Estimating sand content of suspended loads

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Measurements of suspended load

Suspended loads:

- are determined from suspended sediment concentrations
- typically include both suspended sand and fines (clay/silt)
- include organic fractions

How to separate loads of suspended fines and sand?

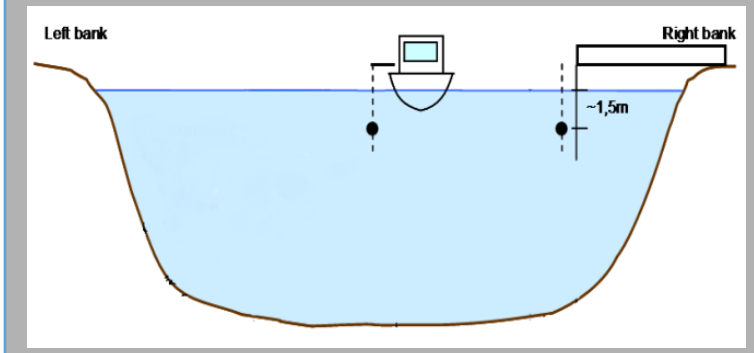
Data base:

- two independent data sets on suspended loads along German Rhine by WSV and BfG

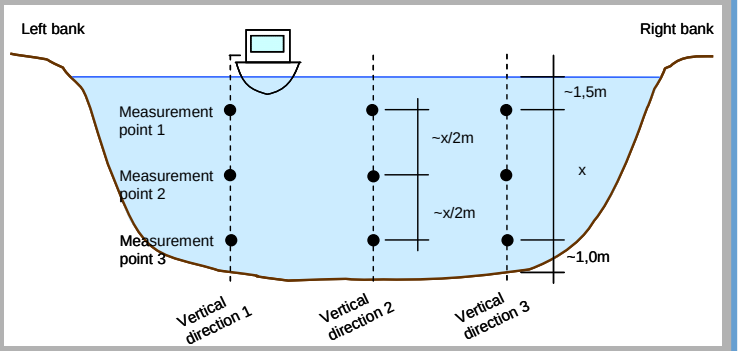
1. free flowing section: separate measurement of fines and sand twice a year
2. complete German part of the Rhine: daily values of total suspended sediment concentrations

Methods: Measurements techniques

Point measurements



Profile measurements



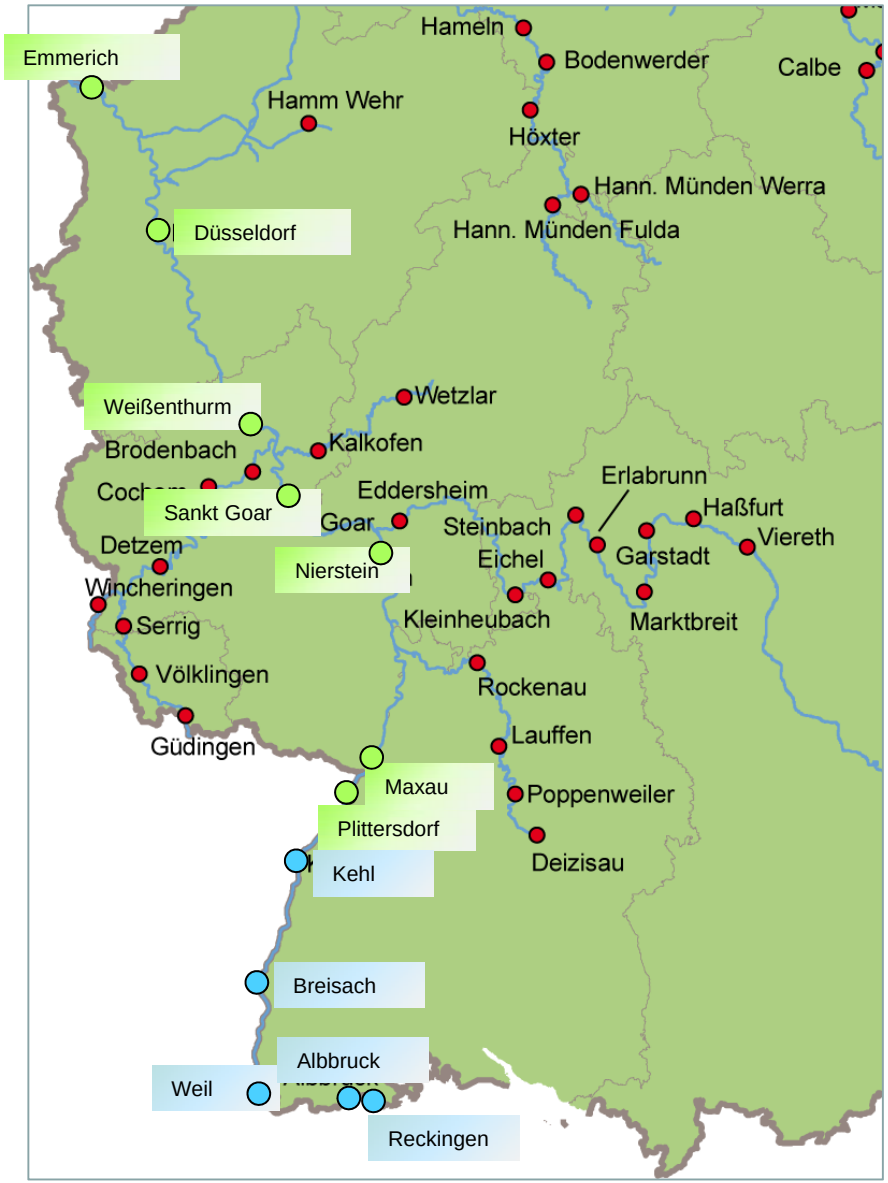
Filter method

BfG, 2013

Multi point measurements (SVP)

WSA Dresden, 2008

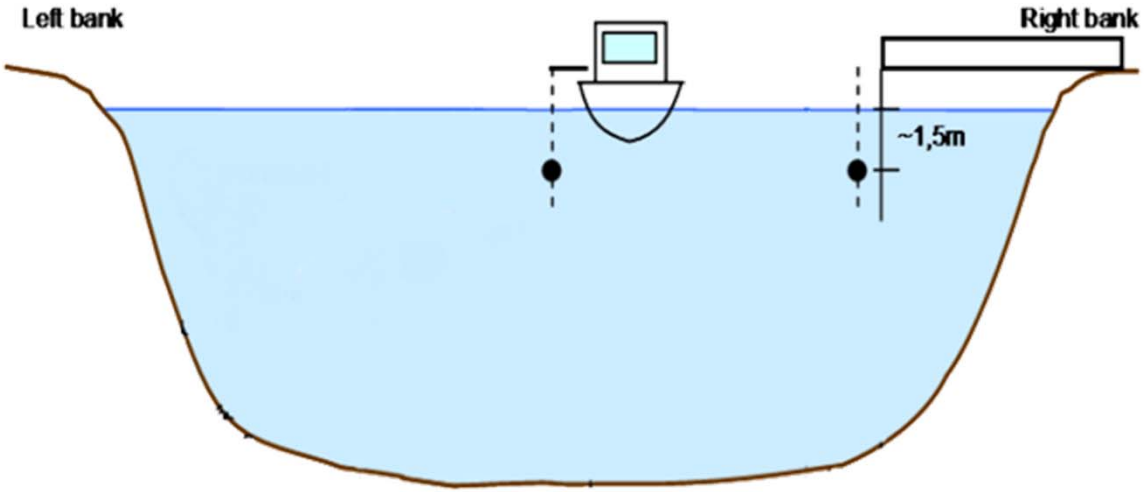
Methods: Filter method



- 12 measurement points along the river Rhine
  - 5 in impounded waterway (Lake Constance to barrage Iffezheim)
  - 7 in free flowing waterway (barrage Iffezheim to the border of the Netherlands)
- Results are saved in the database “SchwebDB”

Methods: Filter method

- 5l samples taken with a bucket
- taken on workdays
- filtered on site with cellulose filter (average pore diameter 6,1 µm)
- Filtration on location
- Determination of the concentration in the sediment laboratory of the BfG



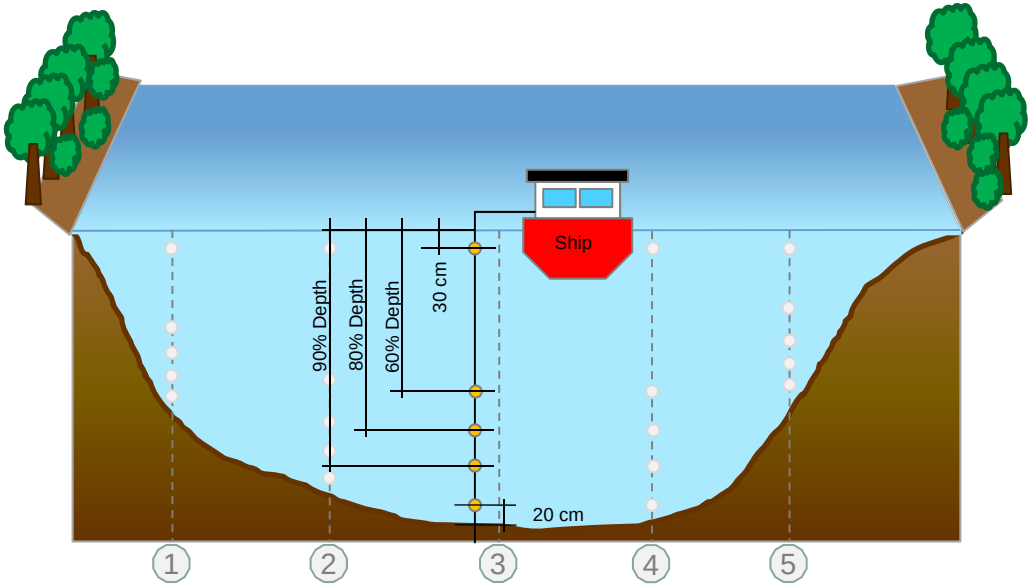
➢ **Only amount of the total suspended concentration measurable**

Methods: Multi point measurements

- 29 measurement points for regular monitoring

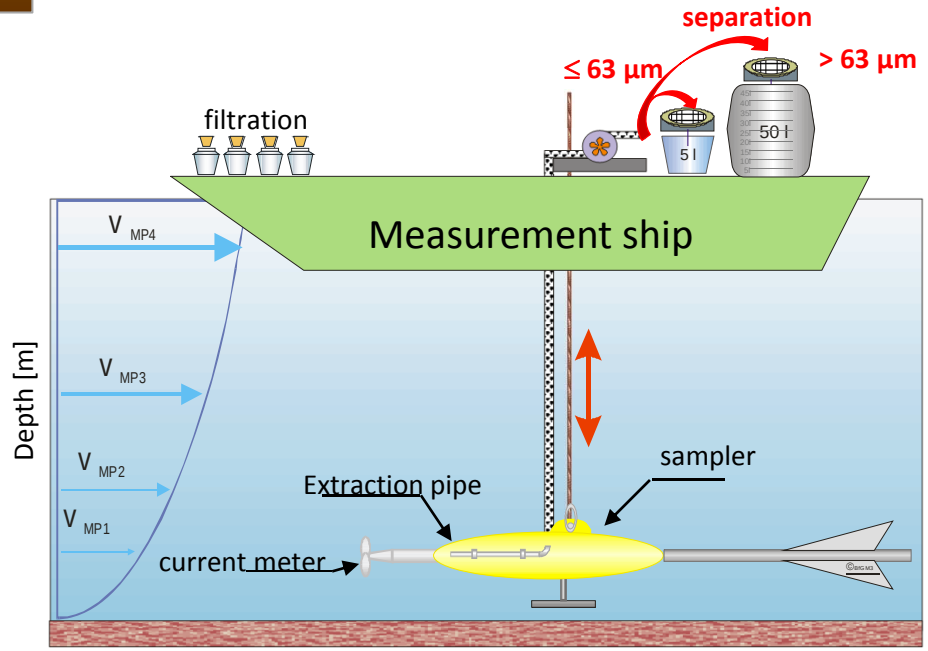
  (barrage Iffezheim to the border of the Netherlands)
- measurements 2 to 3 times per year
- Results are saved in the database “SedDB”

Methods: Multi point measurements



- 3 to 5 verticals
- 4 to 5 points in verticals
- concentrations of suspended sand: 50l to 55l
- Concentrations of suspended fines : 5l
- Filtration like filter method

➢ **amount of suspended sediment concentrations of sand and fines can be calculated separately**



Situation:

Filter method

- Complete river Rhine
- Daily values

Multi point measurements

- Free flowing river section
- twice a year

Clay and Silt Budget

No information on sand content; division into clay/silt and sand not possible

New monitoring system: analysis of calibration samples

Grain Size Analysis possible

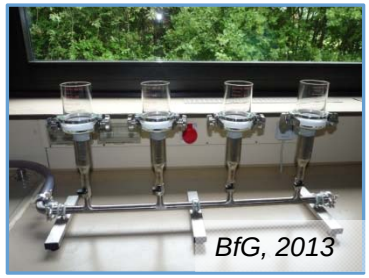
Methods: new monitoring system

BfG, 2013

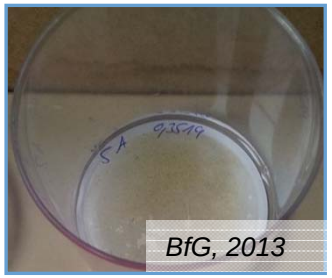
- pilot phase since 2009
- 1 or 2l samples for the calibration of turbidity probes and ADCP Profile measurements
- use of different extraction methods
- grain size analysis possible

Method: Grain Size Analysis

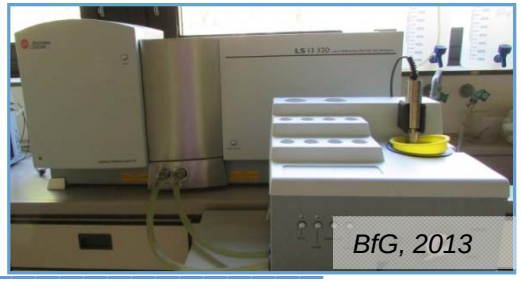
1. **1 or 2 liter samples of suspended matter**
   - Use of approximately 530 samples
   - Analyzed results of approximately 330 samples



2. **Filtration:**
   - Use cellulose acetate filters (0.45 µm pore diameter)
   - Gravimetric filtration
   - Weigh dried filters to calculate the suspended matter concentration
   - ➢ *Total amount of the suspended load concentration*



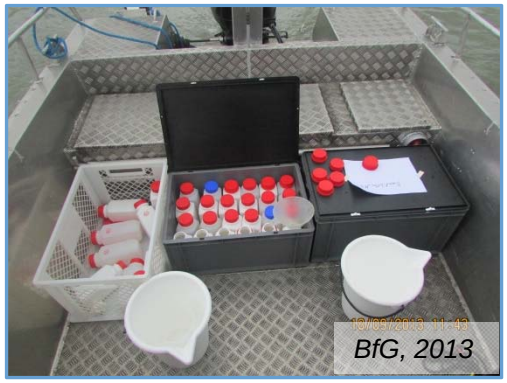
3. **Grain size analysis:**
   - Rinse dried filter
   - Remove the organic part (oxidize)
   - Use the Particle Analyzer to get the grain size distribution (with diffractometer)
   - ➢ *Clay, silt and sand concentrations*



Result:

Results of the grain size analysis:

- Clay and silt: 90.8 %
- Sand: 9.2 %



Additional analysis:

- Gradient (depth, length, width)
- Methods (“Ruttnerflasche”, scoop and pump)
- Sand concentration (river sections, depth)

- Data basis
  - no differences between the measurement points (by mean flow conditions)
  - Not significantly

Uncertainties of the new method

1. Measurement technique
   - Location of the measurement point (near the surface / next to the bank)
   - Filtration
   - Grain size analysis
2. Storage
   - Form of storage
   - Place of storage
3. Volume of the samples
4. Presets, sample preparation
   - instrument
   - e. g. oxidation

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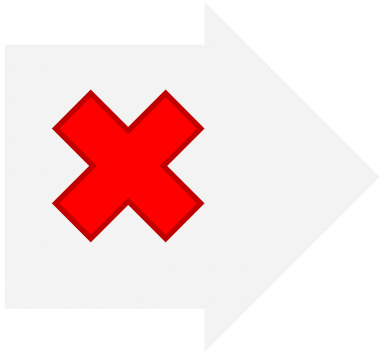
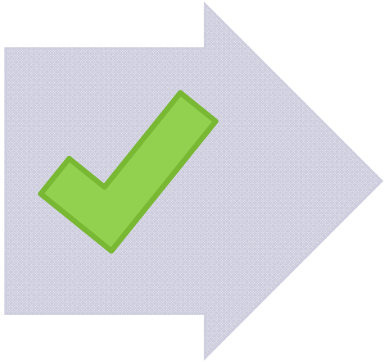
Comparisons of the methods

Filter method



Average values of clay and silt content as well as the sand content:

Multi point measurement

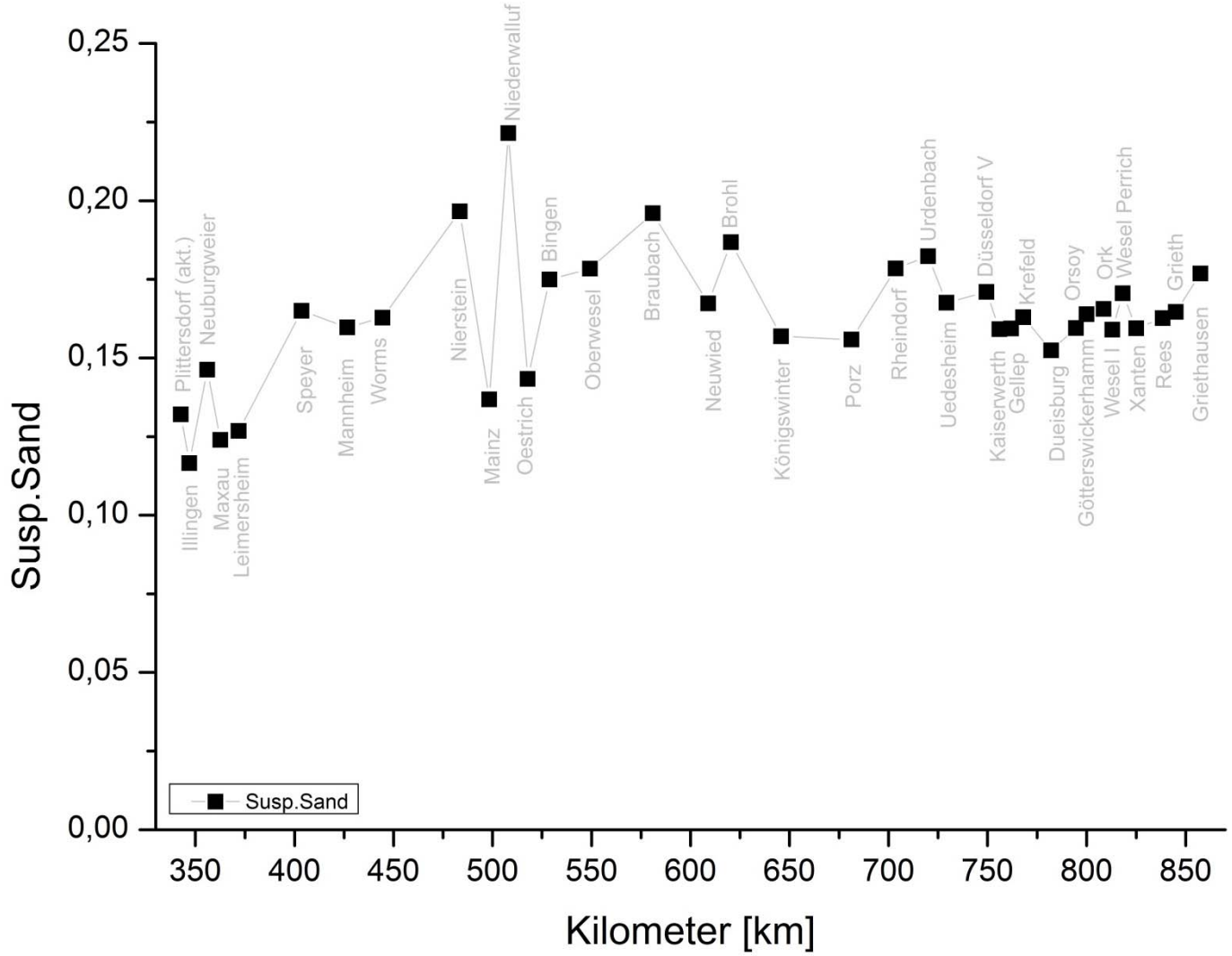


Clay and silt: 87.3 %
Sand: 12.7 %

Grain Size Analysis of calibration samples (Probe method / ADCP profile measurements)

Clay and silt: 90.8 %
Sand: 9.2 %

How the results are used?



Thank you!

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