Between floodplain soil and river bed

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linking results from innovative non-invasive PCDD/F mapping to particle bound mass flux data

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SedNet Conference 2017
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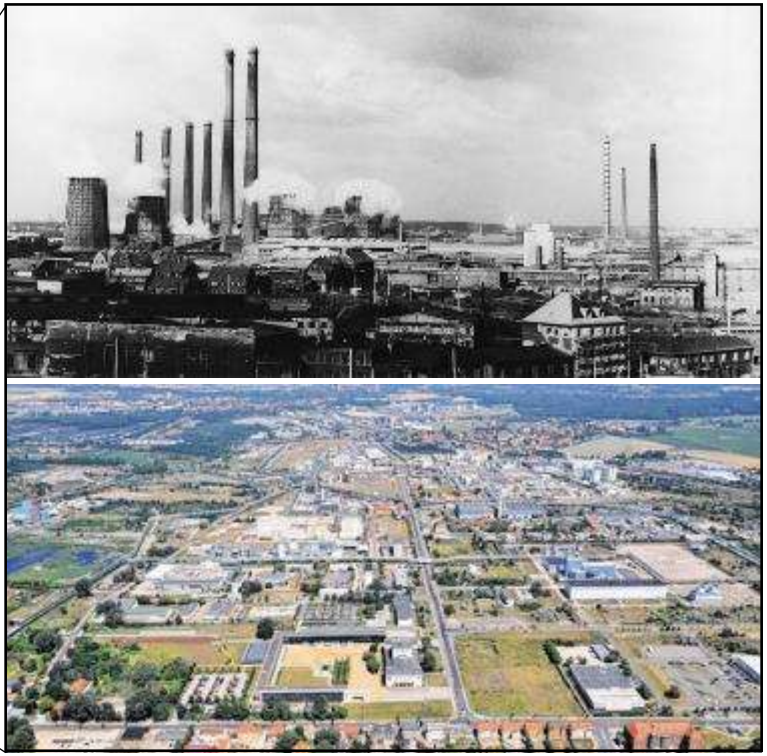
SedNet

Spittelwasser creek and its history

- **Receiving water course of the Bitterfeld-Wolfen industrial complex.**
- **One of the world's oldest complex chemical production sites.**
- **Dioxins released from *Mg* production from early 1930ies to 1945.**



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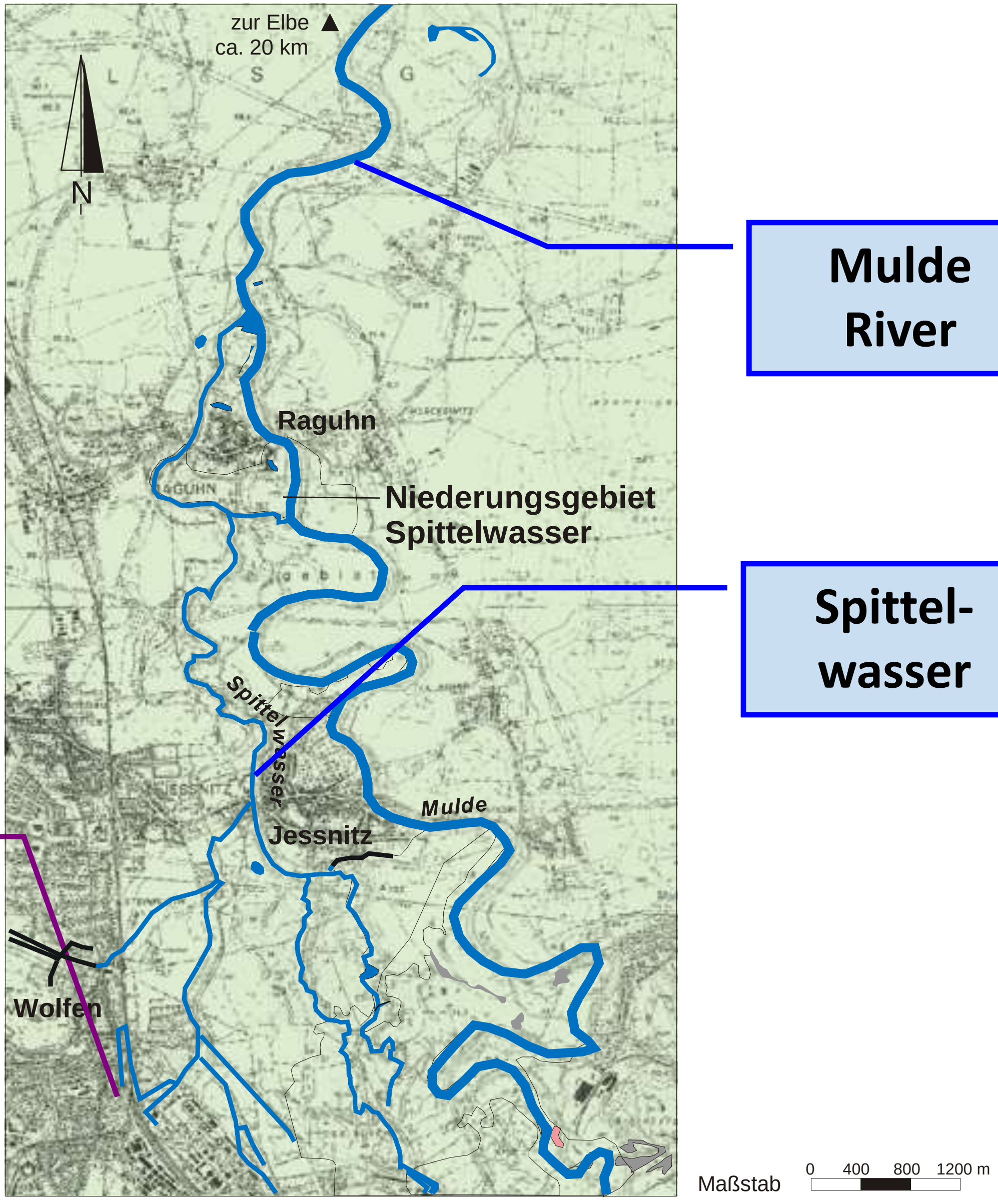
Spittelwasser creek



Mulde River

Spittel-wasser

Bitterfeld-Wolfen industrial complex

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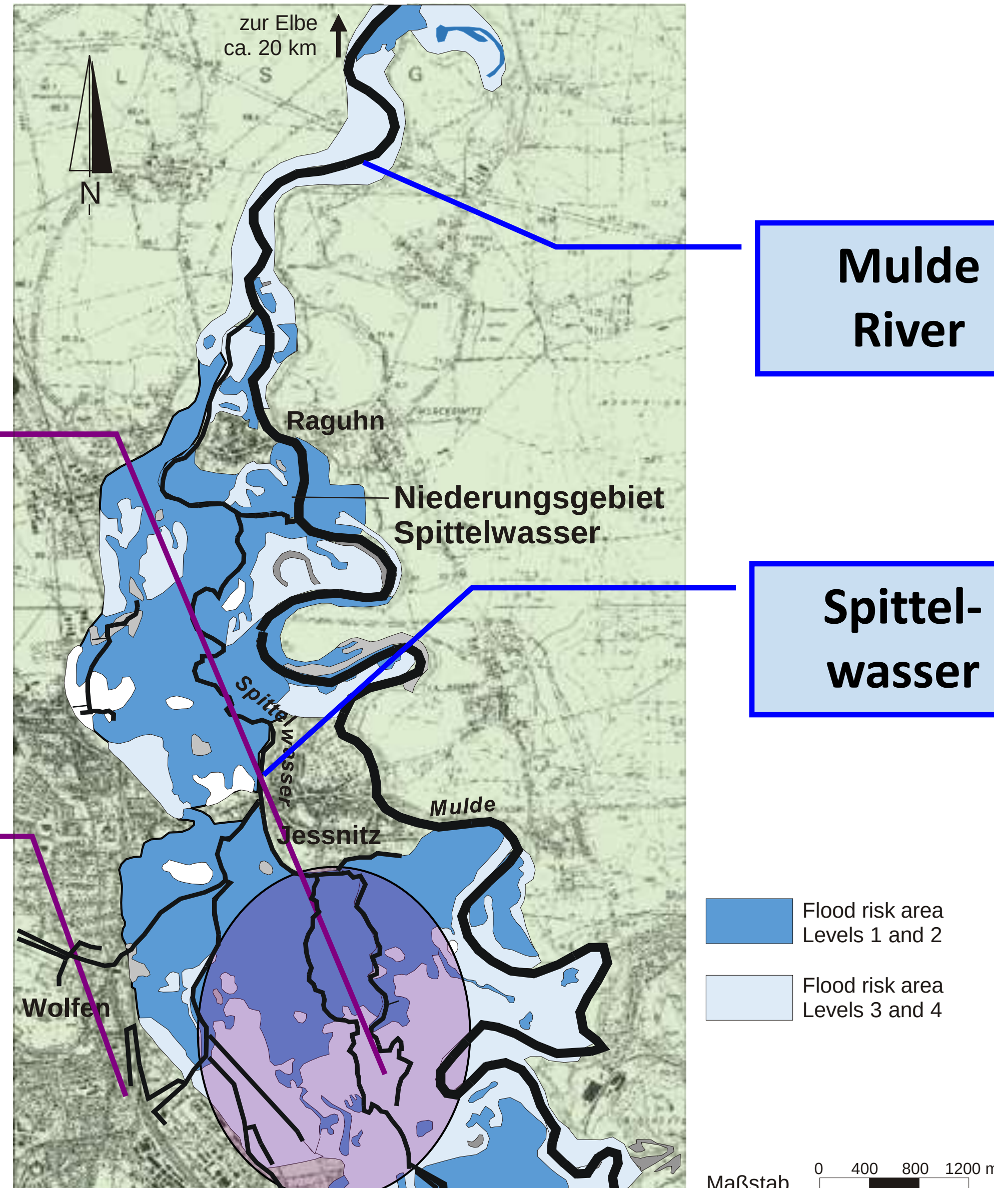
Spittelwasser creek

Areas used in the past for waste water stacking during flood

Bitterfeld-Wolfen industrial complex



Mulde River

Spittel-wasser

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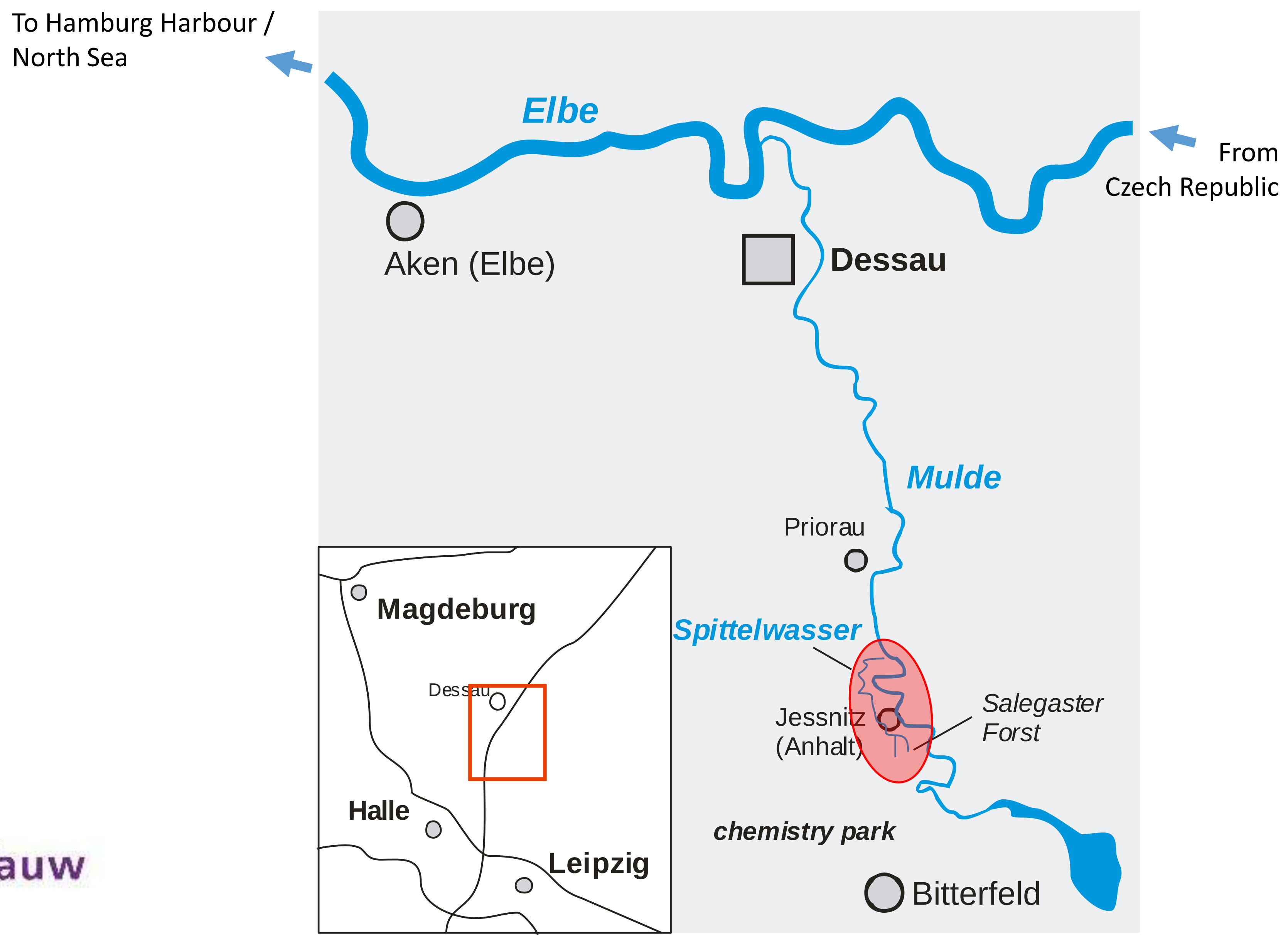
Spittelwasser creek its floodplain in the Elbe River Basin



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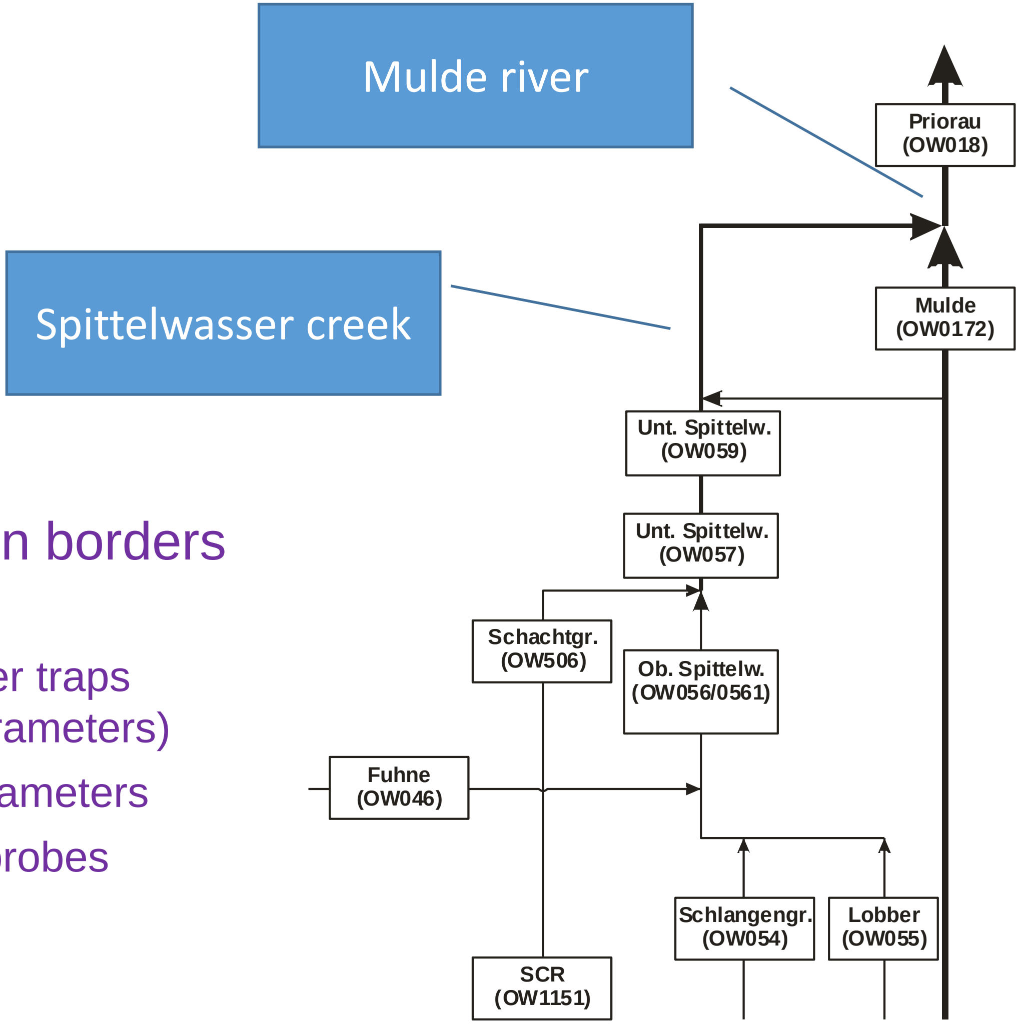
PCDD/F loads in river sections



1 year monitoring:

- Monitoring at section borders
  - discharge rates
  - suspended matter traps (contaminant parameters)
  - water quality parameters
  - multiparameter probes

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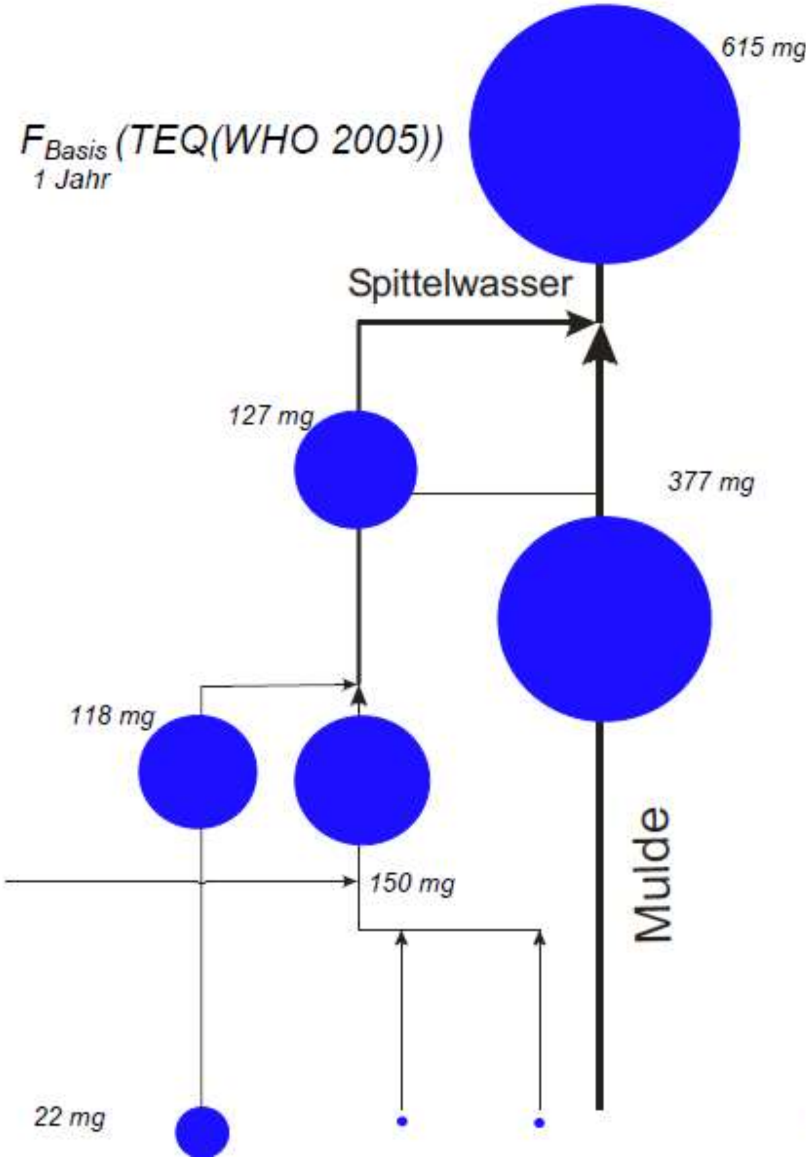
PCDD/F loads in river sections

<u>Monitoring results:</u>

- High background load of Mulde river!
- Low input from industrial site
- Very low input from upstream tributaries to the Spittelwasser creek

<u>Conclusion:</u>

- Dominant input from sediment and/or floodplain soils!



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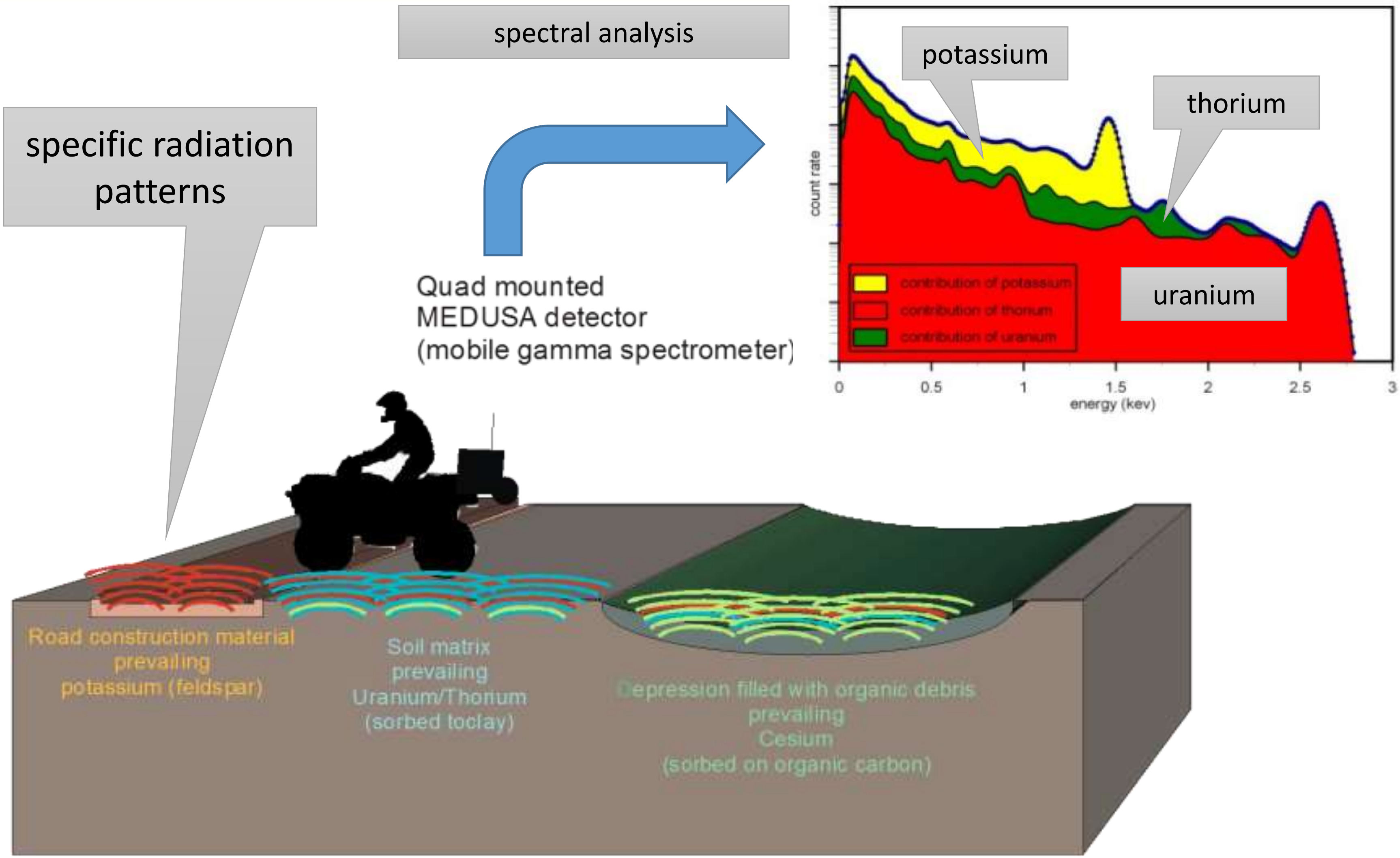
Methods: gammaspectrometric investigation of floodplain soils



Contaminant concentrations from gamma-ray measurements in floodplain soils

Working hypothesis for the Spittelwasser floodplain

- pollutants bound to (fine) sediment particles and deposited during flood events.
- Radionuclides directly related to the soil matrix composition (Th, U and K) and/or adsorbed onto the fine or organic sediments (U and Cs)
- The sediment-genetic background is the same throughout the entire survey area.

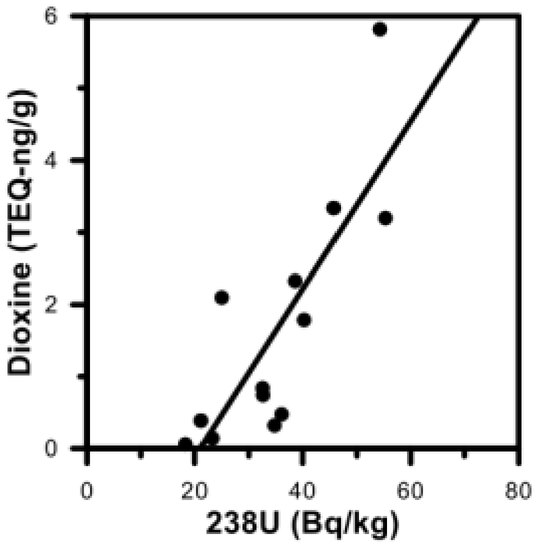
→ If correlation between (A) target parameter for this area and (B) concentration of radionuclides, then proxy for efficiently mapping the dispersal of the pollutants.

Soil samples measured for

- Target parameters
  - Grain size properties, TOC
  - Dioxins, pesticides, organo tin compounds
- Concentrations of radionuclides

Data analysis

- Significant correlations between dioxins, pesticides, and tributyltin vs. radionuclides
- In this area, radionuclides can be used as a proxy for contaminant dispersal!



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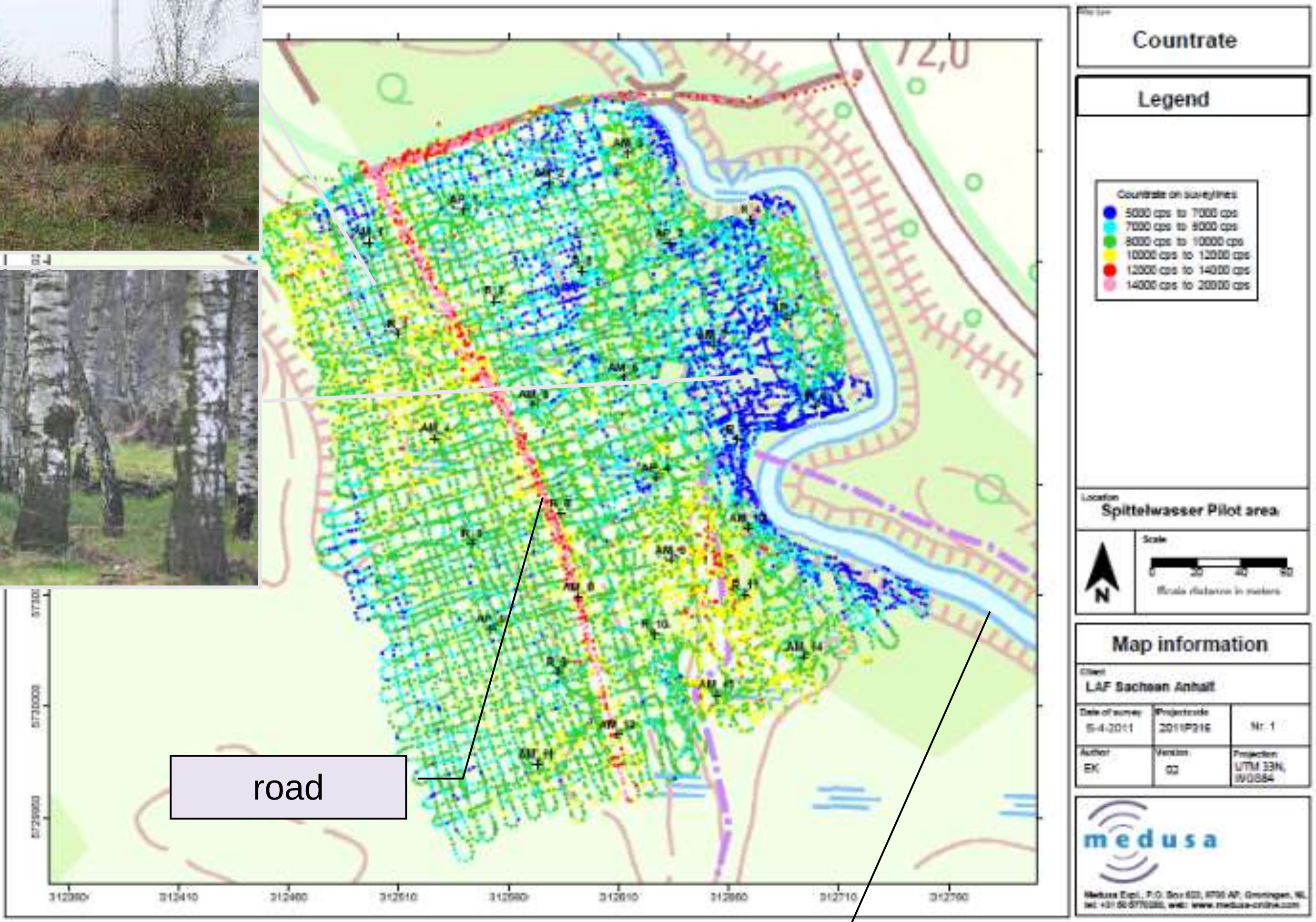
Project set-up of pilot

- Pilot study in small area (400 m x 300 m)
  - to asses practical feasibility
  - to determine spatial variation to calculate survey scheme
- Calibration (sample analysis on 14 samples) to asses feasibility
- Validation by up to 11 retained samples
- After successful pilot: 130 ha full-scale investigation
- (Additional investigation of depth profiles and possible impacts of *wofatite* deposits)

Pilot – raw data: countrate, unspecific



road

Spittelwasser creek

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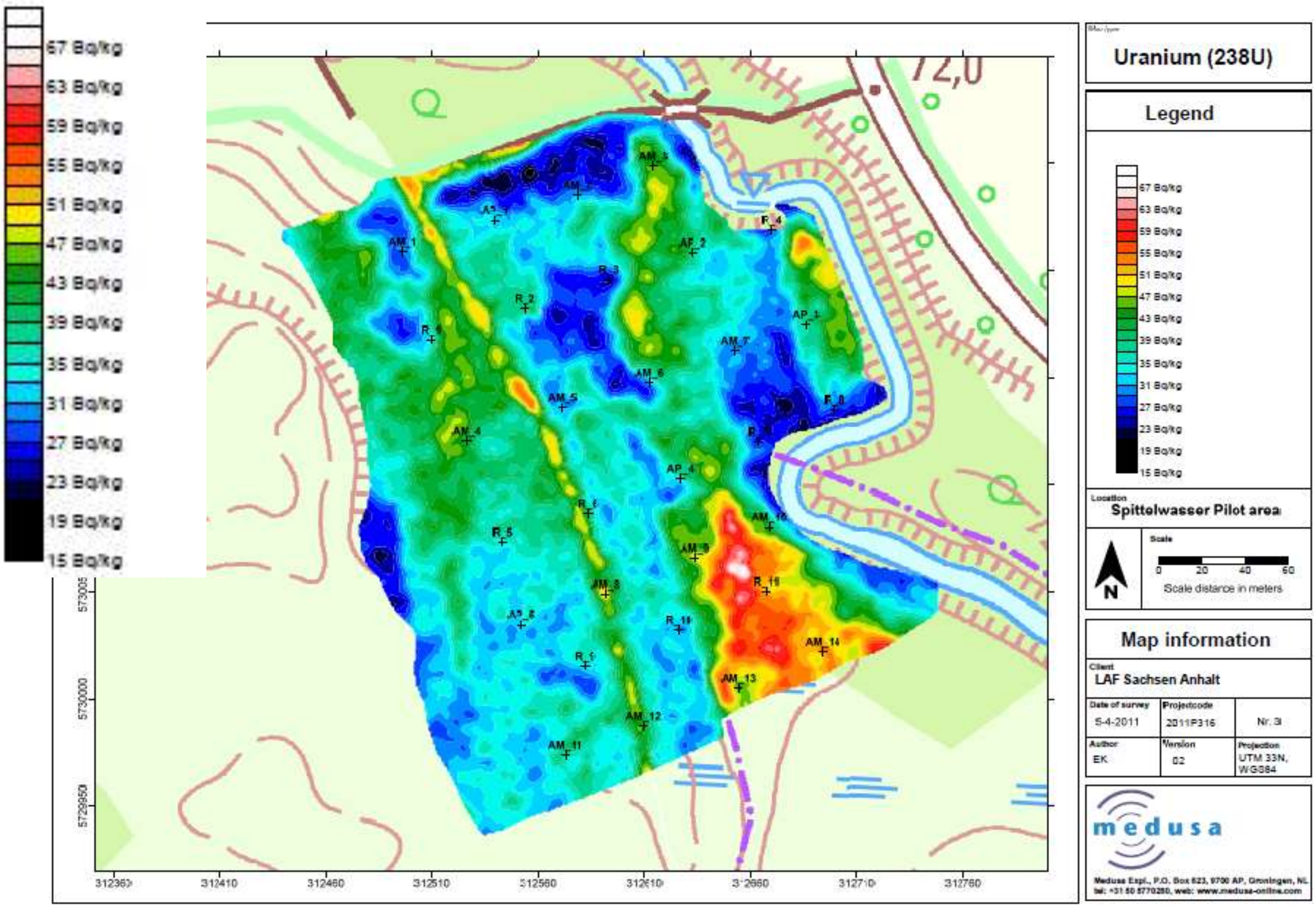
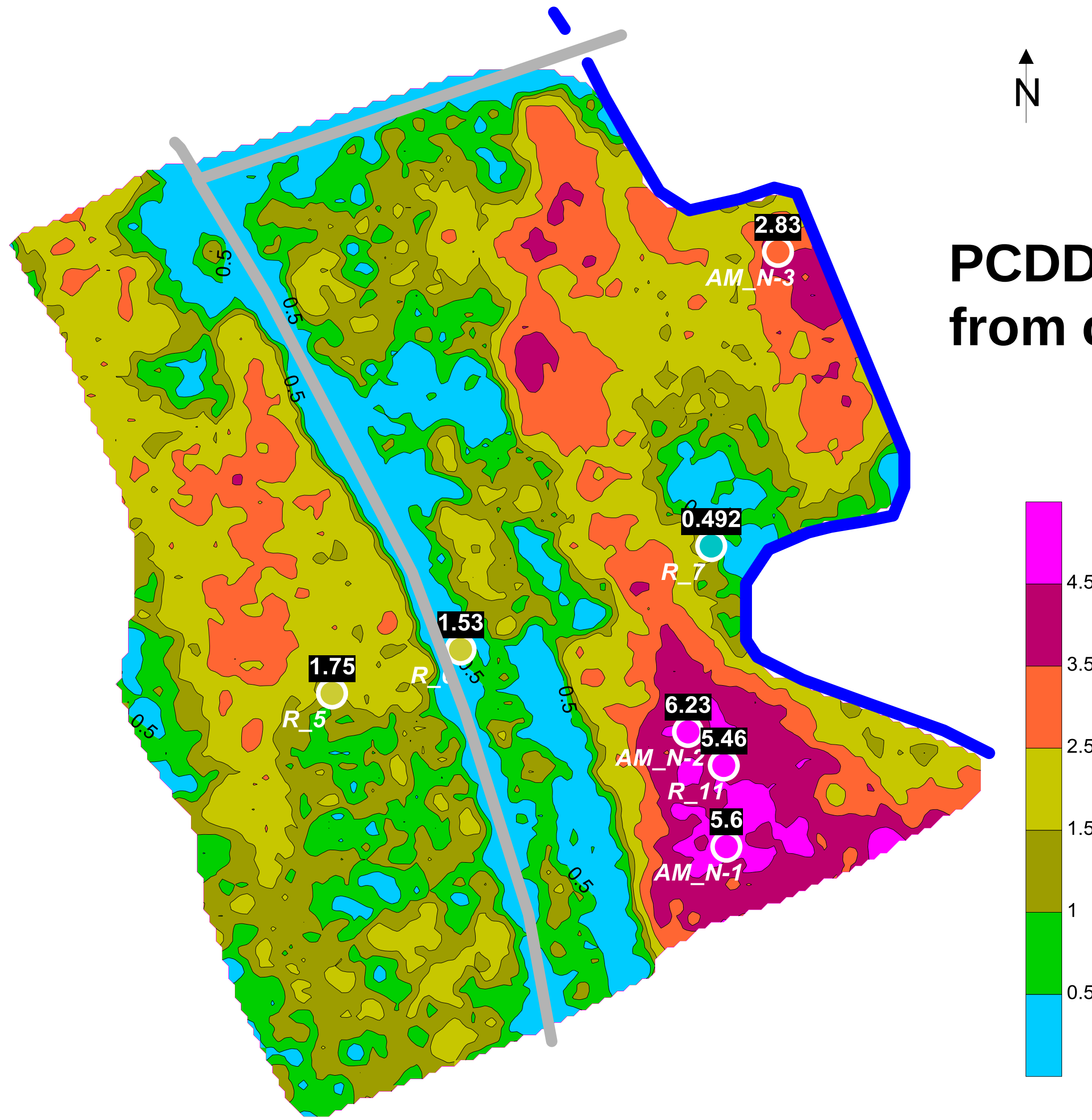
Pilot – processed data: ^{238}U activity



Contaminant mapping and validation



PCDD/F calculated from calibration data

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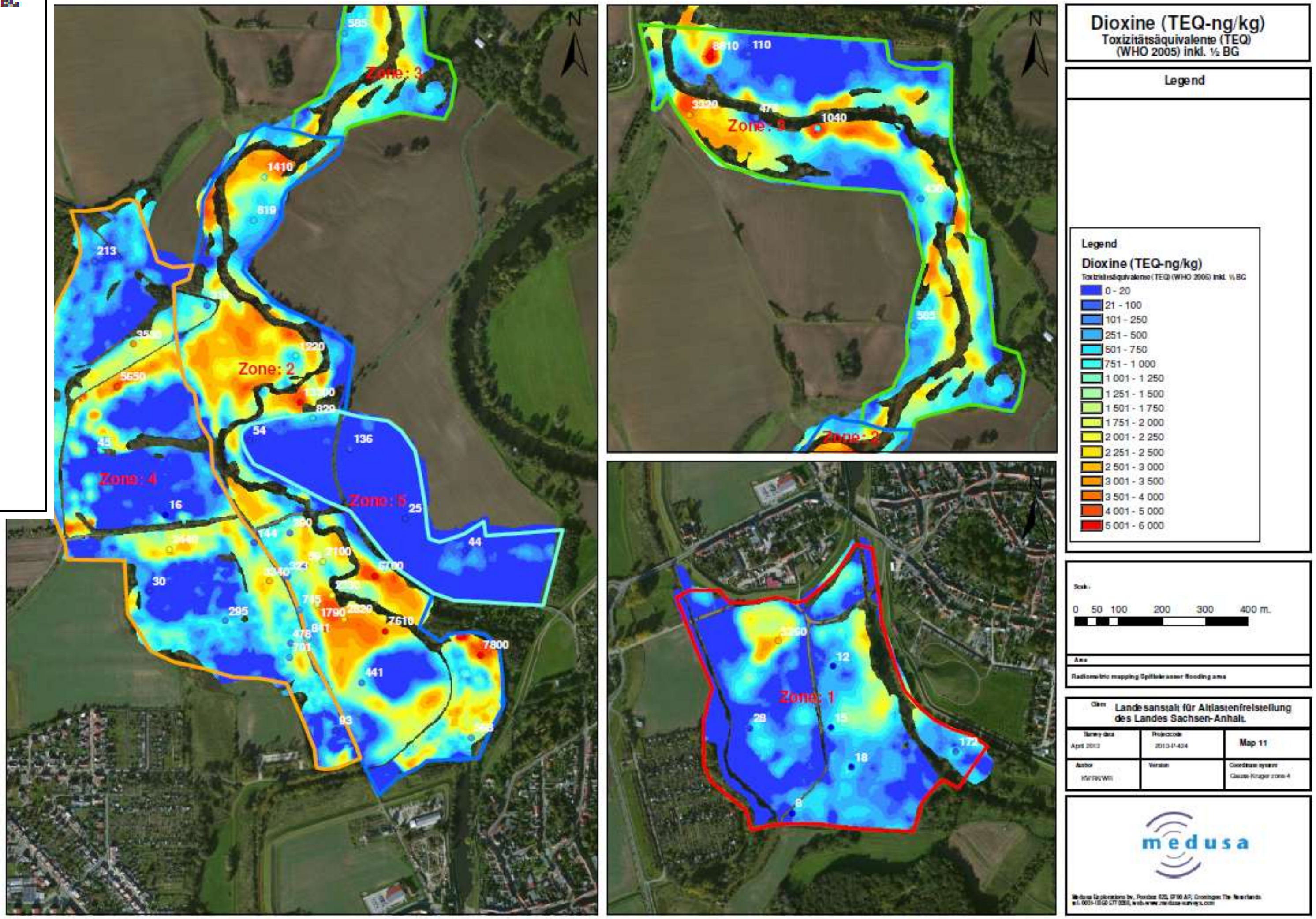
Full scale mapping, PCDD/F

Legend

Dioxine (TEQ-ng/kg)

Toxizitätsäquivalente (TEQ) (WHO 2005) inkl. ½ BG

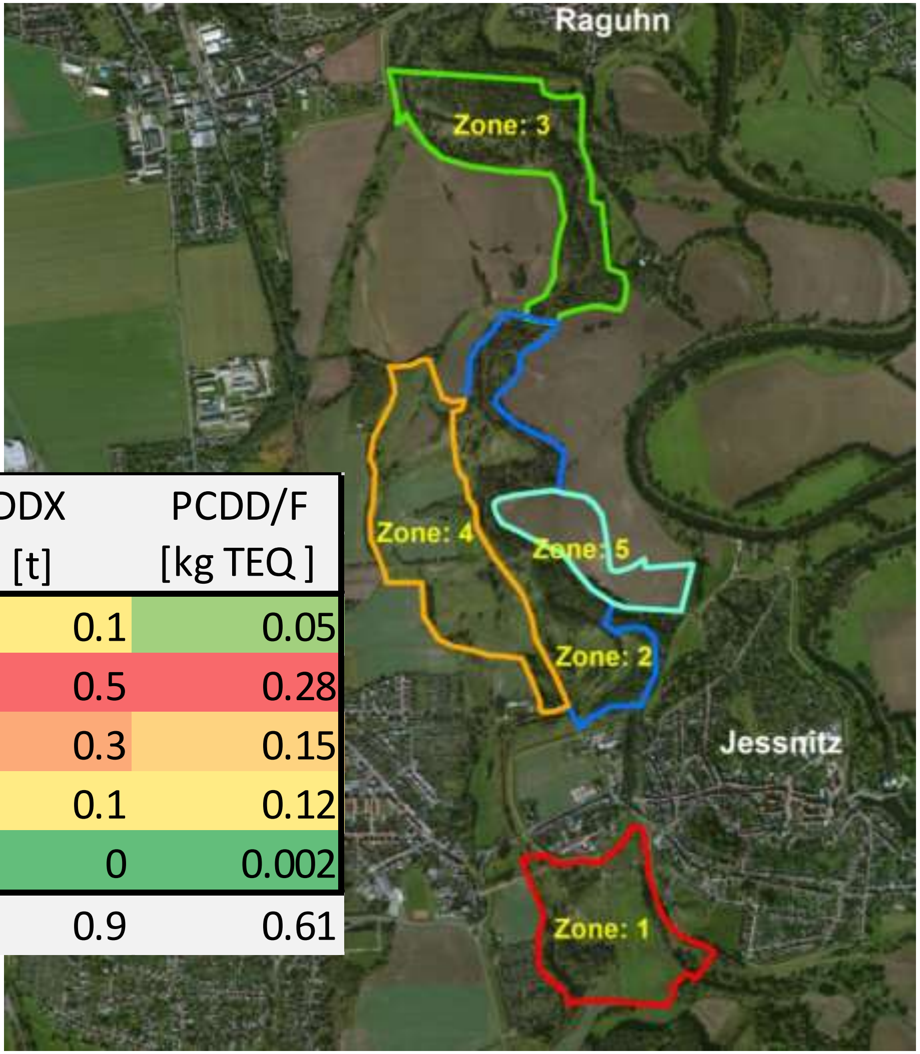
- 0 - 20
- 21 - 100
- 101 - 250
- 251 - 500
- 501 - 750
- 751 - 1 000
- 1 001 - 1 250
- 1 251 - 1 500
- 1 501 - 1 750
- 1 751 - 2 000
- 2 001 - 2 250
- 2 251 - 2 500
- 2 501 - 3 000
- 3 001 - 3 500
- 3 501 - 4 000
- 4 001 - 5 000
- 5 001 - 6 000



400 m

Full scale mapping, results

- Total survey area ca. 130 ha
- 5 survey zones
- 47 soil samples



	Area [ha]	Sn org. [kg]	HCH [t]	DDX [t]	PCDD/F [kg TEQ]
Zone 1	24.3	2.2	0.9	0.1	0.05
Zone 2	32.9	7.3	9.9	0.5	0.28
Zone 3	27.2	4	5.2	0.3	0.15
Zone 4	35.3	4.7	1.9	0.1	0.12
Zone 5	14.1	0.008	0.2	0	0.002
Gesamt	133.8	18.2	18.2	0.9	0.61

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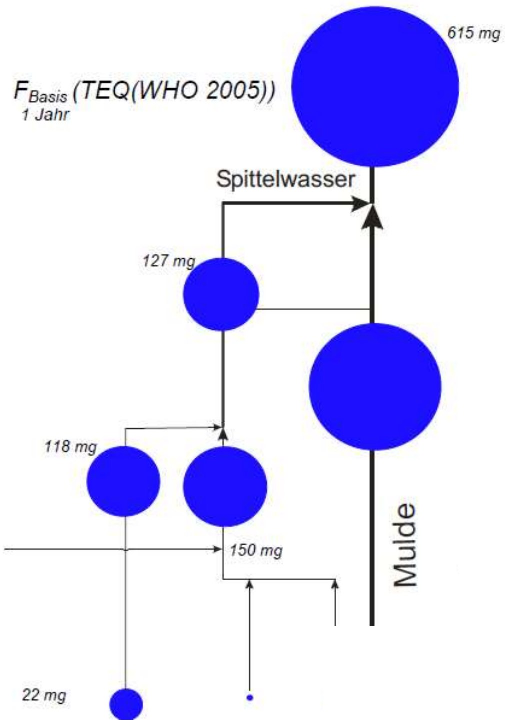
Contaminant inventory calculated



- Surface water monitoring revealed load increasing along Spittelwasser course.
- Release from bed sediment cannot explain contaminant load.
- Input from floodplains dominates
- Contaminant mass discharged negligible compared to inventory of flood plains!

	mass in floodplain soil	mass load surface water	mass depletion per year
	[kg]	[kg/a]	
ΣHCH	18.2	7.06	0.04%
ΣDDX	900	0.63	0.07%
ΣSn-Org.	18.2	3.68	20.22%
PCDD/F, WHO-TEQ	0.61	0.000668	0.11%

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Summary and Conclusions

- The technique is appropriate for pesticides and dioxin mapping under given conditions!
- Hotspots could be detected at high resolution.
- The inventory of contaminants is orders of magnitudes larger than the annual load of the Spittelwasser creek.
- Secondary sources in the floodplain will not be depleted within reasonable time frames.