

Suspended sediment and contaminant transport monitoring in navigable and unnavigable waterways (Wallonia, Belgium)

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Outline of the presentation

- 1. Management of dredged material in Wallonia**
- 2. GISSed Project**
- 3. Methodology**
 - Suspended sediments transport monitoring
 - Suspended sediments quality monitoring
- 4. First results**
- 5. Conclusions and outlook**

1. Management of dredged material in Wallonia

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- In Wallonia (Belgium) rate of **sediment accumulation** in waterways is estimated at **527 000 m³ / year**
→ to maintain navigation capacity: at least **20 % should be removed**
- **Annual cost of maintenance** of waterways is currently estimated at least at:
34 – 39 million €
- **Maintenance is exclusively managed in a curative way :**
 - Bathymetric survey → quantify volume to be removed
 - Chemical analysis of coring samples in sediments to be removed
- **Regulation (Walloon Government): Sediment out of water = waste**
- Characterization and classification procedures on the basis of chemical analysis (heavy metals and organic micropollutant content + leaching tests)
=> 2 classes :
 - A not contaminated**
 - B contaminated**



1. Management of dredged material in Wallonia

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- **Currently there is no available data**
 - **to anticipate the evolution of sediment deposits**
 - difficult to identify/plan the needs for dredging operations
 - not possible to assess the efficiency of sediment control measures implemented
 - **or to measure contaminants in recent sediments**
 - not possible to assess the efficiency of the measures taken
 - not possible to perform an assessment of the evolution of sediment content in toxic pollutants (requirements of the 2008/105/EC not met)
 - not possible to identify the needs in terms of sediment treatment technologies

2. GISSED Project

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- The **general objective of the GISSED project**:
 - Contribute to the development of **operational tools** allowing the **prediction of sediment and sediment quality budget**
 - to improve sediments management in Walloon waterways

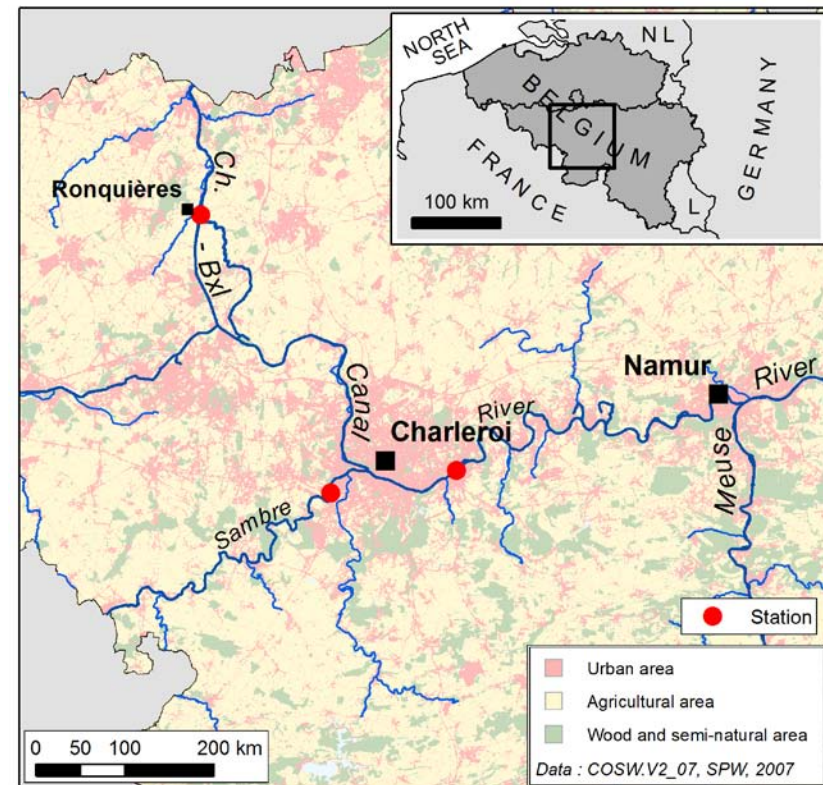
→ **Deployment of a suspended sediment pilot monitoring network**:
3 experimental stations

On a navigable waterway: **the Sambre River**

- At Monceau (upstream Charleroi) (1 608 km²)
 - At Châtelet (downstream Charleroi) (2 310 km²)
- **Budget over the urban area of Charleroi**

On an unnavigable waterways : **the Samme River**

- At Ronquières (outlet of the catchment) (135 km²)
- **Transfers of sediments between a river and a waterway**



3. Methodology

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Suspended sediments transport monitoring

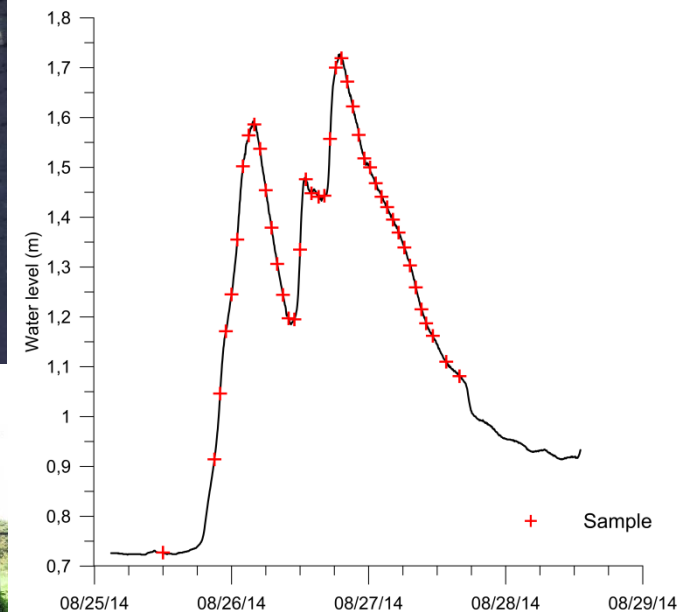
Automatic portable sampler (ISCO 6712) → laboratory

Turbidity probe (YSI 6026 ER) → laboratory

Water discharge (data from SPW-DGO2)

} Estimate sediment budget

Ronquières automatic sampling station (Installation : May 9, 2014)



Example of automatic sampling for a flood event (sampling every hour above a threshold of water level: 0.85 m)

3. Methodology

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Automatic sampling above a threshold
(water level or turbidity)

Water sample

OR

Filtration (1.2 μm)

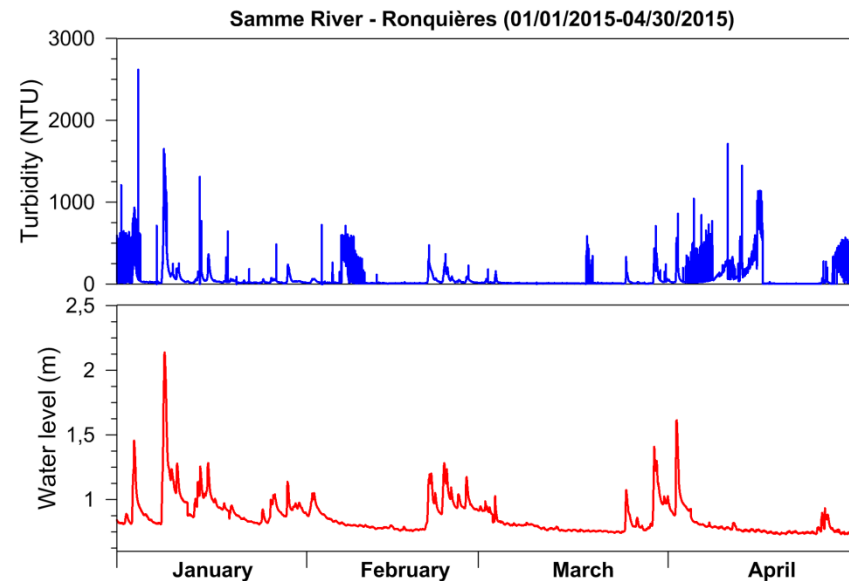
H2O2 treatment

Loss on ignition
(550°C)

Particle-size
analysis

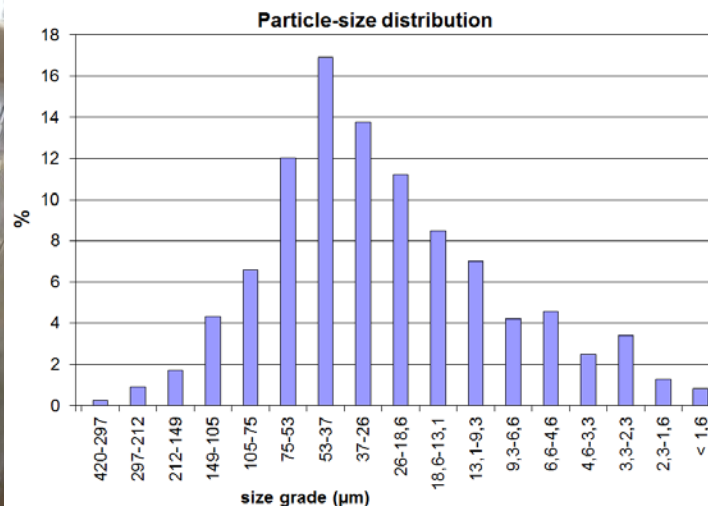
Field

Laboratory



Probe continuously measuring water level and turbidity

Estimate sediment budget



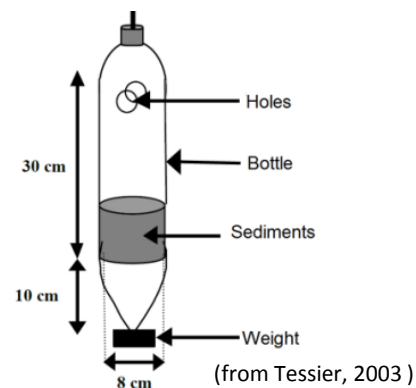
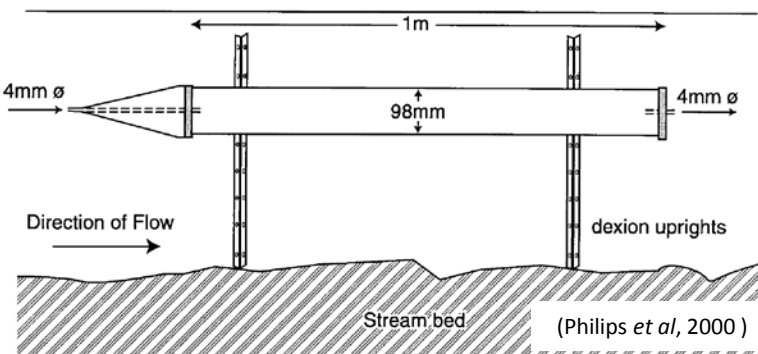
3. Methodology

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Suspended sediments quality monitoring

- Development of a method to collect recent sediments (*Time Integrated Sampler*, sediment trap)
 - Collect enough amount of suspended matter to allow pollutants concentration measurement

Sediment trap, TIS principle = reduction of velocity inside system, inducing particles deposition



3. Methodology

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Time integrated sampling

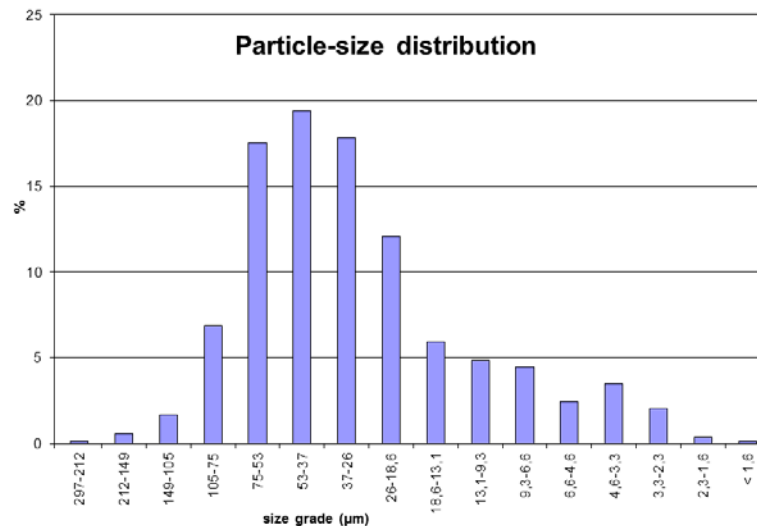
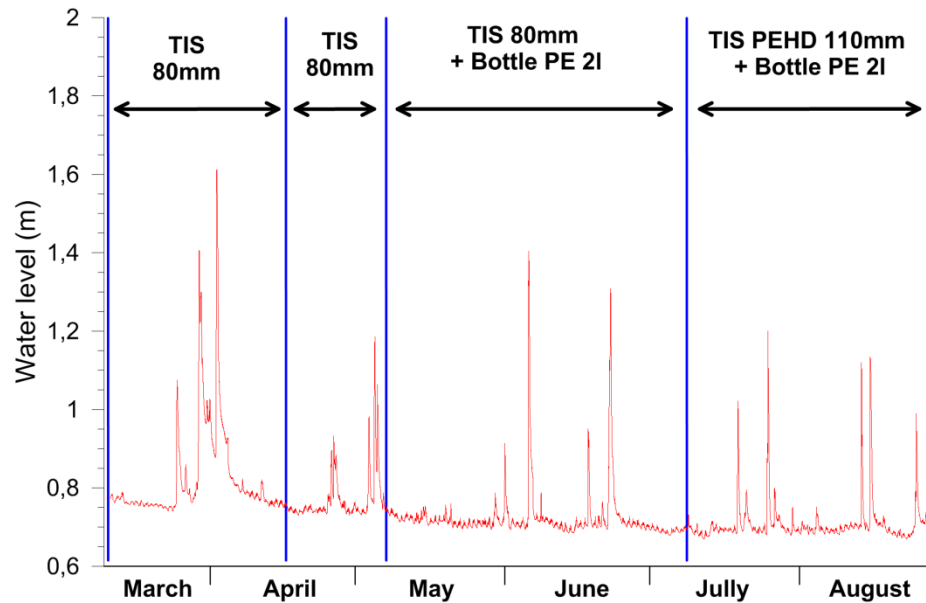
Sediment sample

Chemical analysis:
PCB, Hg, metals,
PAH, Hydrocarbon

Characterization:
Particle-size
analysis, DM, TOC

Field

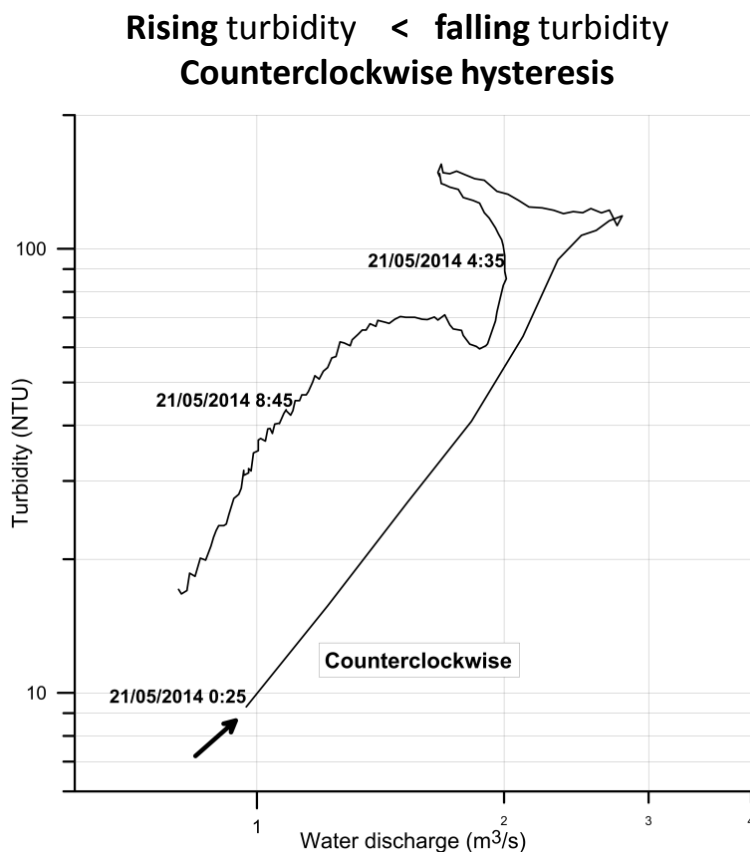
Laboratory



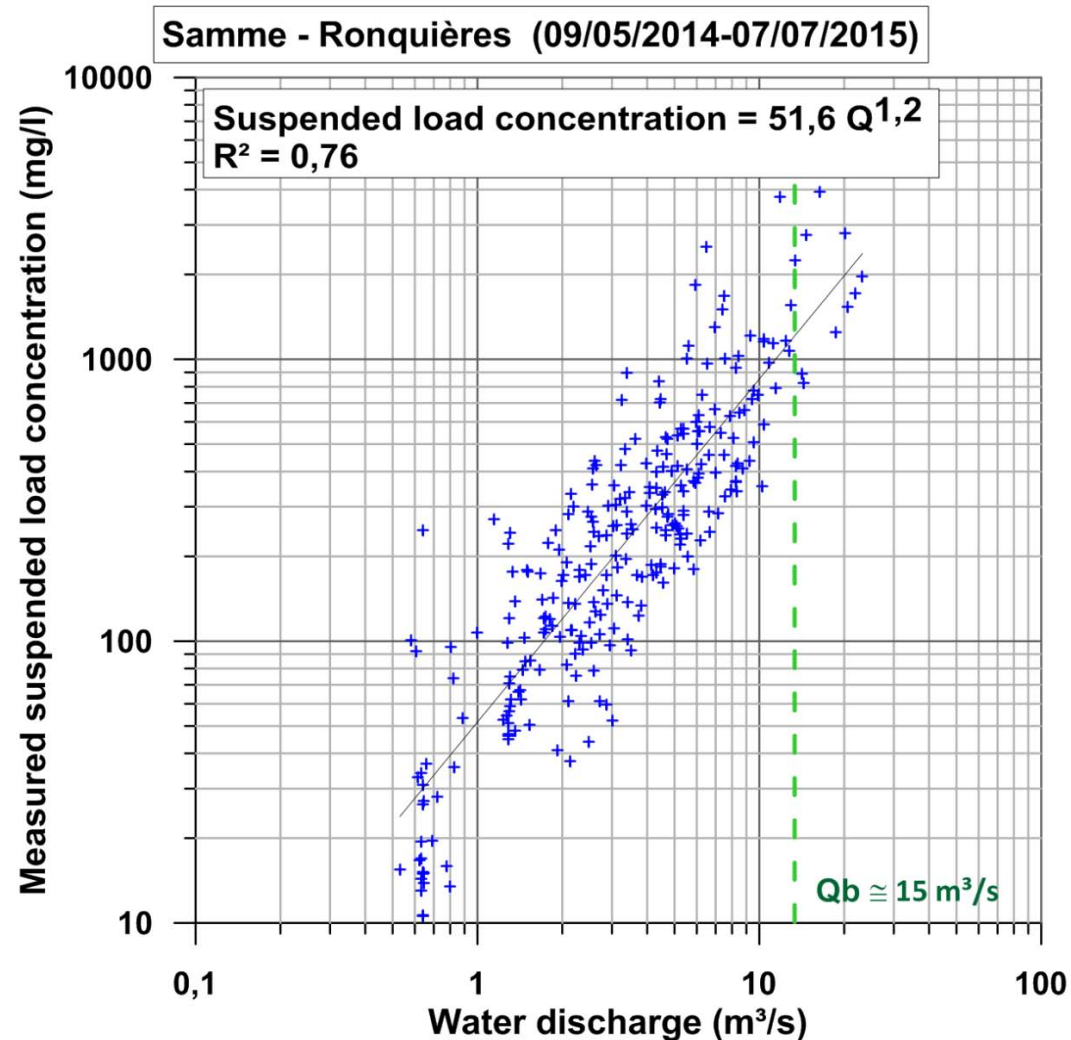
4. First Results

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Suspended sediments transport monitoring Quantification of suspended load transport



Example of relationship between measured turbidity and water discharge during a flood event (May 21, 2014).



4. First Results

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Suspended sediments transport monitoring

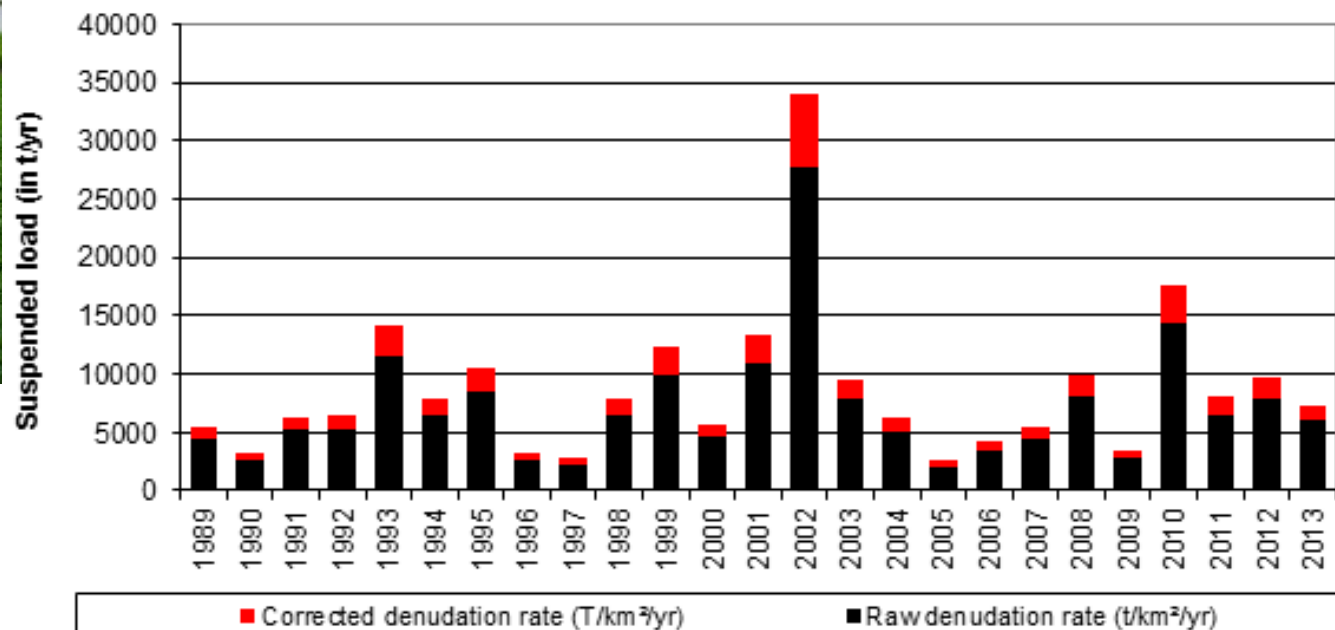
Quantification of suspended load transport

Averaged suspended load at Ronquières (1989-2013):

8 720 T/yr

(calculated on the basis of hourly water discharges data from SPW-DGO2)

Denudation rate: 64,6 T/km²/yr



4. First Results

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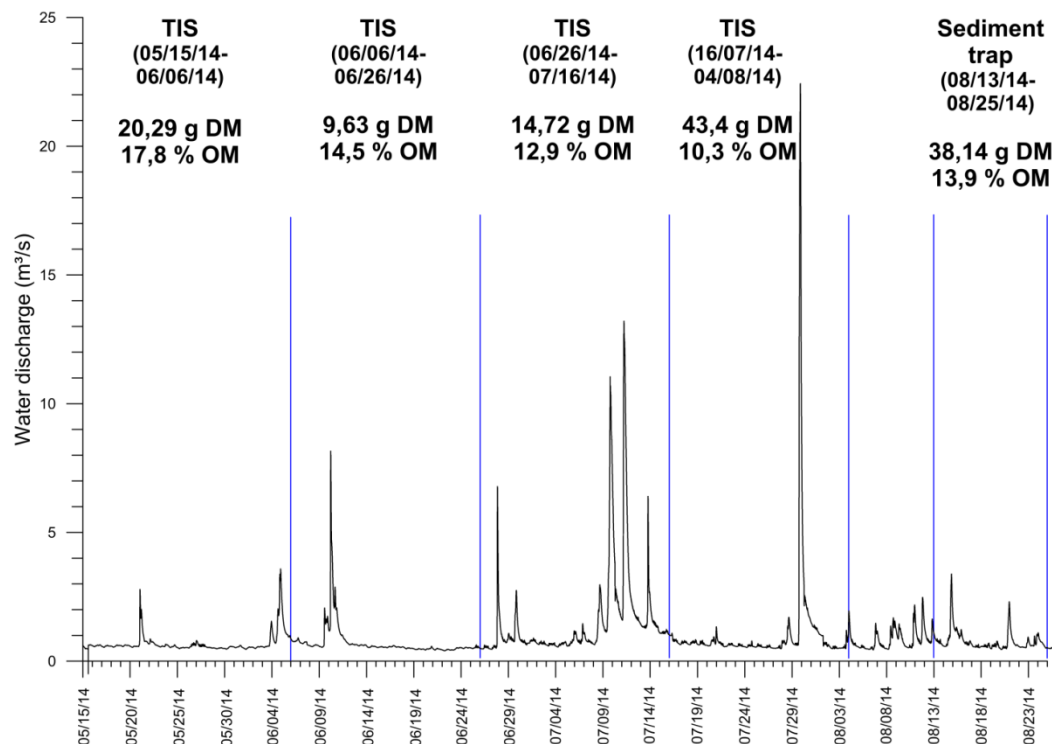
Suspended sediments quality monitoring

Characterization of suspended load – validation of the method

Sampling of 5 to 450 g (dry matter) of recent sediments (suspended load) at Ronquières with a prototype of **Time Integrated Sampler (TIS)** and a **sediment trap (ST)** (bottle)

Samme at Ronquières

	TIS	Sediment trap
	(12 samples)	(8 samples)
Dry matter 40°C	10 to 150 g	5 to 450 g
Organic matter	15 ± 3 %	10 ± 2 %



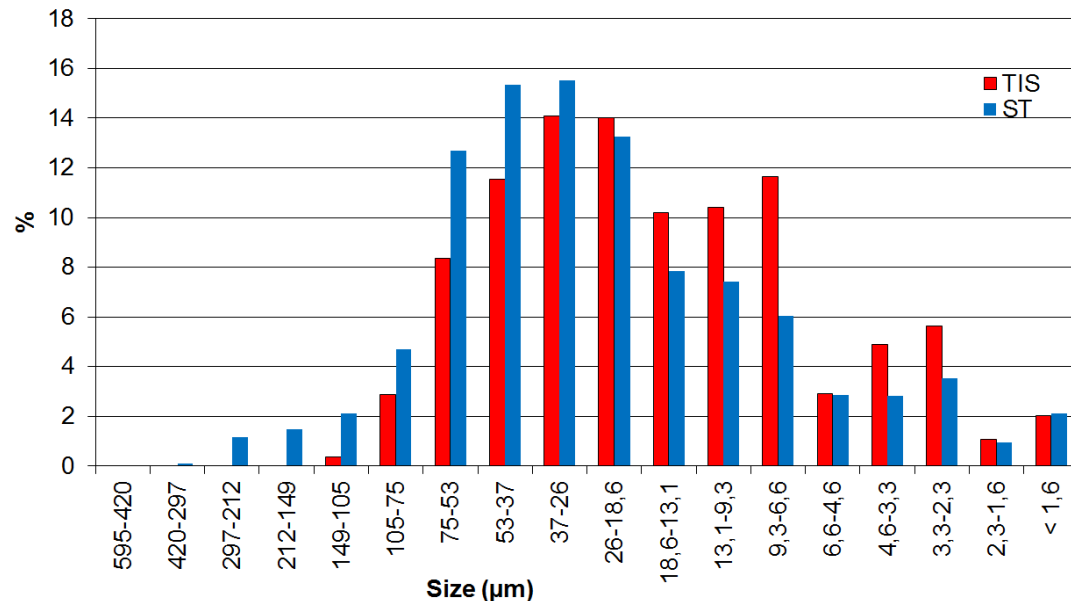
4. First Results

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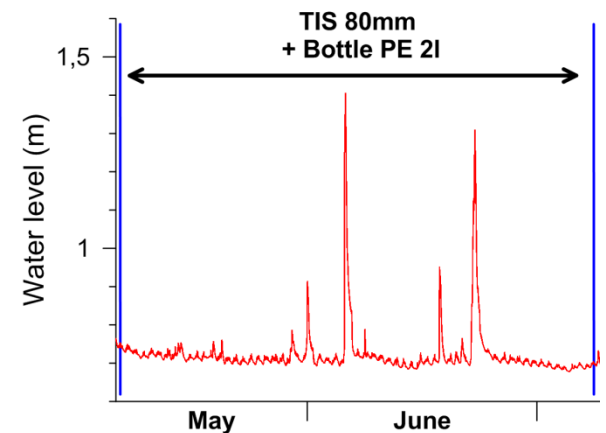
Suspended sediments quality monitoring

Characterization of suspended load – validation of the method

Sampling recent sediments (suspended load) at Ronquières for the same event with a prototype of **Time Integrated Sampler (TIS)** and a **sediment trap (ST)** (bottle)



	TIS	ST
OM (%)	14	13
D50 (μm)	19	28
D90 (μm)	56	73



4. First Results

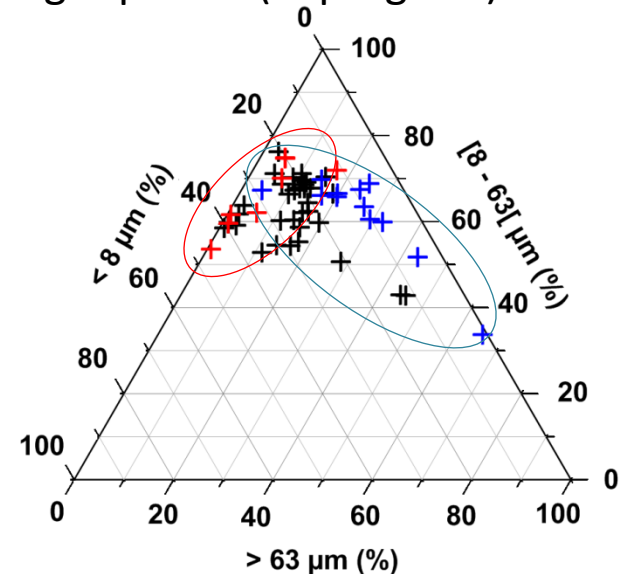
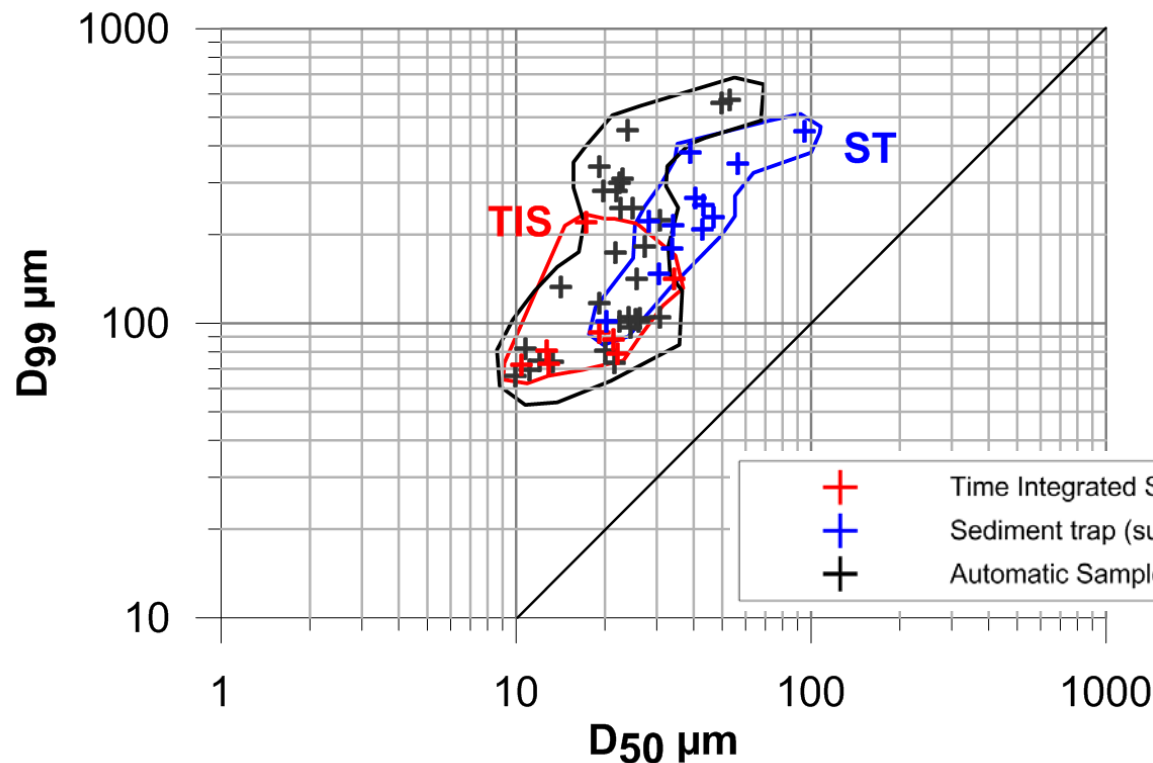
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Suspended sediments quality monitoring

Characterization of suspended load – validation of the method

Grain-size characteristics comparable between **Time Integrated Sampler (TIS)** and **automatic sampler** for samples collected during different periods (flood events)

→ Comparison of samples for the same periods and for a longer period (in progress)



4. First Results

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Suspended sediments quality monitoring

Suspended sediments quality – validation of the method

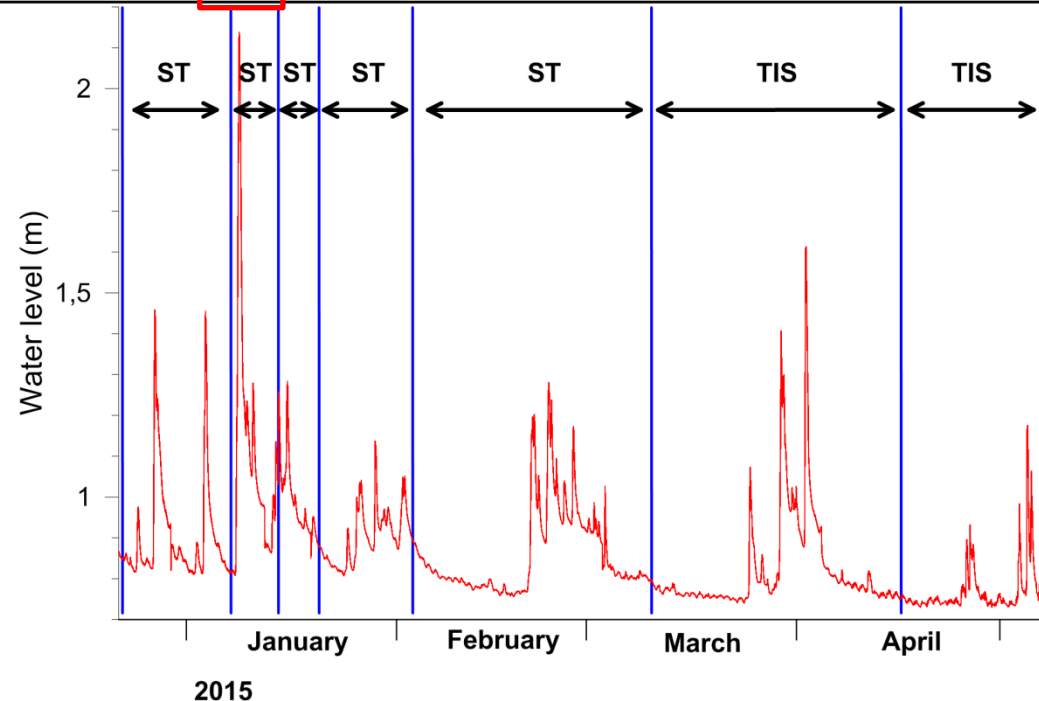
PCBs concentration in sediments depending on D_{99} and OM \rightarrow ? **flood event influence (movement of particles) on micropollutant concentration** (in progress)



D_{99} (μm)	447	347	229	180	253	88
OM (%)	9	8	8	9	10	20
PCBs ($\mu\text{g/kg DM}$)	117	143	125	99	120	111
Hg (mg/kg DM)	0.109	0.128	0.114	0.129	0.175	0.2

	D_{99} (μm)	OM (%DM)	PCBs ($\mu\text{g/kg DM}$)	Hg (mg/kg DM)
13 SE S01A	390	3	84 ± 7	0,48
13 SE S01B	166	10	$150 \pm 1,6$	0,29
13 SE S02A	311	6	$86 \pm 0,8$	0,19
14 SE S02C	350	4	$116 \pm 2,5$	0,3
14 SE S02D	539	2	$37 \pm 1,5$	0,16

PCBs and Hg concentration in sediments from the bed (< 2 mm) of Samme River near Ronquières



PCBs and Hg concentration in suspended sediments collected at Ronquières.



5. Conclusions and outlook

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Deployment of a suspended sediment pilot monitoring network in Wallonia:

Station on the Samme River

- Station installed and operational for more than 12 months on a unnavigable waterway at the outlet of a small catchment (135 km²)
- Sediment budget established at the outlet of the catchment (discharges method) → hysteresis phenomena
- Time integrated sediment quality evaluation in progress

Stations on the Sambre River

- Stations installed for some months
- Challenges associated to a navigable waterway (2 310 km²; W: 40 m)
 - Management of water levels (locks, dams) → water discharge → turbidity relation
 - Navigation → perturbation on fluxes through TIS and sediment trap



Thank you for your attention !



Bibliography

- PHILLIPS J. M., RUSSELL M. A., WALLING D. E.. Time-integrated sampling of fluvial suspended sediment: a simple methodology for small catchments. Hydrol. Process.. 2000; 14: 2589-2602.
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