproduction success. In the [MARA project](#) areas, the mussel plays a key role in improving water balance, while progress remains limited in other regions. In response to temperature

increase and flooding, renaturation efforts improve habitat conditions for the freshwater pearl mussel and reduce climate risks for river basin inhabitants.

Species Conservation as a Driving Force for Water Management Transformation

For centuries, human activity has reshaped Central European landscapes – intentionally or as an unintended consequence of other measures, accelerating water discharge throughout the landscape. These activities include surface and soil sealing, draining wetlands, straightening watercourses and removing natural structures like boulders and logs.

Flood protection often relies on technical solutions like embankments and polders, which remain essential components of holistic flood management and should not be overlooked. However, solely relying on technical solutions is expensive and requires adequate management and regular maintenance. Moreover, it does not resolve local water balance deficits, shifting and often aggravating the associated problems further downstream.

Complementary Nature-based Solutions to existing technical solutions, scattered across entire catchments, contribute to pearl mussel conservation and flood protection, do not require active management and serve multiple other purposes. However, stakeholders affected by water management interventions and the public often don't see their benefits, making communication a key aspect of successful conservation and adaptation. Although pearl mussel conservation is mandatory, implementing measures is often voluntary.

"The conservation of the freshwater pearl mussel demonstrates that successful species protection requires a holistic approach, cooperation with many partners and can additionally serve other purposes like flood protection or adaptation to climate change with Nature-based Solutions."

Sabine Riewenherm, President of the Federal Agency for Nature Conservation

Communication, Awareness Raising and Engagement are Key

Good awareness-raising campaigns, explaining the benefits of freshwater pearl mussel conservation and flood or drought prevention, are essential for achieving long-term conservation and adaptation outcomes. The core aim of the campaigns has always been to reach broader audiences. Information is shared through various channels, including social media, newspapers, radio, and television. Campaigns often feature events that allow for direct interaction and personal experiences. To maximise impact within target groups, partnerships with key individuals and organisations are typically established in advance. The MARA project has taken up this aspect, making conservation and adaptation communication a key to success.

In the project area, private and public properties are small, meaning activities in a single catchment need to involve many stakeholders with different backgrounds and interests, like farmers, fishermen, municipalities, residents or private companies. Convincing these stakeholders to implement Nature-based Solutions requires a good communication strategy, with the following success factors:

1. Disseminating information about reasons, advantages, and correlations of different topics and measures.
2. Establishing personal relationships, especially with key stakeholders, such as landowners, permit holders, or local opinion leaders, is essential for effectively implementing measures.
3. Creating win-win situations, e. g. between farmers and nature conservation, and being open to compromises between project targets and the personal needs of different stakeholders.

Information and Stakeholder Engagement

Offering nature experiences like field excursions to increase public awareness of the target species and its needs helps make conservation and climate adaptation tangible, while also increasing public acceptance of interventions. Reaching groups not yet familiar with conservation and adaptation topics is essential. Linking conservation topics to other fields such as combining pearl mussel conservation, river restoration and art can help communicate the project's broader value and open new perspectives. Exhibition of mussel paintings and sculptures, along with a theatre play about the freshwater pearl mussel, bring the project to life and engaged stakeholders and citizens across different project locations and events.

Creating win-win situations for Stakeholders and Conservation

One example – among others – of a win-win situation for farmers and nature conservation is flattening riverbanks. This intervention reduces erosion, better connects floodplains and rivers, and enables economic activities such as agriculture. Flattened riverbanks cannot collapse under the weight of agricultural machines, making hay meadows safer for farmers, by reducing the risk of accidents. More frequent, but shorter flooding increases nutrient supply without hindering cultivation.



Figure 1: River bend before (left) and after (right) river restoration. The project team flattened the eroding and collapsing riverbank providing stability and increasing floodplain connectivity. Deadwood and boulders provide shelter and habitat structures for aquatic organisms as well as increase hydraulic roughness of the formerly monotonous river channel. Image Credit: © Marco Denic, Landschaftspflegeverband Passau.

Also, restoring natural, well-structured river channels slows water flow and brings back aquatic life, enabling fishery and increasing the recreational value of the landscape for people. Well-established personal contact with responsible persons requires time and consistency to build trust. Tackling the effects of climate change is a long-term process because climate impacts are often temporally delayed (because biological processes are slow) and social transformation is necessary.



Figure 2: Left: A straightened, embanked, and poorly structured stream accelerates discharge and offers poor habitat quality to aquatic organisms. Right: A meandering, well-structured stream. Morphological features slow down water velocity and offer many different microhabitats. Image Credit: © Marco Denic, Landschaftspflegeverband Passau.

Summary

Climate change is increasing the risk of droughts and severe flood events in Germany, a challenge further exacerbated by historic landscape modifications. These pressures have contributed to the dramatic decline of freshwater pearl mussel populations – sensitive species that act as indicators of healthy river ecosystems. Restoring these populations through a holistic approach not only supports biodiversity but also improves natural water regulation and climate resilience. This adaptation story demonstrates how habitat restoration, stakeholder collaboration, and creative public engagement can drive climate adaptation by enhancing ecosystem services and flood resilience. Communicating these broader benefits is key to building lasting support for nature-based solutions.

Further information

The work presented in this adaptation story is part of the [MARA – Margaritifera Restoration Alliance](#) project.

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