AQUACROSS Case Study 6: Understanding eutrophication processes and restoring good water quality in Lake Ringsjön and Rönne å Catchment in Kattegat, Sweden

Summary for Local Stakeholders

The interdisciplinary research project AQUACROSS[1] supports European efforts to protect biodiversity in Europe's lakes, rivers, coasts and oceans. These aquatic ecosystems provide numerous economic and societal benefits to Europe – but they are at risk of irreversible damage from human activities. To counter this and to support achievement of the EU Biodiversity Strategy to 2020 targets, AQUACROSS has developed practical guidance on identifying threats to biodiversity, understanding links between ecosystems and the services they provide, data management, modelling and scenario development, and policy analysis, which fit together as parts of the integrated AQUACROSS Assessment Framework for ecosystem-based management of aquatic ecosystems[2]. We have developed, tested, and applied this research in eight case studies across Europe to solve local biodiversity challenges. This brief summarises our work in **Case Study 6**, and makes recommendations for local policy.

Enhancing water governance using resilience principles in Southern Sweden

The Rönne å catchment is located in Southern Sweden. It includes lakes (e.g. Ringsjön) and rivers (Rönne å) that drain into the Kattegatt sea. Intensive agricultural activities in the past resulted in high levels of eutrophication of the Rönne å water bodies. Today, the landscape is perceived as multi-functional with high recreational values. Lake Ringsjön, for instance, is a major tourist and recreational destination. The turbid lake and its toxic algae blooms thus became a major target of restoration activities by local municipalities.

Figure 1. Inlet into Lake Ringsjön with the highest nutrient inflow, Hörby 2015.

Swedish water governance is influenced by legislative frameworks and policy actors on all scales: local, regional, national, and EU. Enhanced understanding of social-ecological complexity and how to account for it in management through best-practices, multi-level governance and cross-sector collaboration is critical for addressing environmental problems, the provision of ecosystem services, and maintenance of biodiversity. In particular, this case study investigates the process of restoring good water quality from the perspective of two local water councils and its implications for the provision of tourism-related ecosystem services along the Rönne å catchment.

Our Aim: to apply resilience thinking and resilience principles through the AQUACROSS Assessment Framework to improve governance of aquatic ecosystem services and biodiversity, with an emphasis on understanding social dynamics behind policy implementation.

[1] AQUACROSS (Knowledge, Assessment, and Management for AQUAtic Biodiversity and Ecosystem Services aCROSS EU policies), 2015-2018, has received funding from the European Union's Horizon 2020 Programme for Research, Technological Development and Demonstration under Grant Agreement no. 642317. More information: aquacross.eu
[2] All AQUACROSS guidance and outputs are freely available online at https://aquacross.eu/outputs

Policies and governance structure

> **Co-designing research with stakeholders**
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> Our research was co-designed with stakeholders. We invited politicians, civil servants and practitioners in water management to reflect on ecosystem services and biodiversity. 3 workshops and 8 follow-up interviews were conducted to identify current practice of collaboration between actors at multiple scales and potential future policy scenarios. This case study thus also serves as an example for stakeholder involvement in scenarios.

National, regional and local institutions manage the nutrient levels in the Rönne å catchment and implement the national policy framework at the local level (Figure 2). The **water authority** was put in place as a result of the EU Water Framework Directive's demand for management based on hydrological boundaries. The **water councils** were created due to the obligation to have more stakeholder involvement, although they merely replace or run alongside the traditional water associations which have historically undertaken active management, as e.g. of Lake Ringsjön. In this case, water councils are slightly disconnected from the other institutions due to weak collaboration. Their plans represent more of a bottom-up approach to management, driven primarily by what stakeholders perceive as important and what is feasible, including some nitrogen and phosphorus targets according to the Environmental Quality Objectives. Where water authorities are expected to support water councils in the implementation of management measures, the authorities mainly act through their support of **county administrative boards** which provide funding and legislative support for **municipalities**. The water councils are supported by county administrative boards but are very much dependent on the active collaboration by municipality representatives, thus the resulting success of water councils is heterogeneous across Sweden.

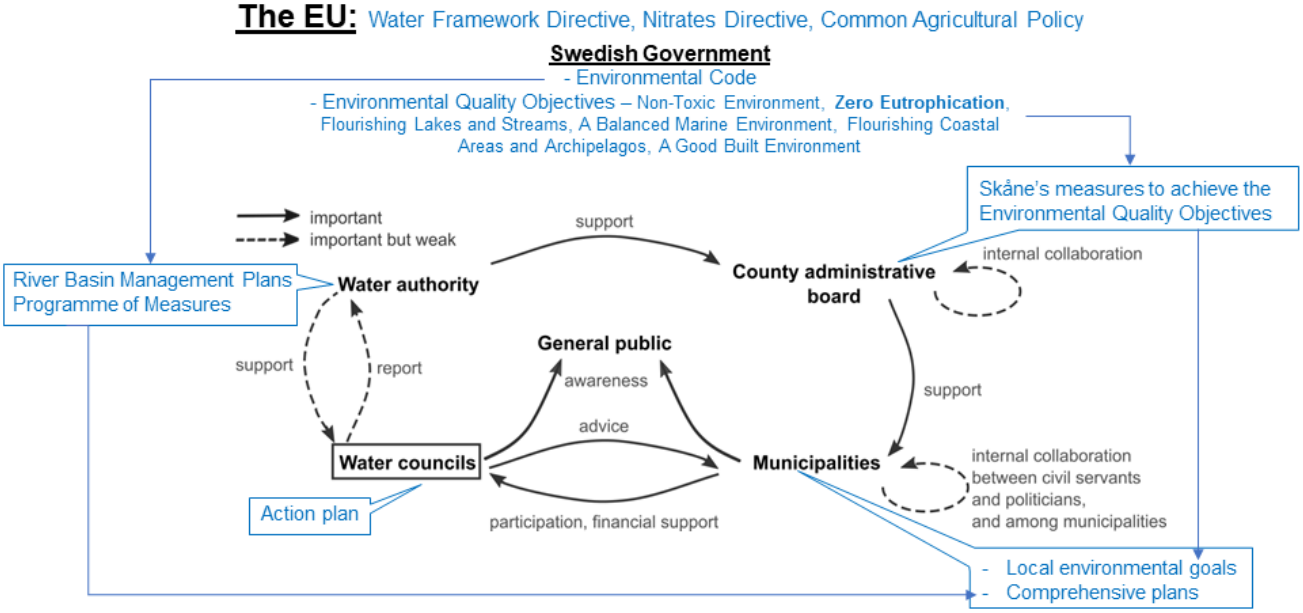

Figure 2 Institutions for managing freshwater and their collaborations in the Rönne å catchment (black). Policies and frameworks that influence nutrient levels in freshwater and how overarching Swedish legislation is incorporated into local plans (blue).

Status of the social-ecological system

The state of Lake Ringsjön and its biodiversity has improved since the 1960s, with decreasing nutrient levels and increasing water clarity. However, there is still some way to go to reach a satisfactory state with respect to ecosystem services and biodiversity. Nutrient inflows from agricultural production and insufficient municipal and private wastewater treatment are the main causes of algae blooms. Regulations of agricultural activities through EU and national legislation have led to reductions in nutrient input from agriculture – from 1995 to 2000, agriculture was responsible for the largest decrease of 19%. However, rural household sewage treatment improved very little, with varying

success depending on enforcement measures and the involvement of home owners in the regulation process.

One future vision and motivation for restoring the lake is that investments to restore a clear state ecologically via biomanipulation (removing selected fish to reduce zooplankton predators) will facilitate more touristic lake use by improving recreational fishing and water quality. This social-ecological interaction would eventually provide revenues for municipalities. However, ecosystem services interact spatially, through time and institutions, for example even if biomanipulation changes the local lake dynamics, the causes of eutrophication will have to be addressed at the catchment scale. In summary, the lake management needs to deal with three challenges simultaneously: 1) the legacy of past practices which caused the nutrient pollution in the catchment, 2) present ecosystem manipulation and pollution at different spatial scales, and 3) linking potential future income through touristic or other beneficiary activities to restoration investments.

Scenarios to steward ecosystem services and biodiversity through enhanced water governance

In collaboration with local decision-makers and practitioners, we developed three scenarios to explore qualitatively how freshwater ecosystem services and biodiversity management may improve.

1) **Baseline scenario** – *the implementation of current measures (biomanipulation, enforcement of private sewage system upgrade).* From a resilience perspective, current restoration measures at Lake Ringsjön reinforce the feedbacks of the clear state (reduce planktivorous fish, increase zooplankton and macrophytes abundance) and reduce the slow drivers of the turbid state (nutrients from agriculture and insufficient sewage treatment). Diversity of zooplankton and macrophyte species is increased to allow redundancy in the freshwater's ability to stabilise the clear water state.

2) New visions for more distant futures – *different planning horizons and particular long-term plans*, motivate currently less popular measures (fishing reduction, private sewage system upgrades) which reinforce the clear water state, by considering social-ecological dynamics.

3) Broader collaborations in the catchment – *cross-sectoral and cross-boundary collaboration* motivates a) a broader appreciation of multifunctional landscapes with multiple interacting ecosystem services, and b) strategies to support multi-scale coordination and secure funding for necessary restoration measures (e.g. in cross-boundary wetlands).

In summary, these scenarios demonstrate, so far, that next to the technical measures such as biomanipulation and wetland restoration, the resilience of ecosystem services and biodiversity can also be enhanced through strengthening and building capacities within the governance system and society. Social interactions can enable or accelerate the implementation of measures, improve the development of measures by integrating diverse knowledge and understanding, increasing willingness to contribute to the financing and implementation of measures. Social interactions are thus fundamentally important and need to be taken into account when developing policies and measures.

Final local policy recommendations

Resilience thinking helps to identify feedback processes and social-ecological interactions which determine long-term outcomes from restoration measures.

Considering ecosystem service trade-offs in policy scenarios can improve fairness of restoration measures over space (catchment vs. sub-catchment), over sectors (producing vs. regulating services) and over time (among generations, considering different planning horizons).

Water councils are well prepared to consider trade-offs among ecosystem services and to form new alliances in support of currently undervalued regulating ecosystem services, which other services depend on in the long term. No single solutions but multiple solutions and continuous learning among stakeholders help identify suitable measures for improving ecosystem state and human well-being simultaneously.