Multiple-stressor mechanisms in European freshwater systems

Introduction

European freshwater systems are threatened by organic and inorganic pollution, geomorphological alterations, climate and land use change, water abstraction, invasive species or pathogens; often, such threats act simultaneously to create multiple-stress situations. Water scarcity, a key stressor itself, adds adversely and exacerbates the interactions between other stressors. The STRESSORS Module is designed to understand the mechanisms and connections of multiple stressors in the GLOBAQUA case-study river basins.

Challenges

- Gather and compile data generated at European level and make them publicly available
- Build integrated climatic and socioeconomic scenarios to determine and connect the drivers of change and their impact on land and water management
- Exploit the connection between drivers and water quality parameters on the chemical and ecological status of water bodies and on their ecosystem functionality in multiple-stress conditions
- Identify sediment/pollutant related stressors and link these to land use, hydrology and climate to account for pressure-stressor relationships
- Characterize and investigate the occurrence of selected pollutants in water, sediments and biota of the case-study basins under different hydrological and multiple-stress conditions

Activities

1. Integrate reference data with climate and socioeconomic projections to simulate changes in land use and water management
2. Employ modelling to improve hydrological process understanding
3. Determine, compare and link trends in water quality parameters of 3 large Mediterranean basins to the drivers of change
4. Determine the main factors and relationships that drive sediment fluxes at the basin scale and assess particle related pollutant concentrations and fluxes based on event sampling campaigns
5. Create and load an internal Relational Data Base and Data Repository to provide historical data and select external data sources to be accessed from the Water-Hub
6. Audit, select, process and downscale climate projections to the case study scale
7. Develop proxies relating stressors to land use, climate, hydrology and other factors
8. Perform 2 general sampling campaigns and 2 event-driven field samplings (Sava, Evrotas and Adige) and a fish sampling campaign (Sava)
9. Investigate the effect of environmental factors on in-stream attenuation of micro-contaminants
10. Study biodegradation, photolysis, and adsorption/desorption processes of pollutants under different weather conditions

Approach

This module aims to understand the mechanisms and interactions of multiple stressors by: (i) collecting and distributing existing information and experimental data; (ii) providing climatic and socioeconomic drivers to set the boundary conditions for impact models; and (iii) analysing surface and groundwater hydrological patterns, sediment and pollutant transport, quality of physical habitat and fate of inorganic and organic pollutants.
Scientific results

An in-depth regional climate model (RCM) analysis reveals a substantial increase of water scarcity in most case-study basins. Trends in water quality can be attributed to varying drivers and result from climate, as well as population and tourism or agricultural change. Field campaigns, event based sampling and novel chemical analyses of water, sediment and biota offer new ways to evaluate the potential impact of pollutants on aquatic ecosystems under multiple stressor conditions.

Key outcomes

- Homogenized data and information systems are crucial for the success of interdisciplinary research
- Climate change and intensified land use increase water scarcity and exacerbate multi-stress situations
- The effect of climate change on hydrological fluxes changes spatially, thereby calling for fine grid simulations able to capture such variability
- Sediment flux is an important factor in multi-stress analysis as it may contribute to habitat-, hydrology- and pollutant-related stressor/pressure relationships
- Results of chemical analyses illustrate new possibilities to evaluate the potential impact of pollutants on the environment and biota under multiple stressor conditions

Recommendations

- Well-equipped and carefully managed monitoring networks are highly important to assess the complex relationship between stressors and water quality parameters
- High-resolution spatio-temporal data are essential as input for detailed hydrological modelling
- Sediment yield is an important factor in multi-stress analysis; efforts to derive data sets on a pan-European scale should be supported
- Analyzing suspended sediments or bulk water samples proofs reliable with respect to pollutant related stressor identification
- Climate and socioeconomic change must be integrated to soundly assess impacts on freshwater systems
- Programmes of measures must be adapted to dynamically changing climate and land use
- Especially due to flood event exposure, measures must be taken to prevent contamination of the riparian soil by agricultural and industrial activities
- Due to the extremely high Hg, MeHg and dioxins concentrations found in predator fish, their consumption in the lower Sava stretch is not recommended or should be restricted to minimum

References