TAILOR-MADE MONITORING PROGRAMS FOR HYDROLOGICAL EXTREMES – CASE ELBE RIVER

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HELMHOLTZ CENTRE FOR ENVIRONMENTAL RESEARCH – UFZ

Introduction

Concentration and quality of suspended particulate matter (SPM) in the River Elbe fluctuate strongly both in terms of space and time.

Among other causes the observed variability is due to

- the re-location of polluted sediments during floods;
- the re-solution of pollutants from sediments in low water periods.

Thus, the portions of pollutants which are transported under extreme conditions form a considerable part of the overall annual load in the Elbe.

Introduction

In spite of the high variability, the monitoring program of the International Commission for Protection of the Elbe River (IKSE) stipulates fix sampling intervals.

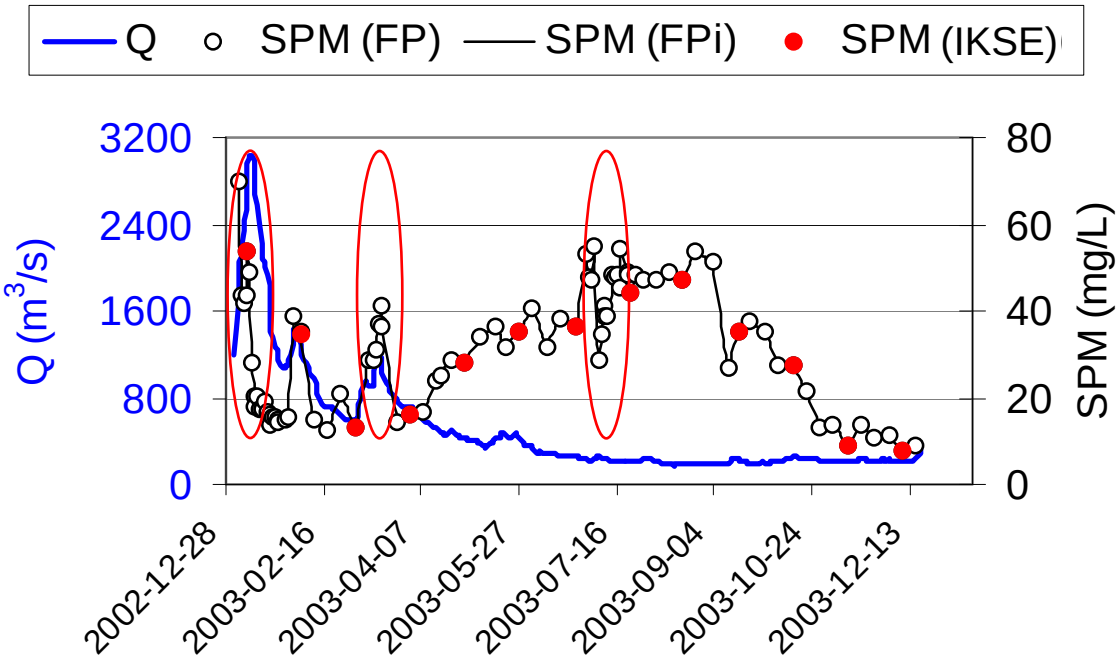
Control samples:

monthly for basic parameters and priority pollutants
bi-weekly (from May to October) for Chlorophyll-a

Pooled samples on monitoring stations:

weekly for heavy metals, HCH, nutrients and main ions
monthly for particulate bounded priority substances.

Seasonal variability SPM concentration



Discharge vs. SPM concentration at Elbe-km 318

The applied (IKSE) monitoring strategy bears the risk of incomplete survey with consequences for risk assessment.

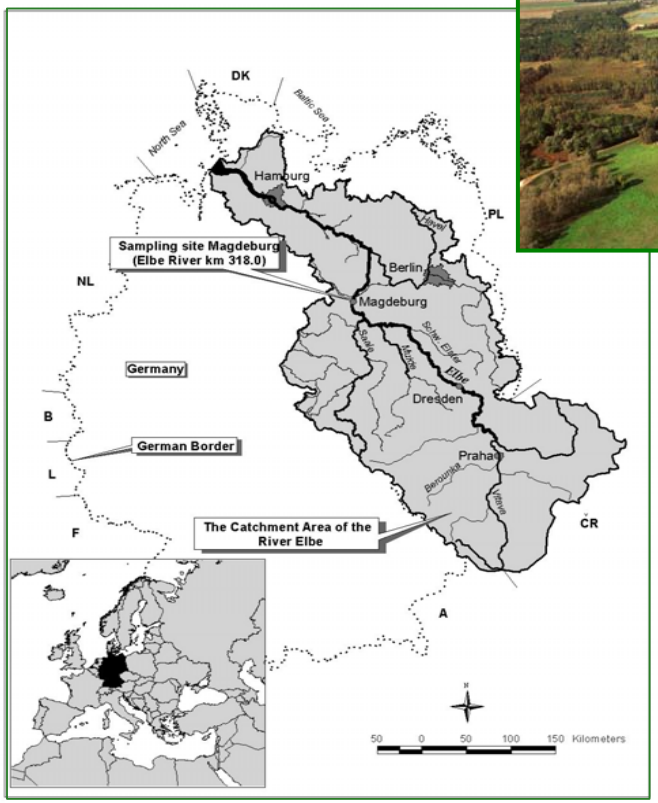
Motivation

Thus, a more specific, tailor-made monitoring at river basin scale during hydrological extremes is strongly recommended to:

- provide a scientific basis for the optimization of sampling strategies;
- identify the principle pollution sources, the sinks and the main transport pathways;
- assess the flood-related input into the floodplains and the sea.

Such knowledge is essential to promote a sustainable development of a river system.

River Basin Elbe



Catchment area: ~ 150,000 km²

~ 50,000 km² CZ
~ 97,000 km² D

Total length: ~ 1,100 km

~ 370 km CZ
~ 730 km D

~ 600 km of the total length are non-regulated by impoundments

~ 485 km of this stretch are regulated by 6900 groynes

Floodplains (D): ~ 800 km²

Groyne fields and floodplains are the main morphological features of the German part of the Elbe.

Prior monitoring approaches during hydrological extremes

The assessment of monitoring programs which were performed in the past by several institutions underline the importance of the sampling strategy with respect to:

(i) the selection of the sampling sites;

(ii) the definition of the starting point, the duration of sampling and the sampling interval;

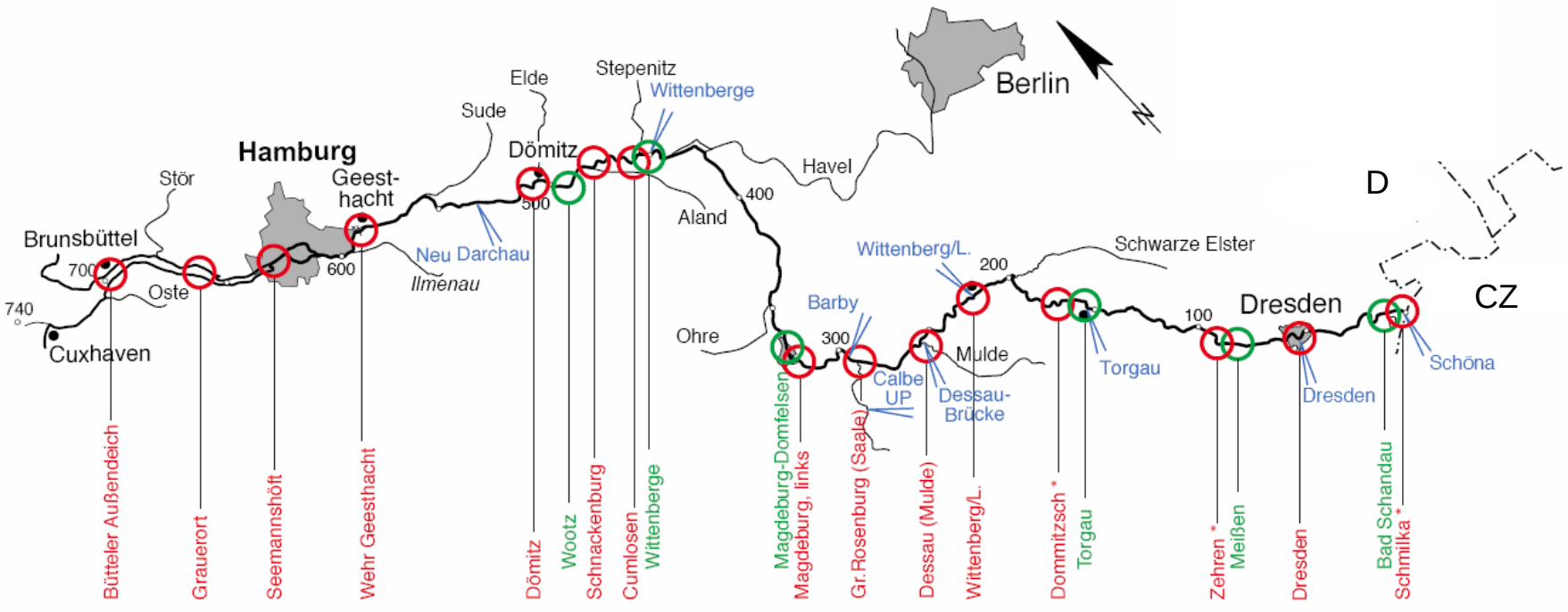
(iii) the selection of the parameter spectrum and the most appropriate analytical methods.

Sampling site

The sampling site should be:

- representative for a defined part of the river basin;
- situated close to gauges;
- preferably be part of regular monitoring programs

Sampling sites



Source: WGE

- main sites represent characteristic river profiles
- complementary reserve sites, if main sites are inundated
- — gauges

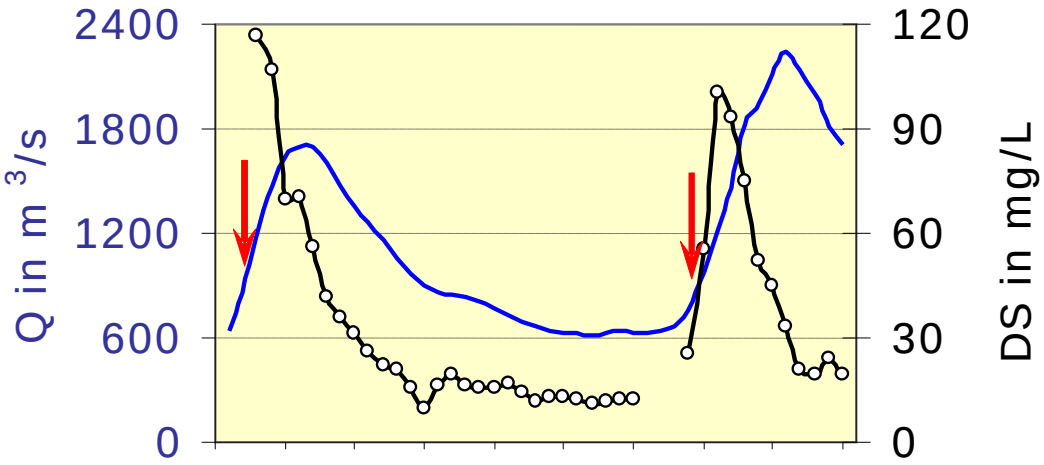
Definition of the starting point

The beginning sediment re-suspension upstream of a sampling site is the most relevant aspect for the selection of the starting time.

Hence, the locally specific discharge threshold for the erosion of the sediments (Q_s) must be known for each site.

Re-suspension can lead to a first SPM-Peak in the course of a flood occurring long before the discharge maximum is reached.

Definition of the starting point



Discharge (Q) vs. dry substance (DS) of SPM (km 318), spring 2005

Q_s: 800 m³/s

MHQ: 1,730 m³/s

HQ (2002): 3,910 m³/s

Duration of sampling

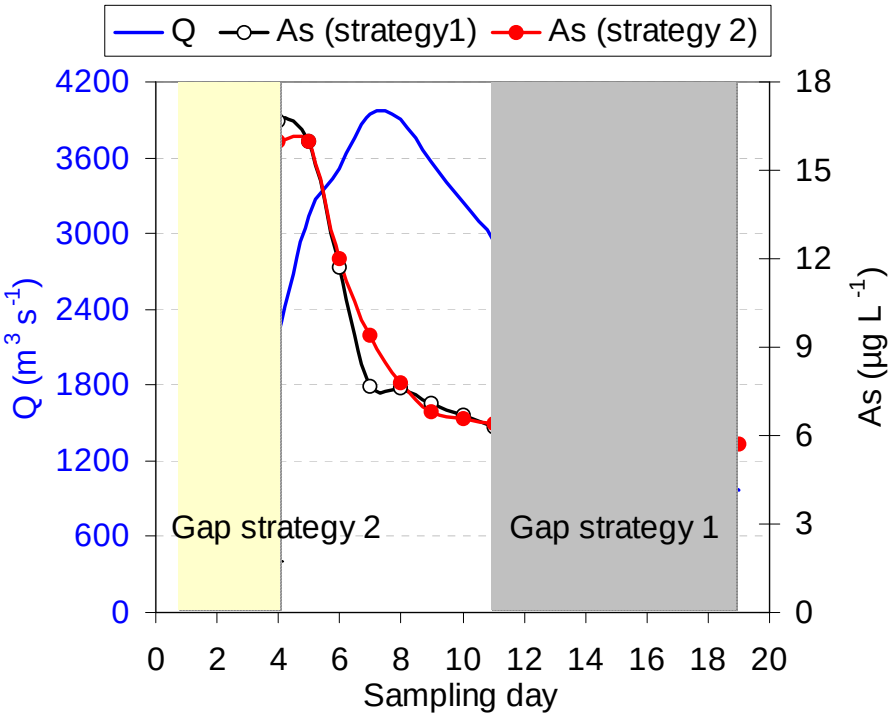
Missing the optimum starting point as well as the early stop of a sampling campaign

- can lead to wrong conclusions about the risk for water quality;
- can result in a significant underestimation of the pollutant loads transported during the flood.

Starting late adversely affected the results more than stopping early.

The duration of sampling should be agreed on between all actors and should cover the whole event.

Consequences of incomplete sampling

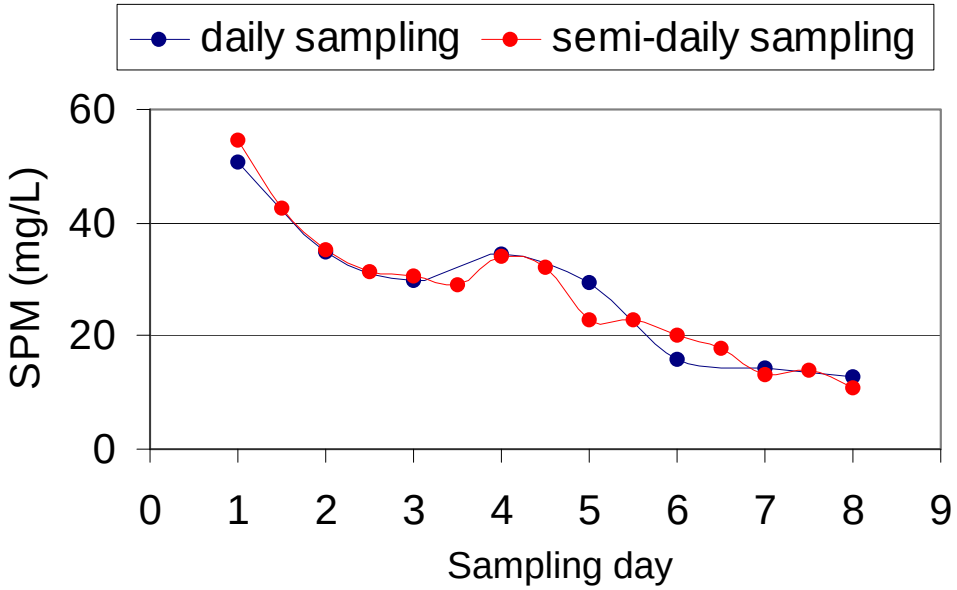


Discharge vs. Arsenic, km 318, August 2002

Calculated loads for different strategies in respect to load of the whole flood event (% underestimation)

Parameter	Strategy 2 late start (3 days)	Strategy 1 early end (7 days)
As	9	19
Cd	13	26
Cr	22	18
Cu	12	23
Hg	16	15
Ni	11	26
Pb	15	10
Zn	13	23

Sampling interval



SPM concentration at Elbe-km 318, summer flood 2002

- Results of daily and semi-daily samplings agreed very well
- For the River Elbe daily sampling is sufficient

Parameters and analytical methods

To compare results on river basin scale a harmonization of measurement parameters, sample preparation and analytical methods is required.

Whereas analytical methods agree well among each other, the methods of sample preparation are sometimes inconsistent.

E.g. inconsistent preparation methods which were applied to determine heavy metals caused deviations up to 25 % for the investigated metals.

Current state

The proposal for a tailor-made monitoring approach on river basin scale is in discussion in the River Basin Community Elbe (FGG).

It links new scientific findings to existing frameworks.

At the same time an information platform for hydrological extremes “Undine” has been developed by the Federal Institute of Hydrology.

„Undine“ information system

“Undine” is a holistic approach of an integrated information and documentation system and was developed because:

- During extreme events the public has a greater need for qualitative and quantitative hydrological information.
- The assessment and ranking of current extreme events depends on the comparison with past events.

„Undine“ information system

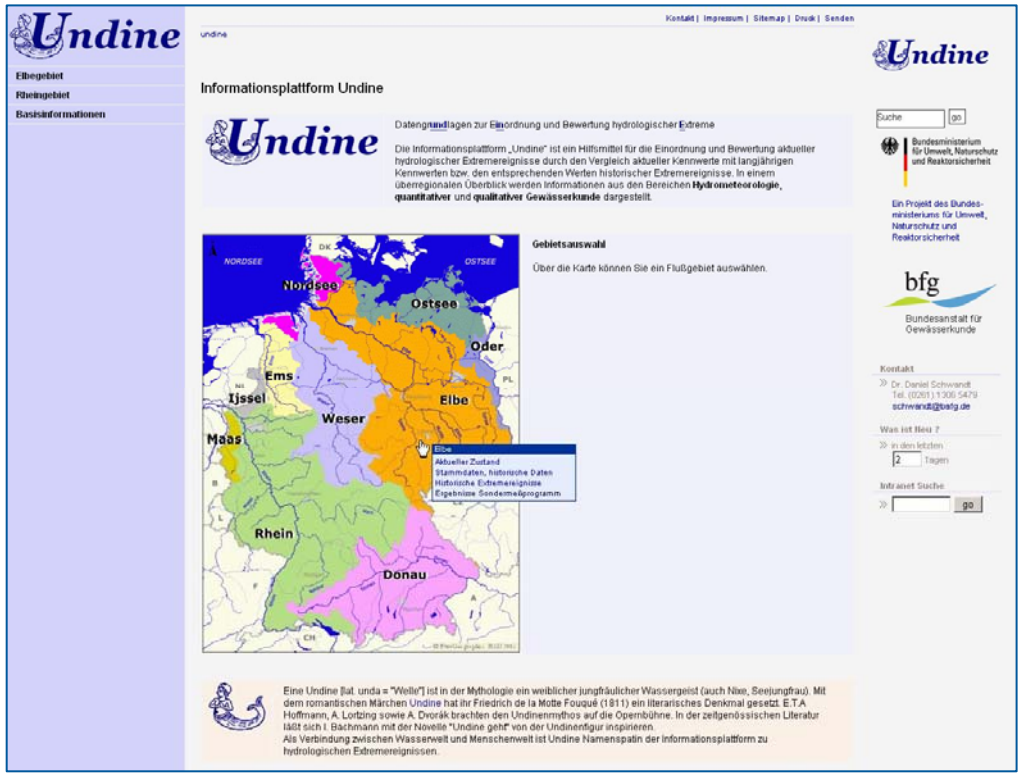
In agreement with the Federal State Authorities and other actors in the Elbe basin, “Undine” is the common tool

- to provide the results of the coordinated monitoring in time;
- to store them as source of information for events to come.

Thereby, for selected gauges and water quality monitoring stations the information is categorized into

- current hydro-meteorological status
- basic data and hydrological data
- compact descriptions of historical events

Welcome page of the Undine System



The internet platform provides the opportunity to integrate and disseminate the results of specific, event-related monitoring programs.

Outlook

Scale and frequency of hydrological extremes are likely to increase due to climate change.

Hence, in addition to socio-economic damage, the environmental consequences of hydrological extremes have to be considered in river-basin management plans.

Tailor-made monitoring strategies are essential to provide accurate information on the anticipated effects of climate change and to support long-term decision making.

Outlook

If the strong monitoring requirements discussed so far are related to the large number of parameters of the IKSE monitoring program, it becomes obviously that

not all parameters can be measured over the whole time of the extreme event on river basin scale.

For this reason event-related monitoring programs should base on few robust parameters which can be measured easily over a sufficient period at representative sites.

The challenge for scientists is to find out the best parameters with indicator function for river-relevant processes.

Thank you!

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