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

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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
• 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
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

• 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

**Suspended sediments transport monitoring**

- Automatic portable sampler (ISCO 6712) → laboratory
- Turbidity probe (YSI 6026 ER) → laboratory
- Water discharge (data from SPW-DGO2)

*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

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

Lab

Probe continuously measuring water level and turbidity

Estimate sediment budget

Particle-size distribution
3. Methodology

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

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**Time Integrated Sampler**

(1 m long, 110 mm Ø, 6 mm Ø opening)

**Sediment trap (PE bottle)**

(21 cm, 110 mm Ø, 3 cm Ø opening)

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*Philips et al., 2000*

(from Tessier, 2003)
3. Methodology

Time integrated sampling

Sediment sample

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

Characterization: Particle-size analysis, DM, TOC

![Graph showing water level changes with time]

![Bar chart showing particle-size distribution]
4. First Results

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).

Rising turbidity < falling turbidity
Counterclockwise hysteresis

Samme - Ronquières (09/05/2014-07/07/2015)

Suspended load concentration = 51,6 Q^{1,2}
R^2 = 0,76

Q_b \approx 15 \text{ m}^3/\text{s}
4. First Results

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

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)

<table>
<thead>
<tr>
<th>Samme at Ronquières</th>
<th>TIS (12 samples)</th>
<th>Sediment trap (8 samples)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry matter 40°C</td>
<td>10 to 150 g</td>
<td>5 to 450 g</td>
</tr>
<tr>
<td>Organic matter</td>
<td>15 ± 3 %</td>
<td>10 ± 2 %</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>TIS</th>
<th>TIS</th>
<th>TIS</th>
<th>TIS</th>
<th>Sediment trap</th>
</tr>
</thead>
<tbody>
<tr>
<td>(05/15/14-06/06/14)</td>
<td>(06/06/14-06/26/14)</td>
<td>(06/26/14-07/16/14)</td>
<td>(16/07/14-04/08/14)</td>
<td>(08/13/14-08/25/14)</td>
</tr>
<tr>
<td>20.29 g DM 17.8 % OM</td>
<td>9.63 g DM 14.5 % OM</td>
<td>14.72 g DM 12.9 % OM</td>
<td>43.4 g DM 10.3 % OM</td>
<td>38.14 g DM 13.9 % OM</td>
</tr>
</tbody>
</table>
**4. First Results**

**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)

<table>
<thead>
<tr>
<th></th>
<th>TIS</th>
<th>ST</th>
</tr>
</thead>
<tbody>
<tr>
<td>OM (%)</td>
<td>14</td>
<td>13</td>
</tr>
<tr>
<td>D50 (µm)</td>
<td>19</td>
<td>28</td>
</tr>
<tr>
<td>D90 (µm)</td>
<td>56</td>
<td>73</td>
</tr>
</tbody>
</table>
4. First Results

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

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)

<table>
<thead>
<tr>
<th></th>
<th>$D_{99}$ ($\mu$m)</th>
<th>OM (%)</th>
<th>PCBs ($\mu$g/kg DM)</th>
<th>Hg (mg/kg DM)</th>
</tr>
</thead>
<tbody>
<tr>
<td>13 SE S01A</td>
<td>390</td>
<td>3</td>
<td>84 ± 7</td>
<td>0.48</td>
</tr>
<tr>
<td>13 SE S01B</td>
<td>166</td>
<td>10</td>
<td>150 ± 1.6</td>
<td>0.29</td>
</tr>
<tr>
<td>13 SE S02A</td>
<td>311</td>
<td>6</td>
<td>86 ± 0.8</td>
<td>0.19</td>
</tr>
<tr>
<td>14 SE S02C</td>
<td>350</td>
<td>4</td>
<td>116 ± 2.5</td>
<td>0.3</td>
</tr>
<tr>
<td>14 SE S02D</td>
<td>539</td>
<td>2</td>
<td>37 ± 1.5</td>
<td>0.16</td>
</tr>
</tbody>
</table>

PCBs and Hg concentration in suspended sediments collected at Ronquières.
5. Conclusions and outlook

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!