URSACHEN-project

Investigating the uncertainties of spatiotemporal variable substance loads estimations in rivers

Introduction

Fine mineral and organic matter are transported in suspension from their sources to the ocean by rivers. These suspended solids transport various chemical compounds, and therefore, affect river morphodynamics, water quality and ecosystem functioning. Concentrations of suspended solids as well as biological and chemical status are monitored in many river systems worldwide. However, these monitoring programs differ considerably in terms of monitoring and laboratory techniques, measuring intervals and sampling locations within the river. Due to spatiotemporal varying concentrations of suspended solids and chemical compounds, river monitoring often provides insufficient or biased information as a result of limited spatial coverage of the monitoring station and infrequent measuring intervals. This leads to yet unquantified uncertainties in load estimations around the globe.

United Nations Educational, Scientific and Cultural Organization

International Centre for Water Resources and Global Change under the auspices of UNESCO

Project Aim

The URSACHEN-project investigates the spatial and temporal variations in suspended solid concentrations and chemical composition and derives the consequences for uncertainties in river load estimations on a global scale.

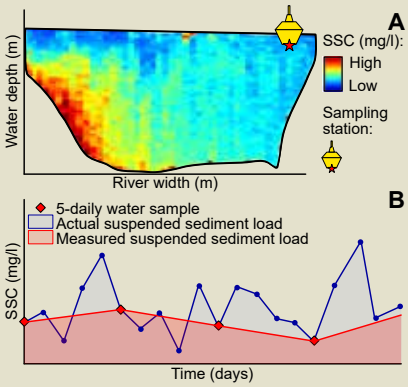
We investigate the uncertainty margins by combining three approaches: conducting river sampling campaigns, establishing continuous monitoring with sensors and analyzing existing global datasets.

A case study is conducted in the German segment of the Rhine river. Several study locations are selected, based on contrasting morphodynamic conditions. River sampling campaigns are conducted at each study location during 3 different river discharge stages (low, middle, high). The large-scale spatial variability of suspended solid concentrations and composition is sampled in vertical depth-profiles along the river width. Our sampling strategy includes simultaneous sampling with automatically closing bottles in each depth-profile. The turbulence-driven, small-scale and short-term variability is addressed by simultaneous sampling at a decimeter-scale using a 2x2m sampling raster and by water sampling at 10-seconds-intervals. Furthermore, the study locations are equipped with optical and acoustical backscatter instruments which continuously monitor the temporal variability of suspended sediment. To study different controlling factors on turbidity and suspended solid concentrations, the study locations are alternately complemented by multiparameter and in situ grain size sensors.

All water samples are analyzed for their grain size distribution, particulate organic carbon content and mineralogical and chemical composition, considering about 60 major and trace elements. Due to the limited sample volume, methods for an acid digestion of whole water samples are developed considering open-vessel and microwave-assisted approaches. Quantification will be carried out by triple quadrupole inductively coupled plasma mass spectrometry taking advantage of a recently developed single-run-multielement-method.

We extend the temporal analysis to a global scale by exploiting existing continuous datasets (e.g. GEMStat, USGS) of total suspended solid concentrations and chemical composition, preferably measured with frequent sampling intervals. We use Monte-Carlo simulations to test how the temporal variability of these concentrations and different monitoring intervals affect the uncertainty of load calculations.

These findings will contribute to a better understanding of the uncertainties that are present in existing river monitoring data. Furthermore, our findings will lead to recommendations on how to improve river monitoring systems worldwide.



The spatial (A) and temporal (B) uncertainties of substace loads (e.g. suspended sediment concentrations (SSC)), as a result of limited spatial and temporal coverage of the sampling.

Intended output products

Beside scientific publications, two other output products are foreseen that help water quality data users to quantify suspended solid and chemical load estimations including uncertainty bounds and suggest improvements for current and future monitoring programs.

The products include:

1) A set of programmed tools, which support river monitoring data users to calculate suspended solid and chemical loads, including estimated uncertainty bounds.
2) A best practice report for improved suspended solid and chemical monitoring worldwide.

Project details:

The URSACHEN project is a collaborative project between the International Centre for Water Resources and Global Change (ICWRGC) and the German Federal Institute of Hydrology (BfG). The Federal Waterways and Shipping Administration (WSV) provides technical support. This project is funded by the Federal Ministry of Transport and Digital Infrastructure (BMVI) for a duration of 3 years (2019–2022), with a budget of roughly 1.3 million Euro.

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