Water quality measurements at hydrological extremes in the lower Mulde River as a supportive decision making aid for the implementation of restoration measures

Photo: UFZ

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Introduction

Lower part of the Mulde River

Due to partly non-fixed riverbanks it can be described as near-natural river with

- dynamic flow conditions and complex patterns of biodiversity
- large range of temporal and spatial scales within the adjacent floodplains

But, because of the Mulde barrage upstream, the lower part of the river is subject to vertical erosion.

Also, the river and its floodplains are subject to historical contamination e.g. from chemical industries and mining.
Consequently, the following parameter are in the focus of the Sediment Management Concept of the River Basin Community Elbe (FGG Elbe):

- Organotin, HCH, HCB, Dioxines/Furanes and
- Cd, As, Zn, Hg, Cu, Pb

Introduction

Thus, the collaborative project ‘Wilde Mulde’ was started in December 2015

- with focus on the restoration of a riverine landscape at selected sites,
- in order to promote the interaction of the river with its adjacent floodplains

Within the project planned restoration measures:

- Re-connection of an old branch
- Establishment of hardwood forest
- Re-movement of riverbank fixation
- Deposition of river wood

Introduction

Interests of natural conservation, flood protection as well as prohibition of deterioration of water/sediment quality at downstream located river stretches has to be respected.

Therefore, the project consists of two parts

i. implementation of project objectives (coordination WWF)
   - planning, approval and execution of measures
   - environmental education
   - public relation

ii. coordination and evaluation of research activities (coordination UFZ)
   - hydraulics, hydro morphology (sediment budget)
   - matter budget (purification potential)
   - biodiversity
   - evaluation and synthesis of the results
   - ecosystem services

Consideration of interests and perspectives of the respective actors and stakeholder is the main challenge within the implementation of the project goals.

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Aim

By using BACI (before-after-control-impact) design, effects of the planned measures on water quality should be estimated.

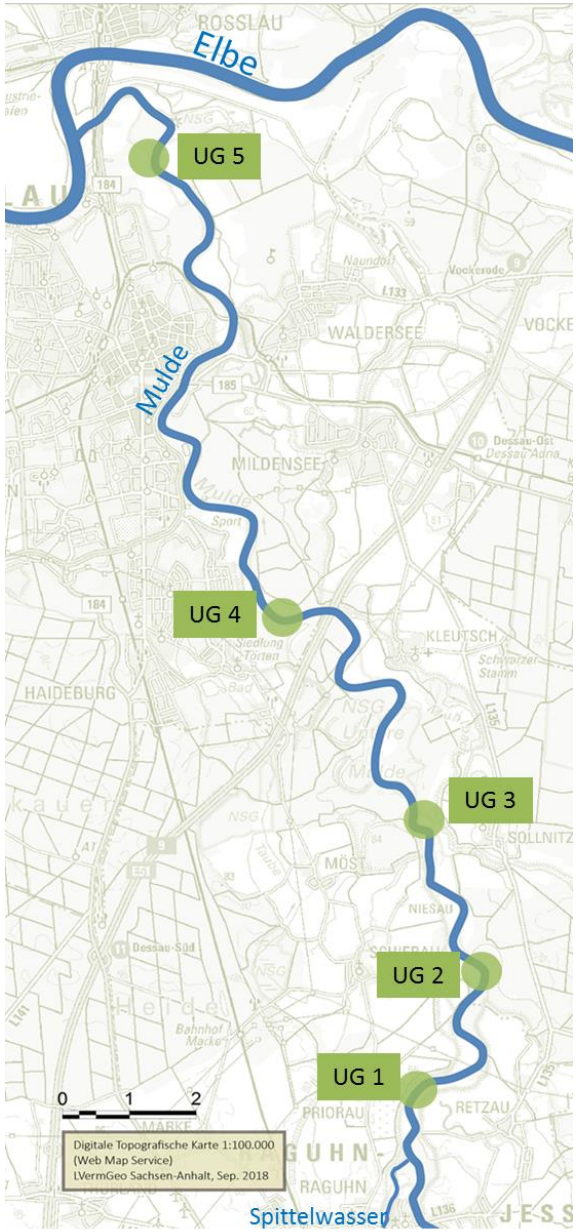
First status quo data for floodplains and sediments were collected.

Partially, local floodplain soils were distinctly polluted, esp. with As and Hg.

Hypothesis:
Information on local soil/sediment pollution alone
- does not provide complete insight into sediment transport process,
- does not allow the assessment of the subsequent risk for water ecosystem

Investigations on matter transport during hydrological extremes considering re-mobilization and retention of sediments are able to answer these questions.

Research area – Soil investigation



Analysis of soil profiles, floodplain surface soils and depositions on sediment traps (fraction < 2 mm)

UG5: Restoration site Jagdbrücke
(Old branche, river wood, hardwood forest)

UG4: Restoration site Törten
(River wood)

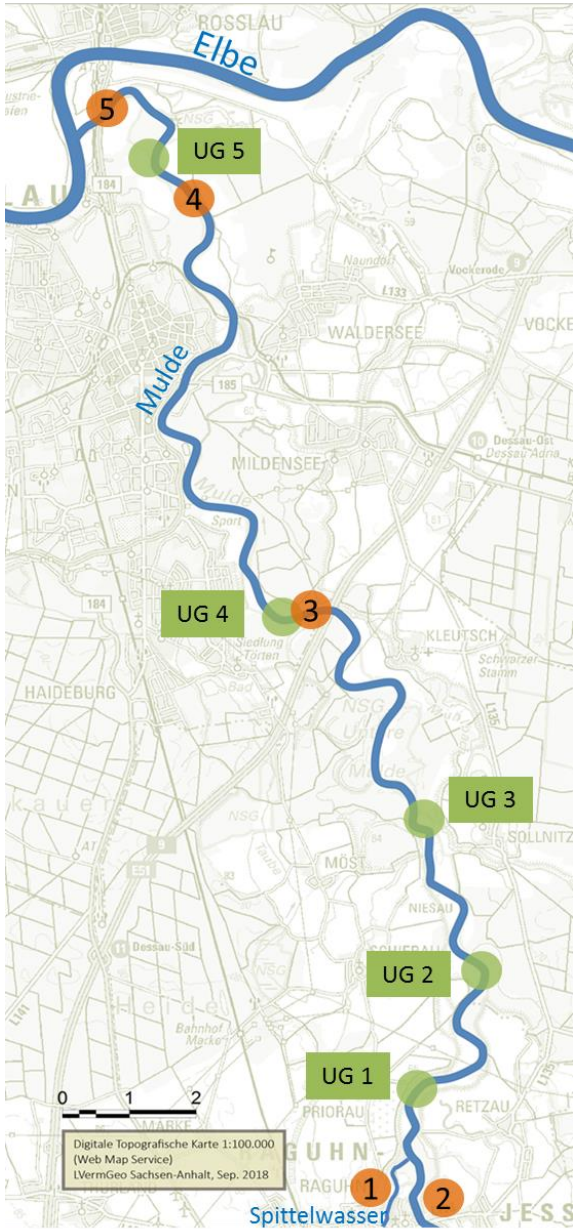
UG3: Reference site Möst
(Natural banks)

UG2: Restoration site Sollnitzer Stillinge
(Restoration of natural banks)

UG1: Reference site Priorau
(Fixed banks)

Quelle: wilde-mulde.de

Research area – Water sampling



Investigations at low and high water in 2017:

– five sampling sites, covering the entire project area
  1 Jessnitz/Spittelwasser
  2 Jessnitz/Mulde
  3 Törten/ Mulde
  4 Dessau/ Mulde
  5 Mulde mouth

- sampling over two weeks
- focus on un-filtrated and filtrated (< 0.45 µm) heavy metals, suspended particulate matter (SPM), nutrients and basic parameters

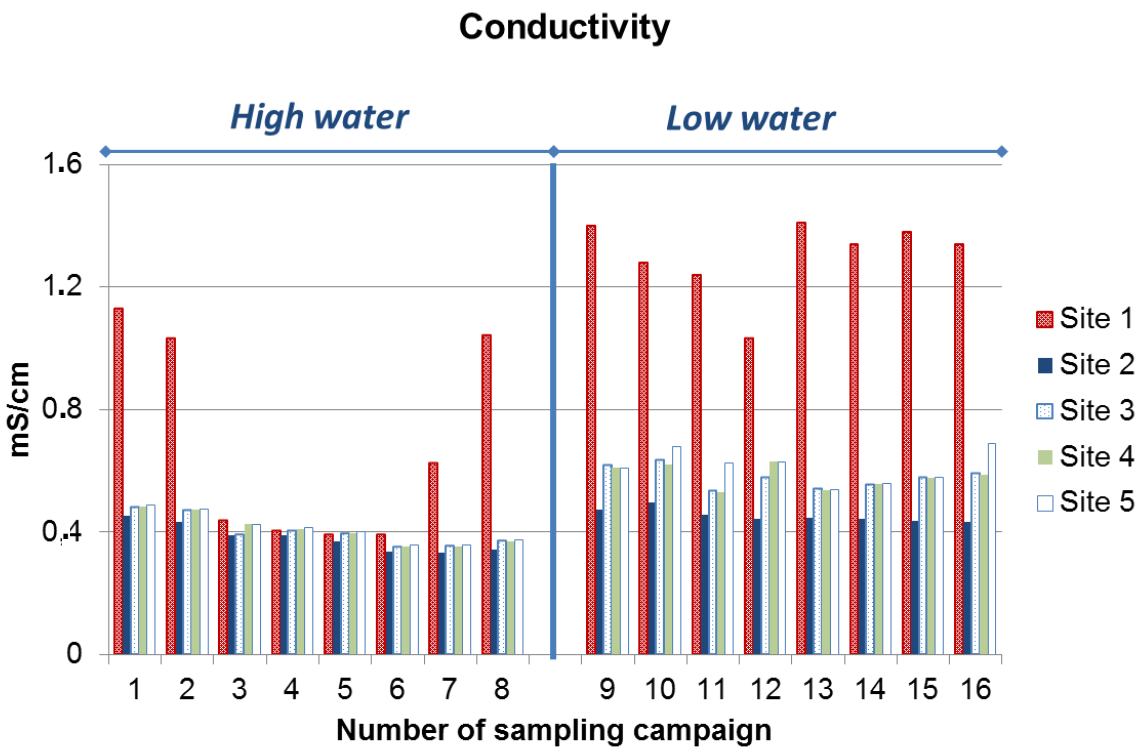
Q high water (23/2/17 to 1/3/17)*):
median (min/max) in m^3/s: 256 (175/367)
Q low water (8/8/17 to 31/8/17)*):
median (min/max) in m^3/s: 32 (15/63)
*)Gauge Priorau, preliminary values LHW

Hydrological numbers Priorau**):
MQ: 67 m^3/s, MHQ: 432 m^3/s, MNQ: 18 m^3/s
**) Schwandt (2018) personal message (Data basis LHW 1995 - 2016)

Quelle: wilde-mulde.de

Results of water sampling

Pathway and pattern (I)



- Dilution with increasing discharge
- Higher values at low water
- Similar behaviour: B, U

particularity site 1:

- lowest values of conductivity at high water
- lower values of U at low water

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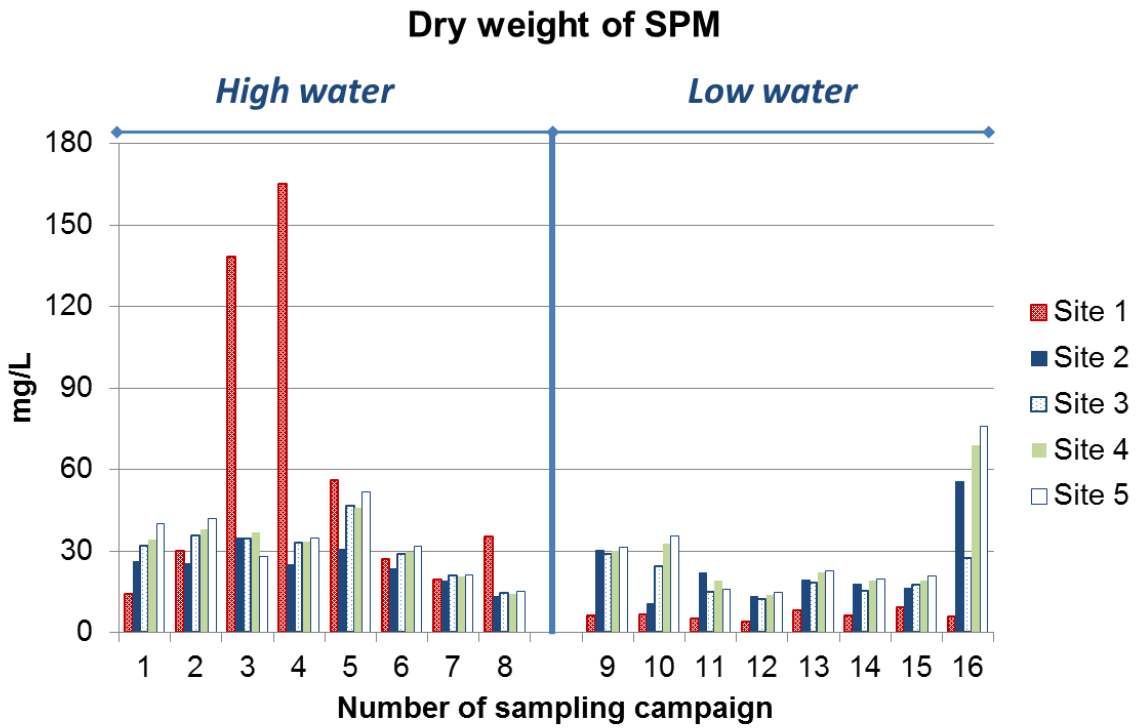
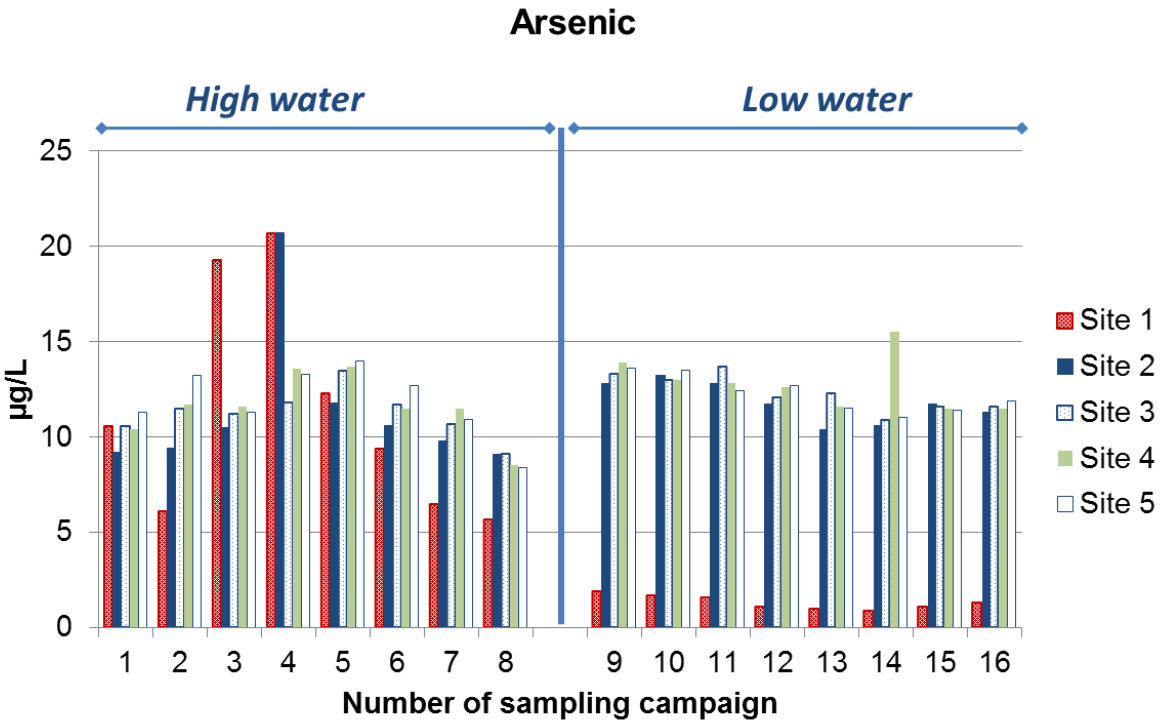
Pathway and pattern (II)



- Highest concentrations at high water
- Erosion of floodplain soil with increasing discharge (site 1)
- Rapid sedimentation of eroded matter during the event
- Similar behaviour of Al, Fe, Hg, Mn and Zn

Pathway and pattern (III)



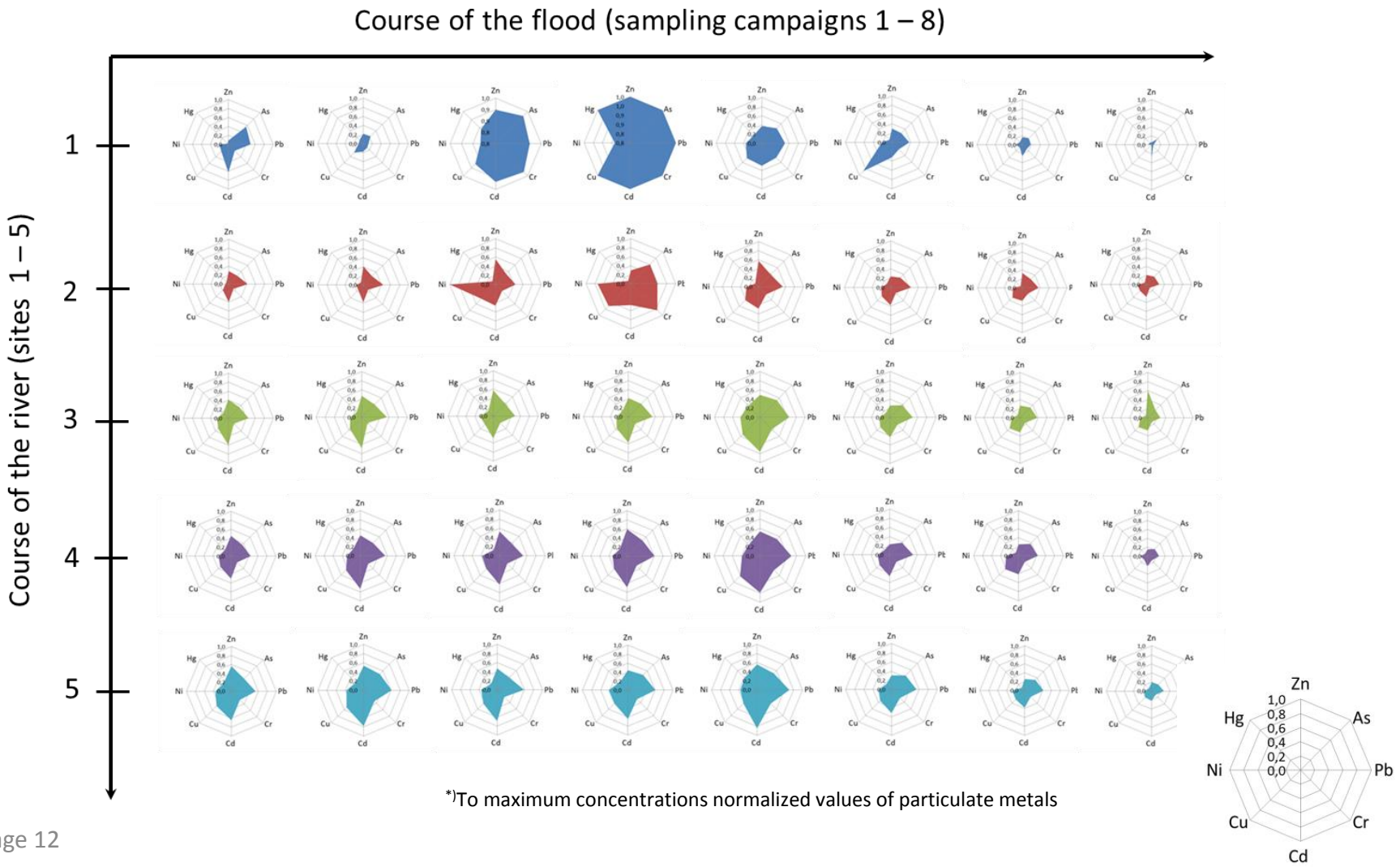
- Inputs from site 1 and site 2 at high water, rapidly decreasing
- Low concentrations at site 1 at low water (similar for Cr, Cu, Ni, Pb)
- Comparable fluctuating concentrations at the other sites at low water (due to geogenic background in the catchment)
- In contrast to As, lower values at low water also for the other sites for Cr, Cu, Ni and Pb

Summary of results

Concentration range of selected parameters, including all sites, 2017

Parameter	Unit	Flood			Low water		
		Minimum	Maximum	Median	Minimum	Maximum	Median
Al	µg/L	190	**6950**	1260	60	380	175
As	µg/L	5.7	**20.7**	11.3	0.9	15.5	12.1
B	µg/L	17	141	21.5	72	**391**	92
Cd	µg/L	0.3	**1.0**	0.7	0.1	0.3	0.2
Cu	µg/L	0.6	**17.3**	6.9	1.2	11.0	4.2
Fe	µg/L	670	**10600**	1360	60	510	240
Mn	µg/L	80	**390**	150	15	140	60
Hg	µg/L	0.005	**0.188**	0.027	0.004	0.020	0.012
Ni	µg/L	5.2	**15.3**	6.8	2.1	8.1	3.4
Pb	µg/L	1.2	**25.8**	13	0.3	4.8	2.0
U	µg/L	1.1	2.5	1.7	0.2	**3.4**	2.6
Zn	µg/L	46	**140**	95	10	45	25
SPM	mg/L	13.2	**165**	31.2	4.0	76.0	18.5
Conductivity	mS/cm	0.330	1.130	0.400	0.430	**1.410**	0.580

Pathways of pollution during the high water event*)



*)To maximum concentrations normalized values of particulate metals

Summary and discussion

- Increasing discharge led to dilution of components, mainly transported in dissolved form e. g. salts (conductivity), B and U.

  Concentrations of these elements were higher at low water in comparison to flood events, indicating a relatively constant pollution level in the lower Mulde River.

- Increasing discharge led to increased concentrations of particulate matter, mainly originated from re-suspended matter of floodplains upstream of the project area (sites 1 and 2)

  Concentrations of these elements were lower at low water compared to the investigated flood event.

Summary and discussion

- During flood temporarily elevated element concentrations (sites 1 and 2) decreased rapidly, immediately before entering the project area (sites 3 to 5).

  Pattern of element concentrations within the project area (sites 3 to 5) were comparable at each sampling day.

- Contrary to sites 1 and 2, concentrations at sites 3 to 5 were slightly increased before floodplain erosion occurs.

  Comparable pattern of sites 3 to 5 indicates either a steady and moderate erosion on the transport way through the project area or the transport of particulate matter of comparable, low settling velocity.

Conclusions

- Monitoring and calculation of sediment transport during flood and low water events can be used as a tool to estimate effects of the planned restoration measures on the amounts of matter that possibly will be transported downstream.

- Results of the investigated low water period can be used to evaluate the results of the flood investigations.

- From the assessment of both investigations in 2017, no restrictions regarding the planned restoration measures can be derived.

- The application of the BACI design also on water investigations during hydrological extremes to control the effect of measures is highly recommended.

Thank you for your attention!

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Photo: UFZ

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