Middle Rhine Supersite

from Iffezheim to the Netherlands

Foto: Federal Waterways Engineering and Research Institute

DANUBIUS-RI, the International Centre for Advanced Studies on River-Sea Systems, is a pan-European distributed Research Infrastructure (RI), which is enabling integrated studies of rivers and their catchments, transitional waters such as estuaries, deltas and lagoons, and their adjacent coastal seas.

DANUBIUS-RI regards River-Sea Systems as socio-ecological systems, where natural processes and human activities are intertwined. That is why DANUBIUS-RI has chosen an integrated, interdisciplinary and participatory approach in order to enhance the process and system understanding and to enable a sustainable management of River-Sea Systems.

For detailed information please visit www.danubius-ri.eu

What is a Supersite?

In DANUBIUS-RI, Supersites are selected study regions within River-Sea Systems, which facilitate case studies along climatic, environmental and socio-economic gradients. Supersites serve as **living labs** to investigate the functioning and development of River-Sea Systems and to develop measures for their sustainable use. To date, DANUBIUS-RI encompasses **12 European Supersites**, which are available for the testing and development of new methods and technologies related to the investigations mentioned above.

River-Sea System:
The Rhine from the Alps to the North Sea

The Rhine is by far **Europe's most important waterway** and it is navigable for about 800 km. Over centuries, the Rhine has seen numerous interventions, such as barrage construction, river straightening and regulation, and implementation of flood defense measures, which have caused morphological changes. Dense population in the river's catchment, shipping and flood protection, water supply for domestic, industrial and agricultural uses, and its popularity as a recreational space result in **intense use** of the Rhine. In contrast, there are requirements for its ecological development, which need to be met.

The multitude of challenges caused by the uses and environmental demands, and the knowledge gaps that were identified in this context, led to **the foundation of several national and international committees**, which are dealing with the sustainable development of the Rhine and its floodplain and with the development of solutions for transnational challenges (ICPR, CHR, FGG Rhein etc.).

60 million people live in the catchment [1]

180 million tons of goods are being shipped each year [2]

3 million tons of sediment are transported each year [3]

Middle Rhine Supersite:
The free-flowing German Rhine

The Middle Rhine Supersite comprises the free-flowing Rhine from its last barrage at **Iffezheim to the Dutch border**. Within these 524 km, the Rhine flows through the Upper Rhine Graben (river straightening transformed the Rhine to a single-channelled river), the Mainz Basin (shallow and broad river section), the Rhenish Slate Mountains (high gradient and narrow bedrock channel) and the Lower Rhine Embayment (gravel bed turning into a sand bed close to the Dutch border). The Lower Rhine is also characterized by its intense use due to the dense population in the Rhineland and the Ruhr area.

The free-flowing Rhine is characterized by a **multitude of river training structures** to ensure suitable shipping conditions. Substantial **sediment nourishment** is being conducted continuously at the beginning of the Supersite and at the Lower Rhine, to face the constant threat of bed erosion in large sections. Additionally, the maintenance of the waterway requires regular **sediment relocation** in large quantities. The Middle Rhine Supersite connects to the Rhine-Meuse Delta Supersite downstream, which extends to the North Sea.

Challenges

Along the Rhine, the fundamental challenge is to reach an agreement between its role as a waterway, the manifold other human uses and environmental demands to improve its ecological condition.

- **Maintain a dynamic balance of the river bed:**
  Various human uses and engineering measures resulted in insufficient sediment supply in large parts of the Rhine. Adapted management is required to reach and maintain a dynamic equilibrium of the sediment budget and the river bed.
- **Ensure water availability:**
  The ecological demand for a dynamic exchange of water between the river and its floodplains is in potential conflict with the demand for reliable water depths for shipping and sufficient water quantities for further uses. An agreement between these demands needs to be scientifically justified and accepted by the society. Furthermore, climate change and the associated projected increase of extreme events are a challenge for reliable and user-oriented water availability in the Rhine.
- **Improve biodiversity:**
  After the extensive pollution of the Rhine until the early 1970s, water quality has recovered considerably, but there is still a need for action. Long-term morphological alterations have degraded riverine habitats and are a prominent reason for reduced biodiversity. Water and sediment pollution, e.g. with microplastics and pharmaceuticals, could cause emerging problems. Therefore, measures to improve habitat diversity and water quality of the Rhine are urgently needed. Additionally, measures need to be taken to reduce the establishment of invasive species.

Research Priorities

Research priorities deal with the science-based agreements between demands for human use and the protection of available resources. Focus is on a balance between human use and ecological improvement, adaptation to effects of hydrological extremes, as well as sediment balance and its adapted management.

- **Sediment balance**:
  How did human use change the sediment budget and the morphological conditions? How can a dynamic equilibrium be reached efficiently, in an ecologically sustainable and user-friendly manner?
- **Hydrology:**
  How can the existing water resources be used by means of tolerable compromises (e.g. reconnecting cut-off meanders vs. shipping requirements)? Which measures can be taken to adapt to potentially more frequent hydrological extremes?
- **River restoration and biodiversity improvement:**
  What are the benefits for humans and the environment from river restoration measures? How can biodiversity be improved effectively (e.g. through ecologically-oriented river training and habitat restoration)?

Services

During the Implementation Phase of DANUBIUS-RI, the following services are being developed within the Middle Rhine Supersite, which will be made available to users based on defined criteria:

Provision of access to facilities and equipment for

- observation (e.g. field equipment, research platforms)
- analysis (e.g. lab equipment)

→ e. g. buoys, bed load samplers, multi-parameter sensors, ADCP

Development and provision of access to methods and tools, such as

- methods and standards for sampling and analysis
- available and well-maintained models, scenario and sensitivity analyses, and projections

→ e. g. analysis tool for dune tracking, methods for hydromorphological monitoring, hydrodynamic-numerical models

Generation and provision of access to data, such as

- remote-sensing and in situ measurement data in high temporal and spatial resolution
- modelling data (e. g. from scenario analyses)

→ e. g. in situ hydrological and sediment data, data regarding water quality or taxonomy, water temperature data derived from remote sensing, archived samples

Compilation, integration and provision of knowledge in cooperation with regional, national and international partners to

- develop scenarios and strategies for a sustainable management
- identify additional research questions for observation, analysis and modelling

→ e. g. for ecologically-oriented river training and habitat restoration

Exchange with experts to

- conduct joint research projects and theses
- provide expert support and training in observation, analysis and modelling for Supersite-specific issues

→ e. g. research collaboration and workshops

[1] ICPR: https://www.iksr.org/en/topics/rhine

[2] CCNR (2020): Annual Report 2020, Inland Navigation in Europe, Market Observation

[3] Hillebrand & Frings (2017): Von der Quelle zur Mündung: Die Sedimentbilanz des Rheins im Zeitraum 1991–2010. Report No. II-22 of the CHR

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