DANUBIUS-RI | International Centre for Advanced Studies on River-Sea Systems

www.danubius-ri.de

DANUBIUS-RI (International Centre for Advanced Studies on River-Sea Systems), is a Research Infrastructure with many components distributed throughout Europe. It enables integrated research across rivers, their catchment areas, transitional waters, such as estuaries, deltas and lagoons, and adjacent coastal seas. Within DANUBIUS-RI, river-sea systems are regarded as socio-ecological systems, in which natural processes and human activities are closely interwoven. The integrated, interdisciplinary and participatory approach aims at improving the understanding of processes and systems and at promoting sustainable management of river-sea systems.

Further information about DANUBIUS-RI you can find at www.danubius-ri.eu

What is a Supersite?

In DANUBIUS-RI, supersites are selected study areas within river-sea systems with particular climatic, ecological, and socio-economic prerequisites. The supersites serve as **Living Labs** to study the functioning and evolution of river-sea systems, and to develop measures for their sustainable management. DANUBIUS-RI comprises currently of **12 supersites in Europe**, which are available for scientific and socio-economic investigations and in which new methods, procedures and technologies can be tested and applied.

River-Sea System:
The Elbe from the Riesengebirge to the North Sea

Over the centuries, **human activities** have significantly altered the natural and water balance of the Elbe, affecting the flow regime, natural cycles and associated ecosystems. These anthropogenic activities include dike construction, river development and straightening of river channels, bank stabilization, construction of weirs, barrages and dams, water transfers, large-scale open-cast lignite mining in the catchment area, and the drainage and irrigation of agricultural land. In addition, there are stressors due to climate change and its interactions with various human interventions. To address these transboundary challenges in the Elbe River, the **International Commission for the Protection of the Elbe** (ICPER) and the **Elbe River Basin Community** (FGG Elbe) were founded, so that the ten federal states, through which either the Elbe or its tributaries flow, can join forces.

65% of the catchment area is in Germany

25 Million people live in the catchment area

80% of the catchment area is arable and pasture land

Elbe-North Sea Supersite:
The Lower Elbe from Geesthacht to the North Sea

The Elbe-North Sea Supersite extends from Geesthacht, Germany near the beginning of the Lower Elbe River, to the German Bight coastal waters influenced by the Elbe River. Therefore, the Elbe-North Sea Supersite includes **freshwaters, transitional and coastal waters**, including the Wadden Sea. The distance from the Lower Elbe to the mouth of the estuary discharging into the North Sea is 142 km. This region, where water levels are governed by tides, is also called the **Tidal Elbe**. The average tidal range is currently 2 m in Geesthacht, almost 4 m in Hamburg and 3 m in Cuxhaven (at the river mouth). The Hamburg **current splitting area** with the Norder- and Süderelbe (northern and southern current) represents an interconnected large port region with deepened navigation channels, where water moves upstream and downstream over several tides. Located at the current splitting area is **Hamburg** (1.73 million inhabitants), the largest city on the Elbe. The **Hamburg Port** is the largest German seaport and the second largest port in Europe. The container port is one of the largest in the world. The part of the Elbe River used for shipping, from the mouth to Hamburg port, has been deepened and widened several times.

Challenges

The **various uses** of the Lower Elbe and the adjacent regions as habitat, recreation area, waterway, industrial area and arable land, result in a variety of complex challenges, which are partly exacerbated by climate change :

- **Habitat Preservation:** The Lower Elbe harbors specialized flora and fauna, as well as some species that can only be found here. The food web is characterized by a high secondary production, exploited by fish larvae and juveniles. The Elbe has the highest fish diversity of all European rivers, and the fish migrate both upstream and downstream the Lower Elbe.
- **Giving more space:** Currently, 335 km of dikes and 17 storm surge barriers protect an area of more than 2,400 km², including the urban region of Hamburg. However, these barriers have reduced the natural retention volume of regions around the Elbe by 8 billion m³.
- **Reduction of Nutrient Inputs:** Nutrients from the catchment area accumulate in the Elbe and lead to mass growths of microalgae, which are carried into the Lower Elbe. There, the microalgae die. The remains are degraded by bacteria, consuming oxygen and releasing nutrients that contribute to the eutrophication of the North Sea.
- **Reduce pollutants:** A wide variety of pollutants, which enter the Elbe in various ways, are transported dissolved or bound to suspended matter, deposited in port areas or side reaches, or remobilized until they reach the North Sea. This poses a health risk to flora and fauna, as well as to humans.
- **Maintaining the waterways:** To enable large container ships to enter and leave the Port of Hamburg from the North Sea via the Lower Elbe, the shipping channel and port basins have to be dredged regularly. Dredging volumes have increased, especially after the fall of 2013. Climate change, waterway adjustments or diking can further intensify these observed trends.

Research Focus

In order to address the above challenges, the current research focus is to **analyze, assess and predict multiple interactions and effects** of human activities, as well as climate change and extreme events on the biodiversity, functioning and ecosystem services of the Lower Elbe. For this purpose, the following research priorities have been identified so far, which are closely linked :

- How **biogeochemical turnover** (e.g., nutrients), oxygen balance, greenhouse gas emissions (e.g., carbon dioxide, methane, and nitrous oxide), and pollutant transport and fate are changing as a result of climate change and other human interventions?
- What influence do tidal and discharge changes, sea level rise, and channel deepening have on suspended **sediment dynamics and sediment balance**?
- How does the (ground) **water balance** change, especially in the current splitting area, depending on precipitation and use in the catchment? How do the **hydrodynamics** change, especially in the tributaries and in the estuary?

Services

The following services are currently being developed for the Elbe-North Sea Supersite and made available to interested parties according to defined criteria:

Access to facilities and equipment for:

- Observation (e.g. Research Platform Tesperhude, Cuxhaven FerryBox Station, RV Ludwig Prandtl, small boats Storch and Zwergseeschwalbe, as well as equipment for collecting samples, like water samplers, filtration systems and boxcorer)
- Sample analysis (e.g. FerryBox incl. diverse sensors, ADCP, IRMS, MC ICP-MS)
- Modeling (e.g. high performance computing)

Development of and access to methods and tools such as:

- Methods und standards for sample collection and analysis (e.g. various mass spectrometric methods for multi-element and elemental species analysis, for non-traditional isotope systems and stable nitrogen isotopes, as well as laser-based methods for nitrous oxide analysis)
- Advice on development and application of numerical models for hydrodynamics, sediment dynamics, biogeochemistry, and water quality
- Advice on the selection of software programs, modeling approaches, parameterizations, data sources for and preparation of model boundary values
- Provision of model data examples from existing simulation results

Collection, aggregation and access to data such as:

- Data from remote sensing and in situ measurements and their merging (e.g., temperature, pH, dissolved oxygen, salinity, chlorophyll, algal classes, turbidity, CDOM)
- Selected data from measurements at representative sites, such as Geesthacht and Cuxhaven, and along the Tidal Elbe (e.g. nutrients, suspended solids, carbon dioxide, methane, nitrous oxide, metals)
- Model data that can fill in the gaps where measurements are missing

Attain, integrate and provide new knowledge, with regional and national partners in order to:

- Improve process and system understanding
- Develop scenarios and solutions for sustainable management with stakeholders
- Identify further research questions for observation, analysis, and modeling

Exchange with and support from experts, in order to :

- combine interdisciplinary expertise and promote the exchange of knowledge
- carry out joint research projects and research theses
- offer consulting and training regarding observation, sample analysis and modeling

Helmholtz-Zentrum hereon

BAW Bundesanstalt für Wasserbau

bfg Bundesanstalt für Gewässerkunde

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