ELSA

Schadstoffsanierung Elbsedimente

# Side Structures along the Elbe
# - the local and regional risk from sediments -

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# What are „side structures“ of the Elbe?

*Side structures are water bodies that have no or restricted connection to the major river, but which can be flooded under elevated discharge situations and potentially exchange sediment with the river.*

Such as:

- Small harbours
- Floodplain lakes, formed during high water situations
- Remains of the former Elbe bed such as oxbow lakes, („Altarms“, Altwässer)

# Relevance of side structures for the Elbe?

>1000 side structures in the non-tidal area of the German part of the river

➢1/3 of these: longer than 500 m long

➢Total surface of side structures (> 500 m length): 30,6 $km^2$

Relevance: Sinks for historic contaminated sediment?

Assumption:

Upper 30 cm of sediment are contaminated → 9 mio $m^3$

But is it also a „source“?

Can material be resuspended and e.g. be transported towards the Elbe river?

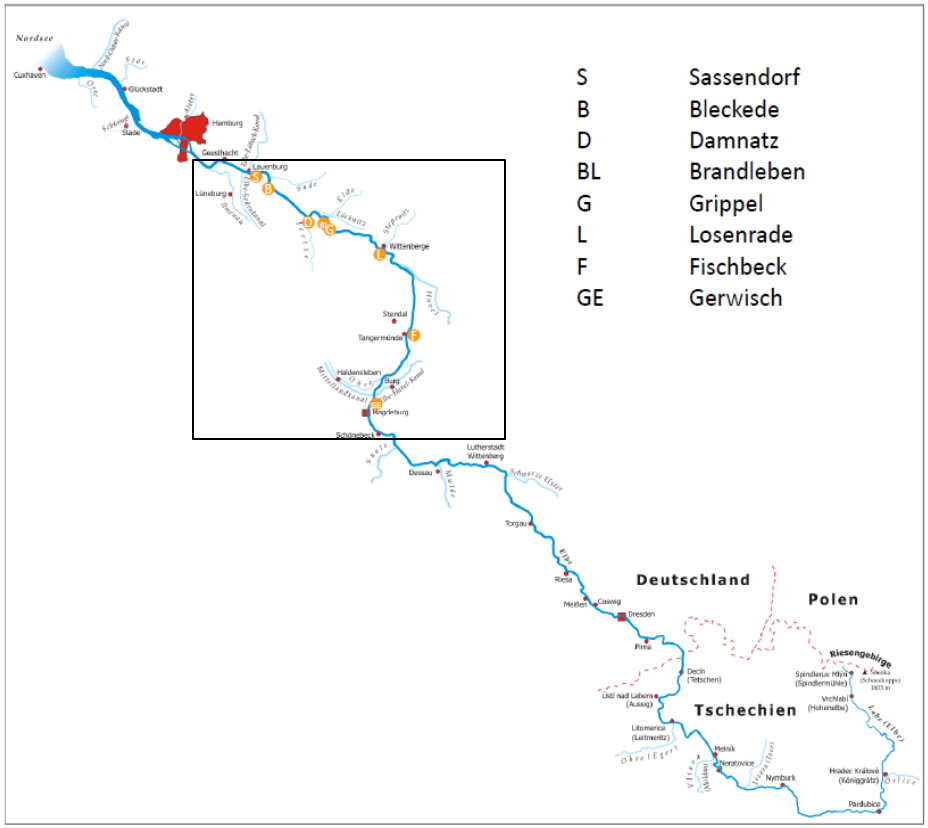
# Aim of this research

- Evaluation of potential risk of selected side structures for the Elbe River
- Identification of parameters that are correlated with this risk (location of s.s. in the flood plain, frequency of flooding etc)
- On that basis: formulating assumptions on how many of the existing side structures in the Elbe River present a risk
- Delivery of this information to the International Commission of the Protection of the Elbe (IKSE)

→ sediment management plan for the Elbe

# Investigated sites

Lage der Probenahmeareale im Elbeeinzugsgebiet






Elbe-km 340 - 569
15 side structures in 7 areas,
on average 2 side-structures sampled per area
2 – 3 locations per side structure

# Conceptual approach

- **Investigation of 15 side structures**, comprising the following information:

  Erodibility of surface sediment

  Eroded mass at over-critical shear stress

  Depth of sediment layer

  Chemical contamination

  (Ecotoxicological effects)

# The investigation in detail

On site measurement of erosion stability

Transport to the lab to determine mass erosion at high shear stress (worst case)

Microtox test (methanol extract)

Fluffy layer
0-1,5
3-4,5
6-7,5
9-10,5

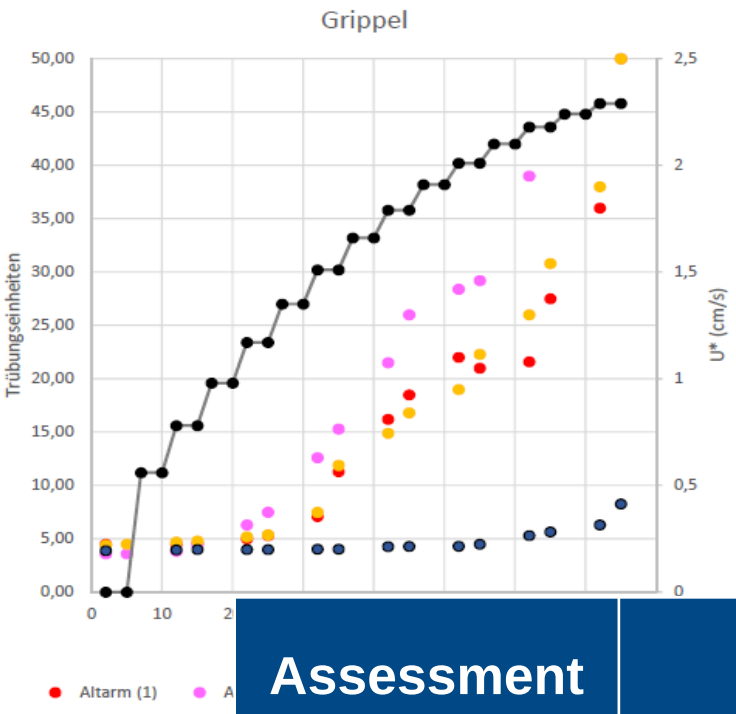
0-10 cm

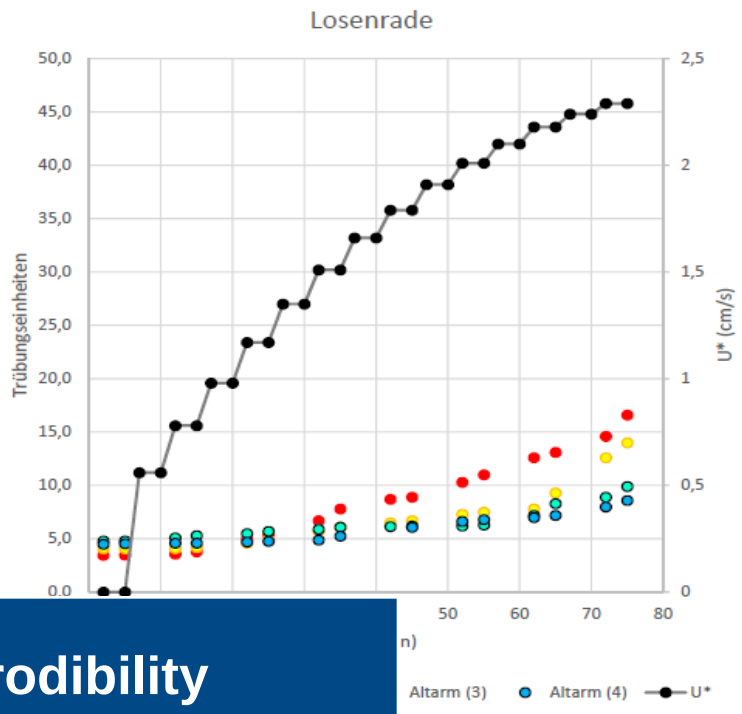
10-20 cm

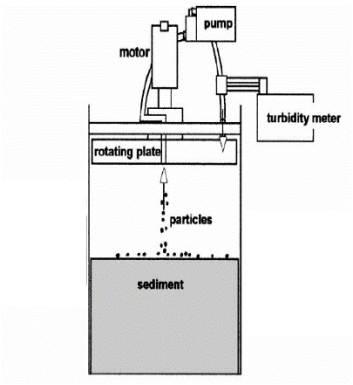
Analysis of historic substances (HM, HCB, PAH, PCB)

Deep sample with peat corer

# Classification of erosion results



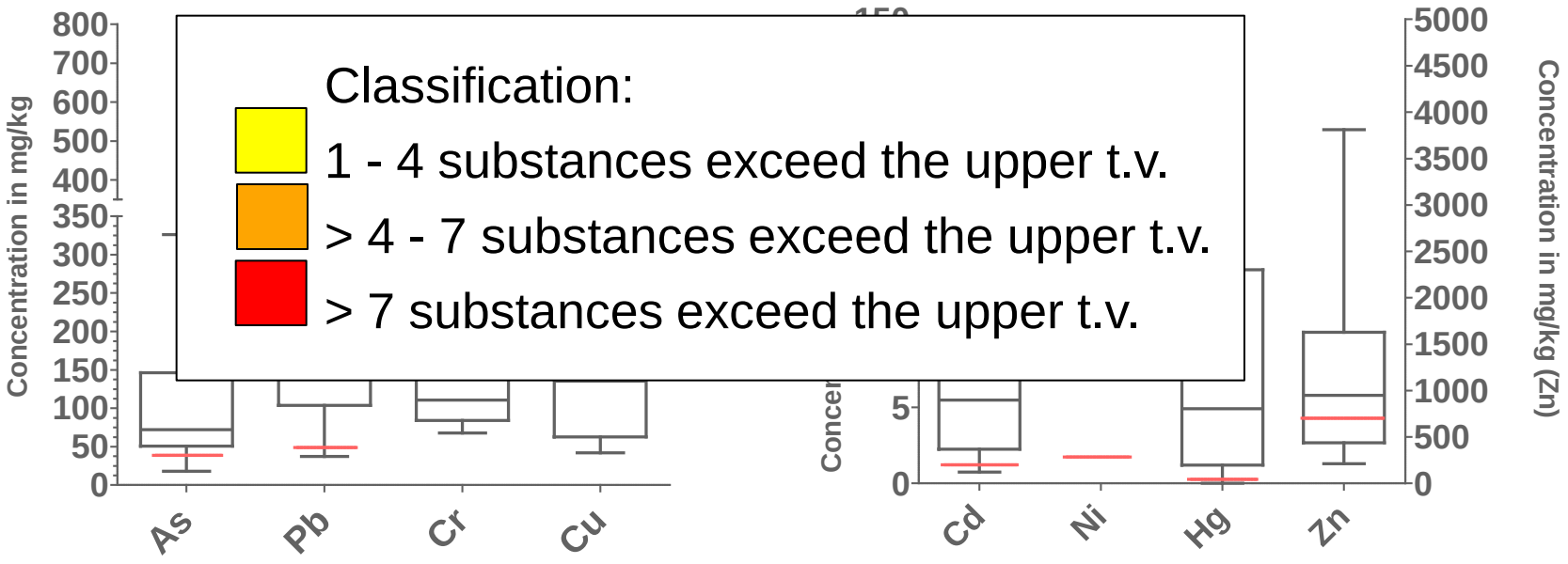

| Assessment | Erodibility |
|---|---|
| | high $u_{crit}$ (>2 cm/s), low mass erosion |
| | medium $u_{crit}$ (1 to 2 cm/s), moderate mass erosion |
| | low $u_{crit}$ (<1 cm/s), high mass erosion |

# Classification of contamination (acc. to IKSE)

Upper Threshold: corresponds to EQS for sediments

Range of contaminant concentration in 90 sediment samples in relation to the IKSE classification:

e.g. METALS




More than 75 % of sediment samples from 15 side structures exceeded the upper threshold value of As,Pb, Ni, Cd, Hg, p,p DDD

# Categorization of sediment depth

Sediment layer as measured by a sediment level stave

Considered as potentially resuspendible:

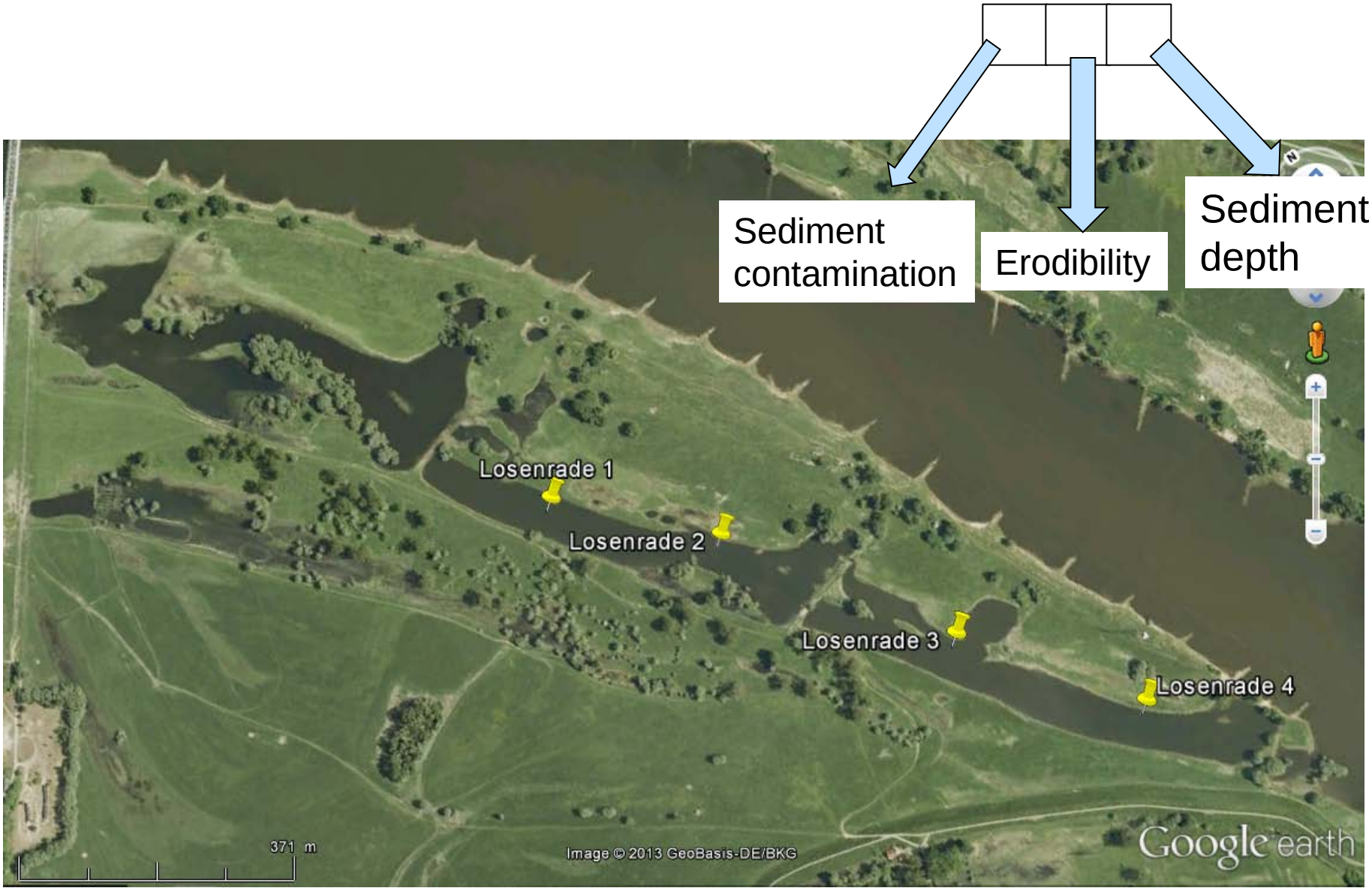
Categorization:

**thin sediment layer**: < 20 cm

**Medium sediment layer**: 20-50 cm

**Thick sediment layer:** > 50 cm

# Visualization of results: Side structure at Losenrade



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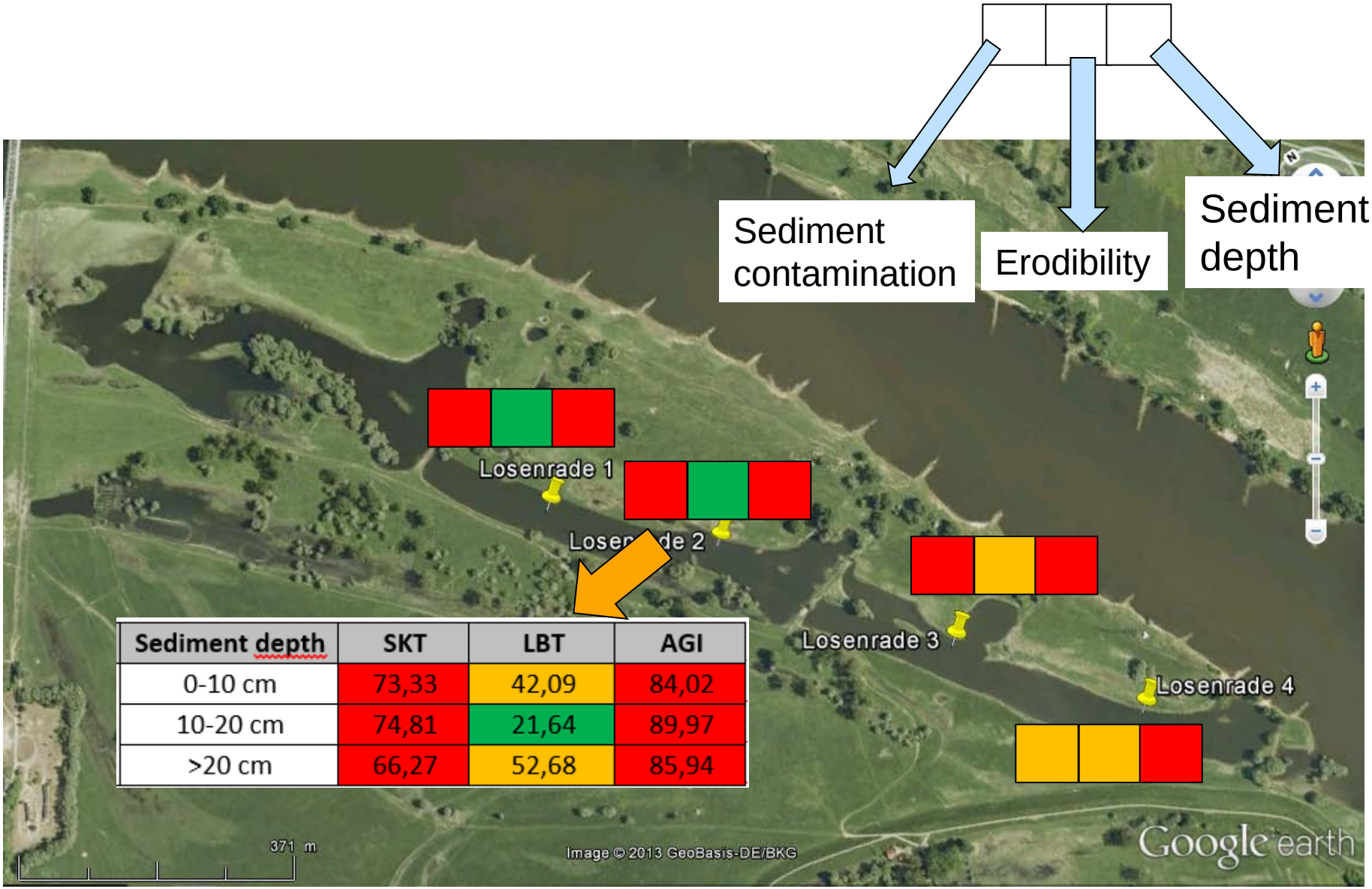
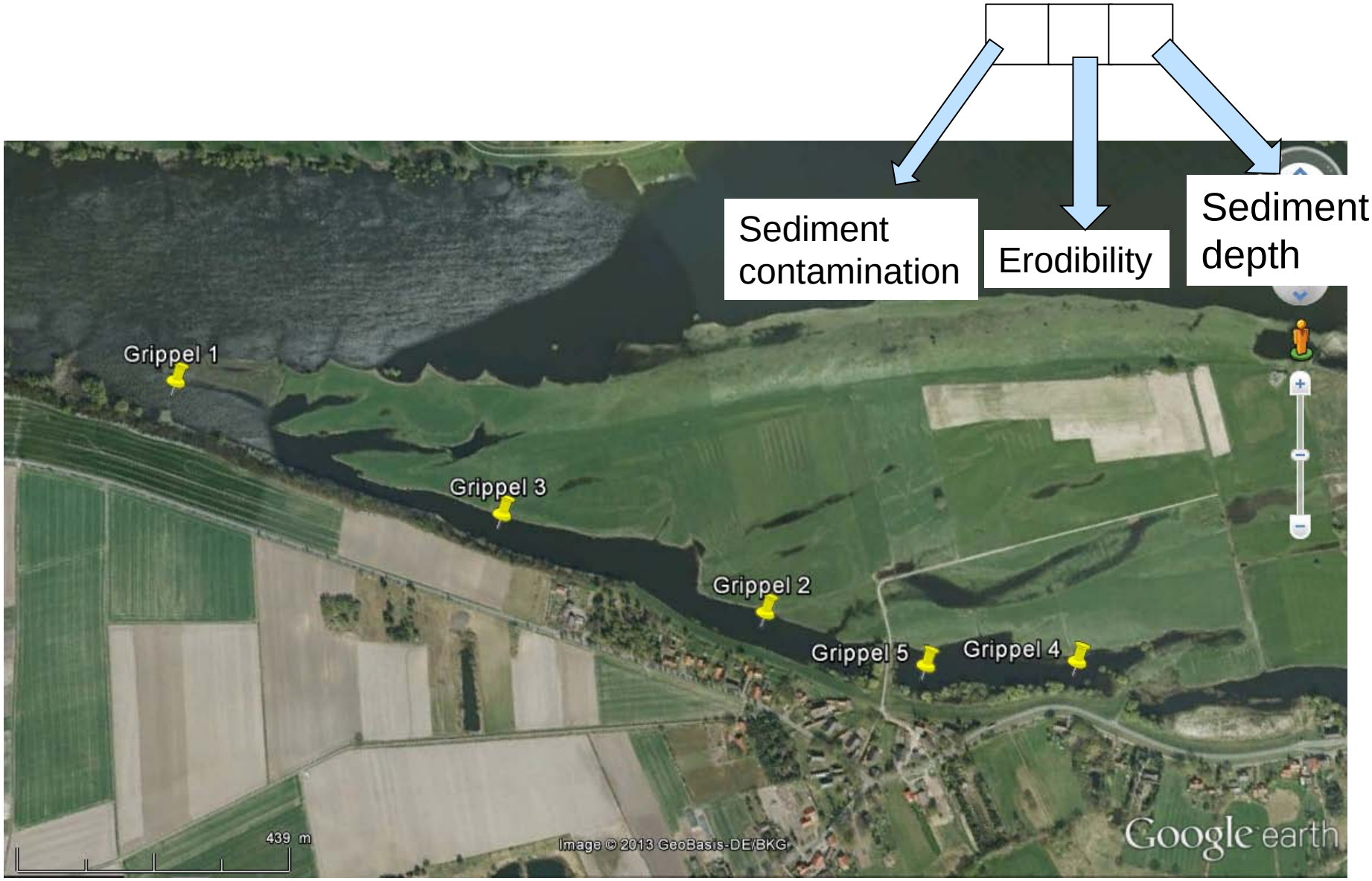


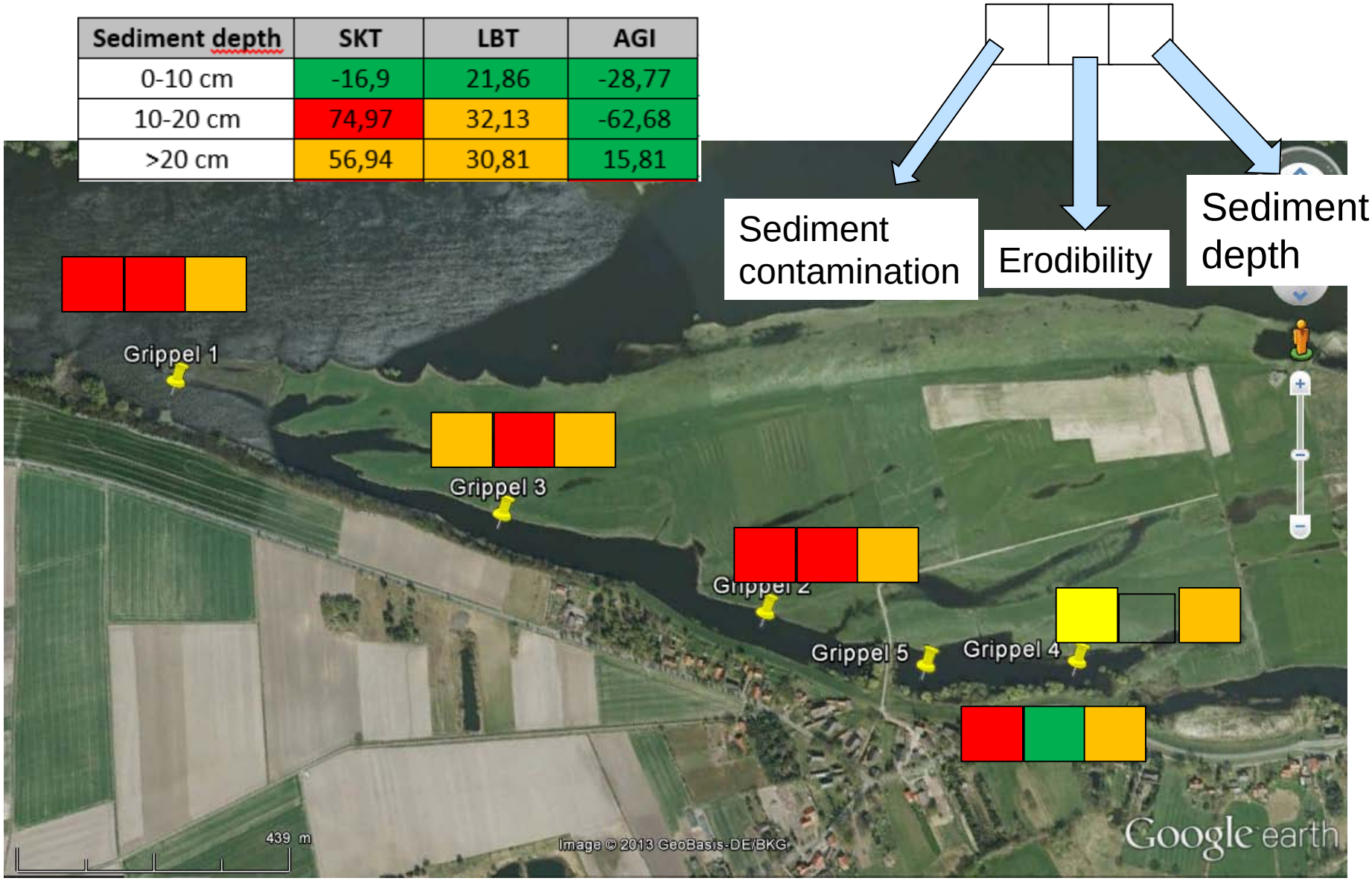

| Sediment depth | SKT | LBT | AGI |
|---|---|---|---|
| 0-10 cm | 73,33 | 42,09 | 84,02 |
| 10-20 cm | 74,81 | 21,64 | 89,97 |
| >20 cm | 66,27 | 52,68 | 85,94 |

# Example: Side structure at Grippel

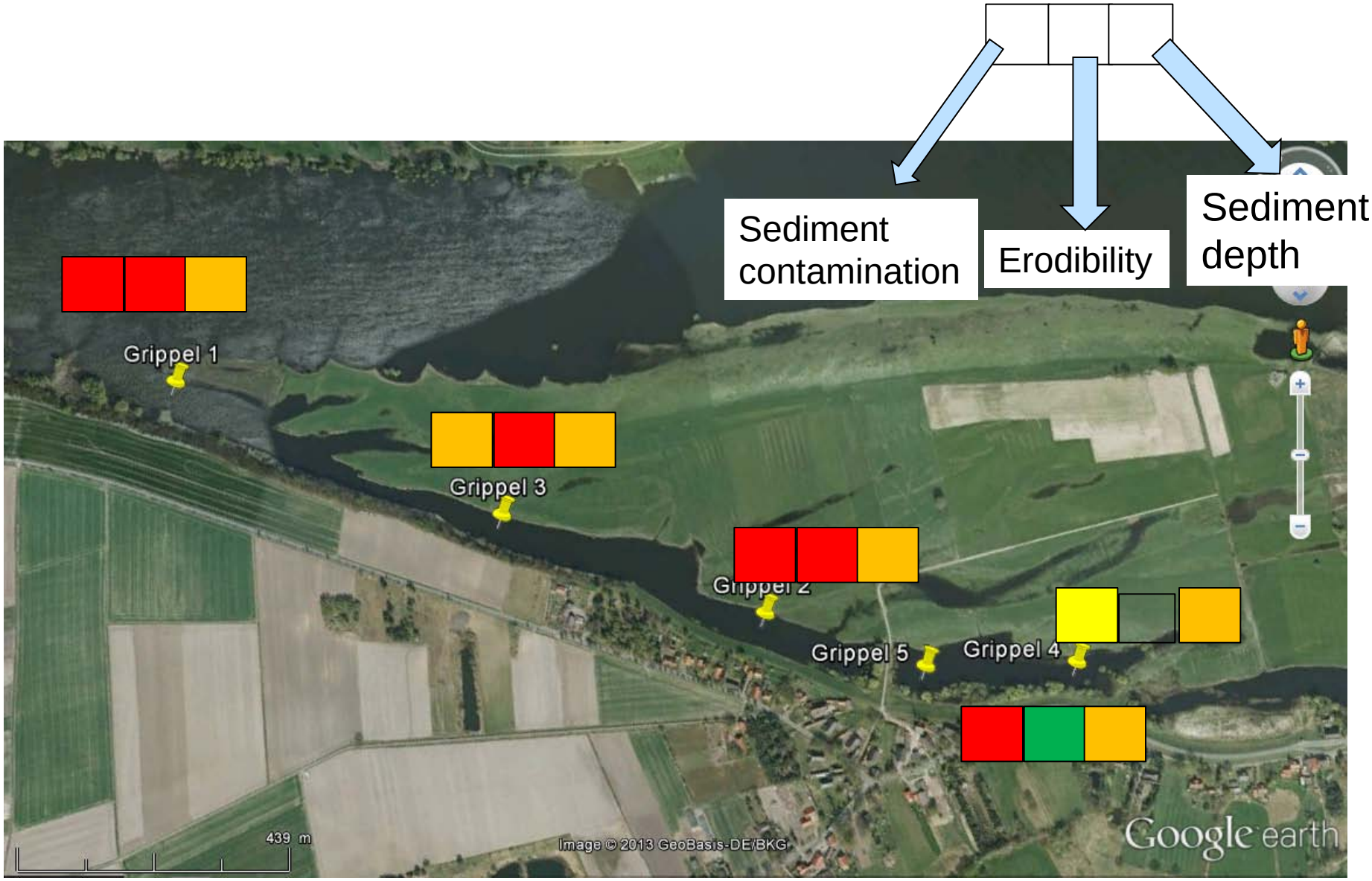


# Visualization of results: Side structure at Grippel

| Sediment depth | SKT | LBT | AGI |
|---|---|---|---|
| 0-10 cm | -16,9 | 21,86 | -28,77 |
| 10-20 cm | 74,97 | 32,13 | -62,68 |
| >20 cm | 56,94 | 30,81 | 15,81 |



# Integrating Results



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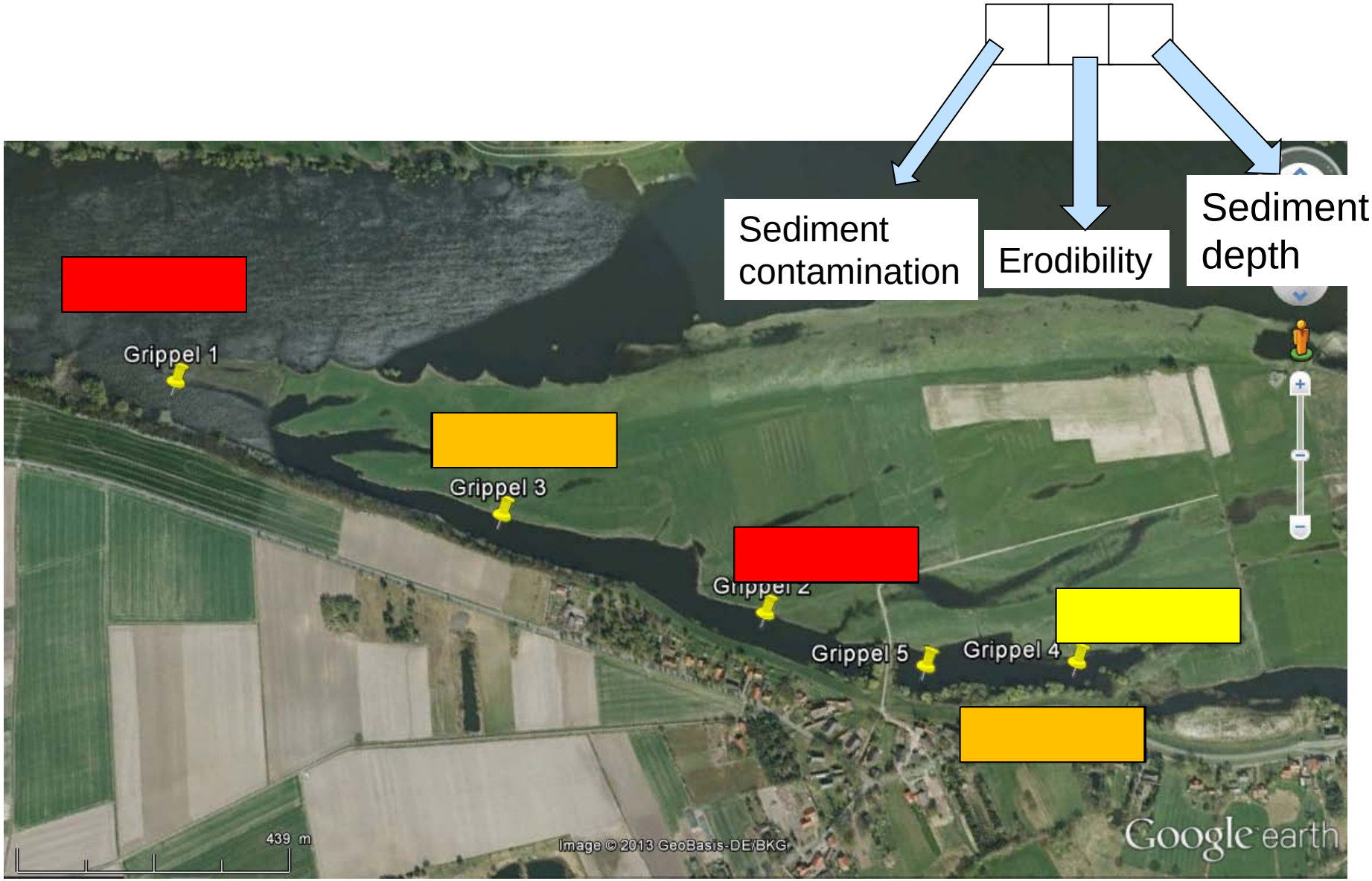
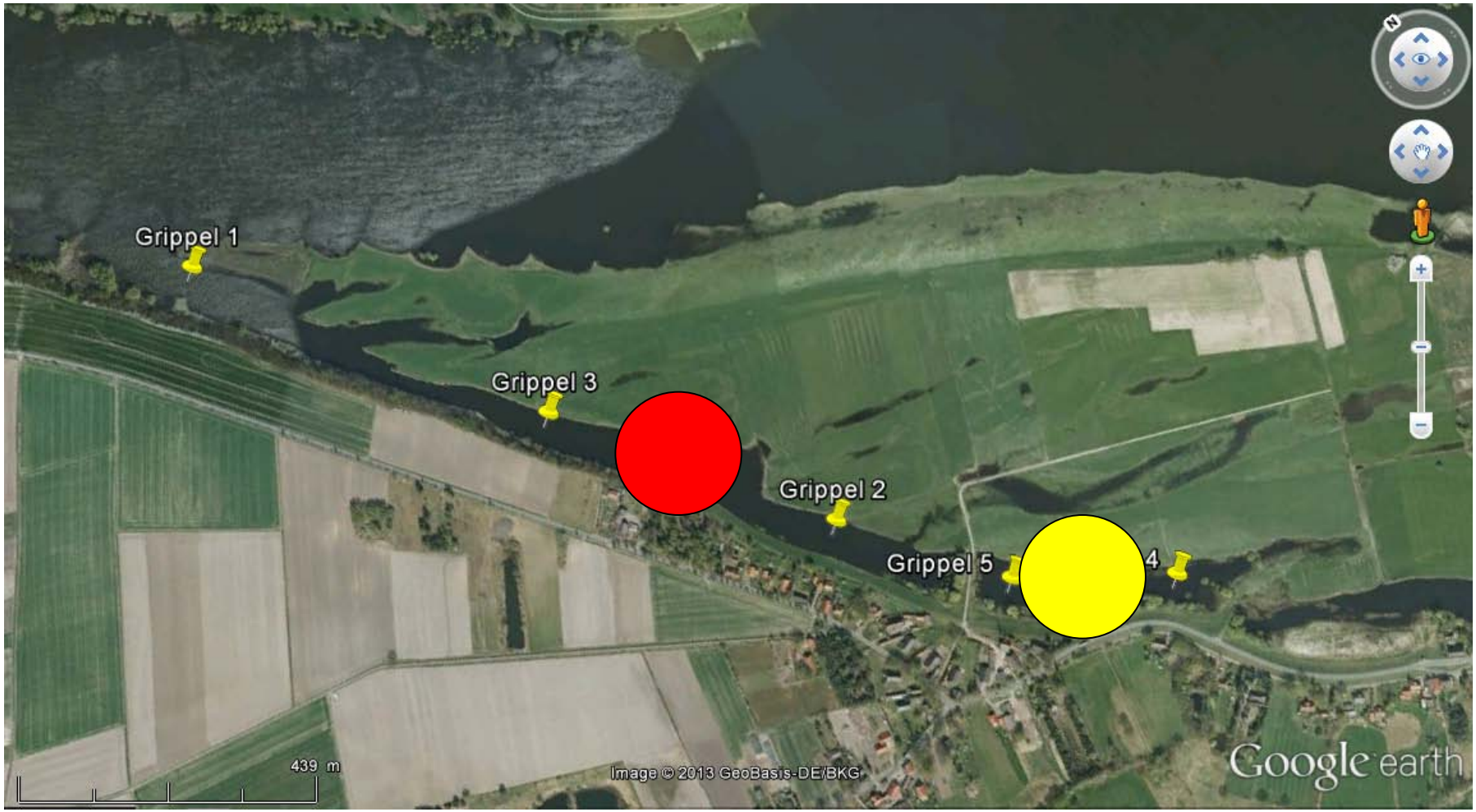
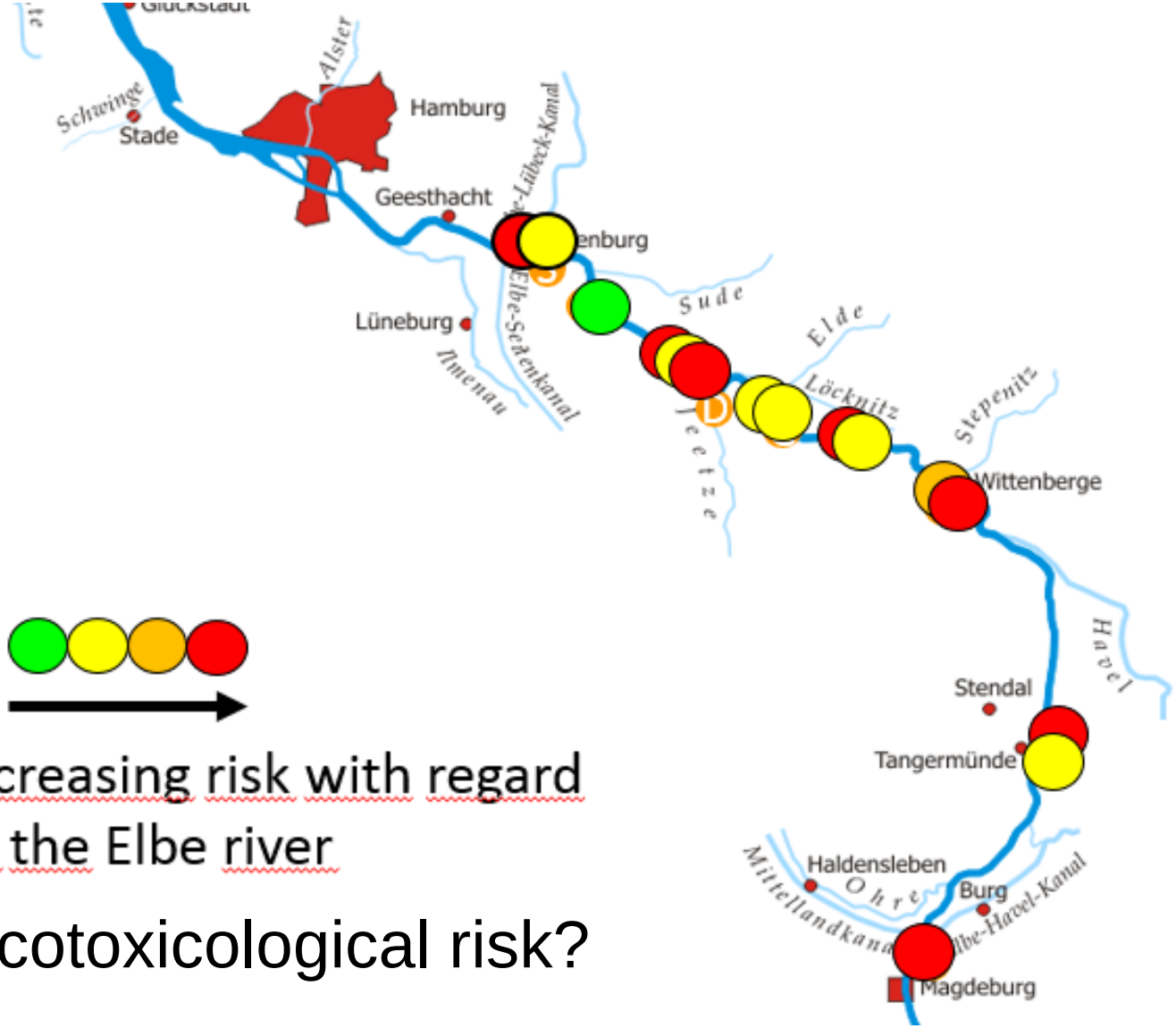


# Results: Side structure at Grippel



# Overview: Risk potential at side structures




Increasing risk with regard to the Elbe river

Ecotoxicological risk?

# Local risks due to side structures?

All side structures are intensively used by locals for fishing!

BUT

- Sediments are partly highly contaminated and partly toxic
- Bioaccumulative substances can reach high concentrations:

p,p-DDD  up to 1300 µg/kg
Hg: up to 61 mg/kg
Cd: up to 39 mg/kg

Foto: umweltplanung.pr-naturtours.de

**Inventory of side structures (and impact on fish) is necessary**

# Conclusions

- Many side structures pose a potential risk for the Elbe River quality during high water events as they are contaminated and form a thick layer which is at least at the surface erodible.
- During average water discharge, sediment from these sites are likely to present a local risk to the environment and to humans, as
- bioaccumulative substances (p,p-DDD, Hg, Cd) partly show very high concentrations

- Clear need to inform the local population about the situation

→ Monitoring of fish (carp, eel) advised.

# Thanks for your attention

Susanne Heise
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And thanks to the people who helped durng sampling surveys
Nadine Heuer
Andreas Zipperle
Henning Tien
Henning Herrmann
Sascha Seemann
Stanislav Taran
Oleg Ernst

**And thanks to ELSA for funding**

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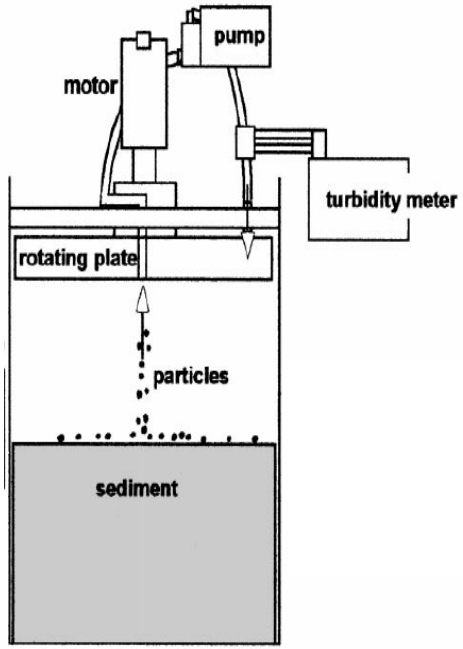
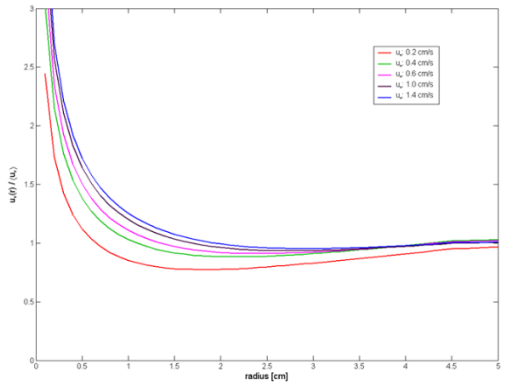
# Principles of the measurement of erosion stability using the microcosm from Gust



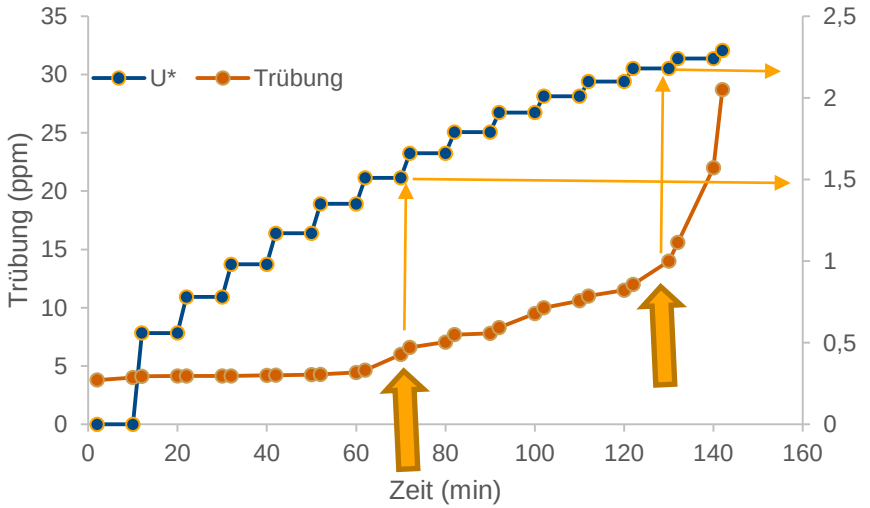

From Thomsen & Gust, 2000, modified



Radial distribution of friction velocity

Mobile microcosm set up

Principle:
stepwise increase of shear stress,
Monitoring of turbidity




$U_{crit\ 2}$

$U_{crit\ 1}$

# Categorization due to erodibility

| | | Erosion threshold at surface ($u^*_{crit\ 2}$) | | |
|---|---|---|---|---|
| | | < 1 cm/s | 1-2 cm/s | > 2 cm/s |
| **Mass eroded** | Low (< 1g/h) | 2 | 2 | 1 |
| | Medium (1-2 g/h) | 3 | 3 | 2 |
| | High (>2 g/h) | 4 | 4 | 3 |

More than 2,3 cm/s:
Erosion risk: 0?

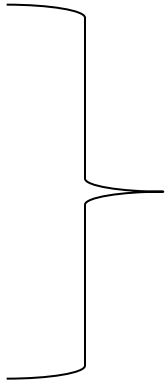
# Integration of data

Contamination

Erodibility

Depth of the sediment layer

(Ecotoxicity)



RISK?

| Assessment | Contamination | Erodibility | Sediment layer |
|---|---|---|---|
| | low | low (>2 cm/s) | mostly < 20 cm |
| | moderate | | mostly 20 to 50 cm |
| | elevated | medium (1 to 2 cm/s) | |
| | high | high (>2 cm/s) | mostly > 50 cm |