Tracing of micropollutants sources in urban receiving waters based on sediment fingerprinting

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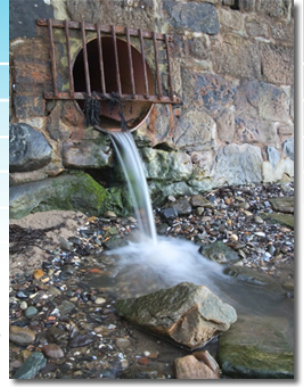
Micropollution problem



Wastewater;
http://www.dcmprocesscontrol.com/

- Increase of occurrence in water bodies
- Difficulties in managing **because:**

- **Various** places of an introduction into the environment (**entry points**):
  - wastewater effluents
  - combined sewer overflows
  - stormwater discharges
  - and diffuse inputs from arable land

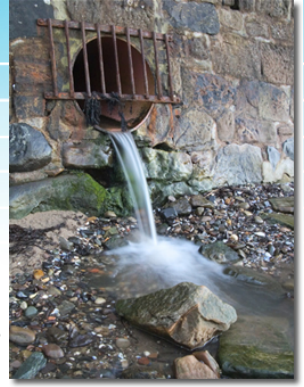
http://thecalmspace.com/

Wastewater effluents;
http://toxics.usgs.gov/

- **Simultaneous application** of the same micropollutant within catchments of mixed land use type
  (e.g. biocides and pesticides are often used simultaneously in urban and agricultural areas)

Stormwater effluents,
http://www.andoverks.com/

Micropollution problem



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  - comb
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  - and o

Needed **fast methods** to screen receiving waters for micropollutants to **identify** their **sources**

Wastewater effluents;
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Stormwater effluents,
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Our research questions

http://www.ci.hillsborough.nc.us/

1. Can **sediments** from surface waters act as **passive samplers** of medium polar contaminants?

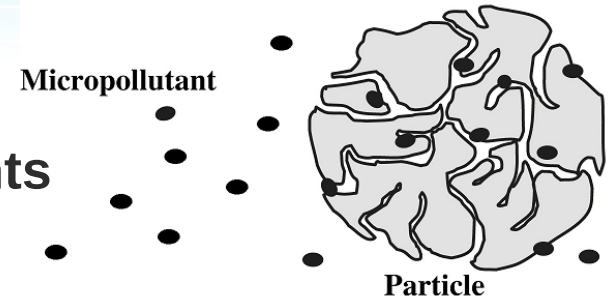
2. Does such a sample contain information of the **pollutant sources**?

Our approach

Advantage:

1) Medium polar micropollutants **sorb onto sediments**

2) Each land use type has a different and **unique** micropollutants composition (**fingerprint**)

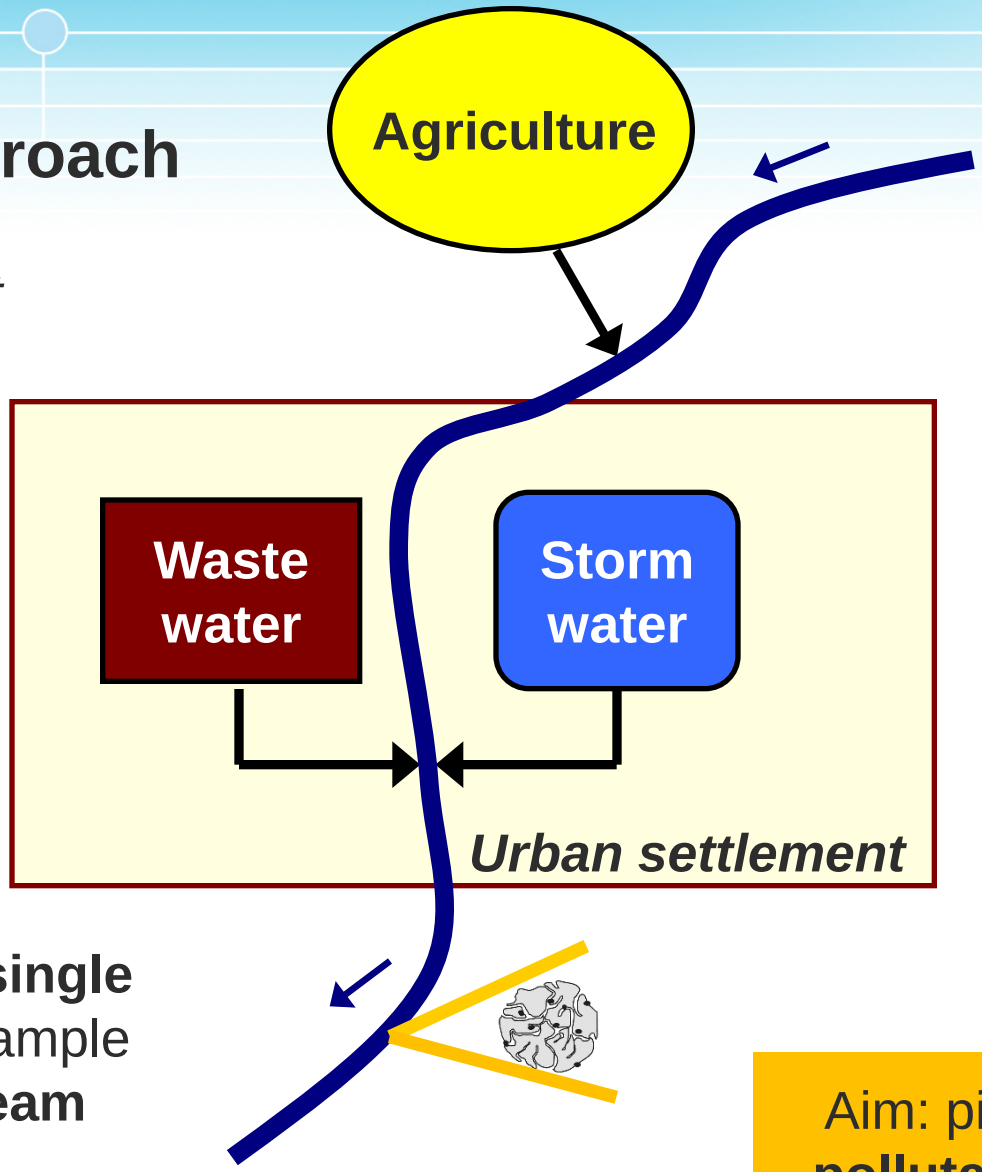


Adapted from Barret et al.., 2009

Sediment sample from different land use types has a **unique fingerprint**

Our approach

Catchment



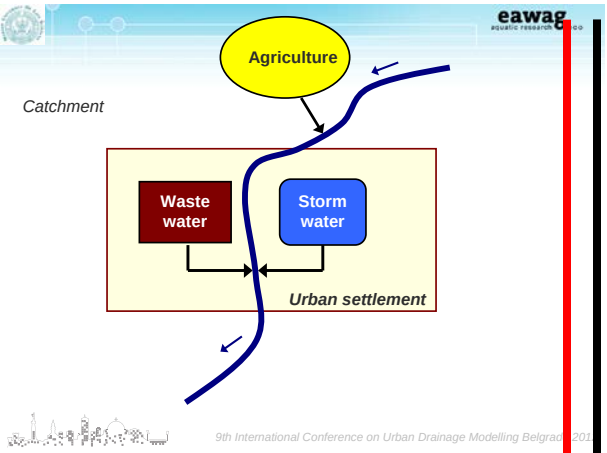
Only **ONE single** sediment sample **downstream**

Aim: pinpointing the **origin of pollutants** based on sediment sample **fingerprint**

Experts' system:

Prior investigation → **Prior** *P(W,S,A)*

Micropollutants **fingerprints** ← Experts' knowledge



Sample collection

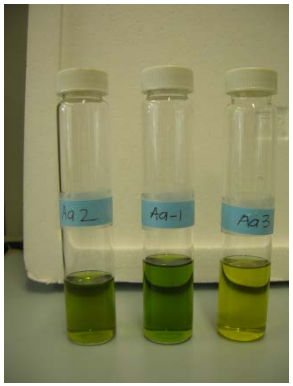
Sample screening

Detection data ***D***

Experts' system updating

Posterior *P(W,S,A | **D**)*

Posterior investigation



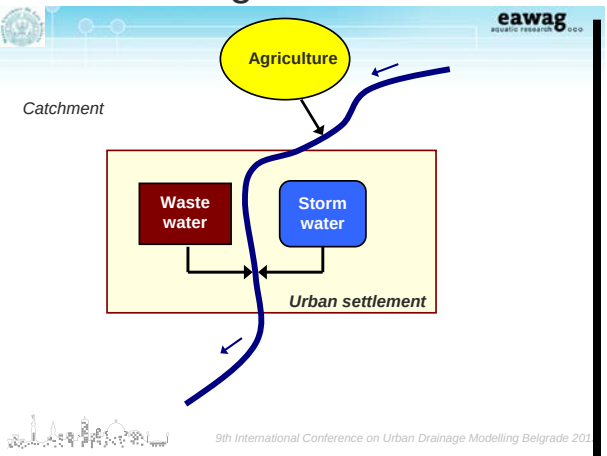
Experts' system:

Model inputs:

Prior investigation → **Prior** *P(W,S,A)*

Micropollutants **fingerprints**

Experts' knowledge



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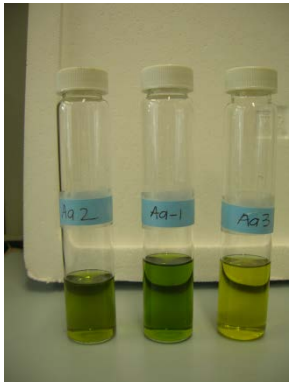


Experts' system updating

Bayes' theorem to update probabilities

Posterior *P(W,S,A | **D**)*

Posterior investigation

Posterior investigation

Where model can be **useful**?

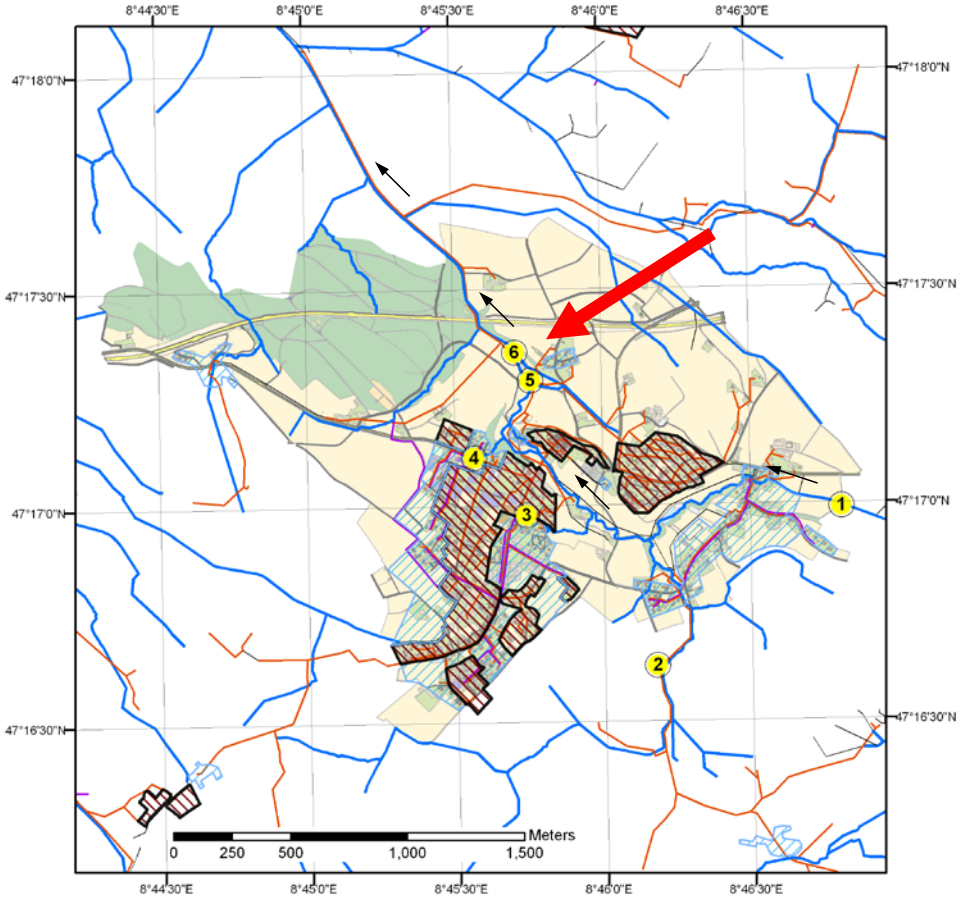
To support **water management communities**:

- As a cheap and fast **first screening** based on a **single sample** to optimize future measurement campaigns;
- By **pinpointing** where within an urbanized catchment **a problem with micropollutions** most probably occurs
- and where **detailed monitoring** is required

Case Study

Mönchaltorfer Aa catchment / the community of Grüningen

Area = 8.8 km^2; Population = 3200 people



Analyzed micropollutants

The screening method using **HPLC-HRMS** (*liquid chromatography - high resolution mass spectrometry*) includes **225** compounds:

- personal care products,
- biocides,
- [illegible]
- [illegible]
- [illegible]
- [illegible]

Experts' knowledge on **micropollutants sources**

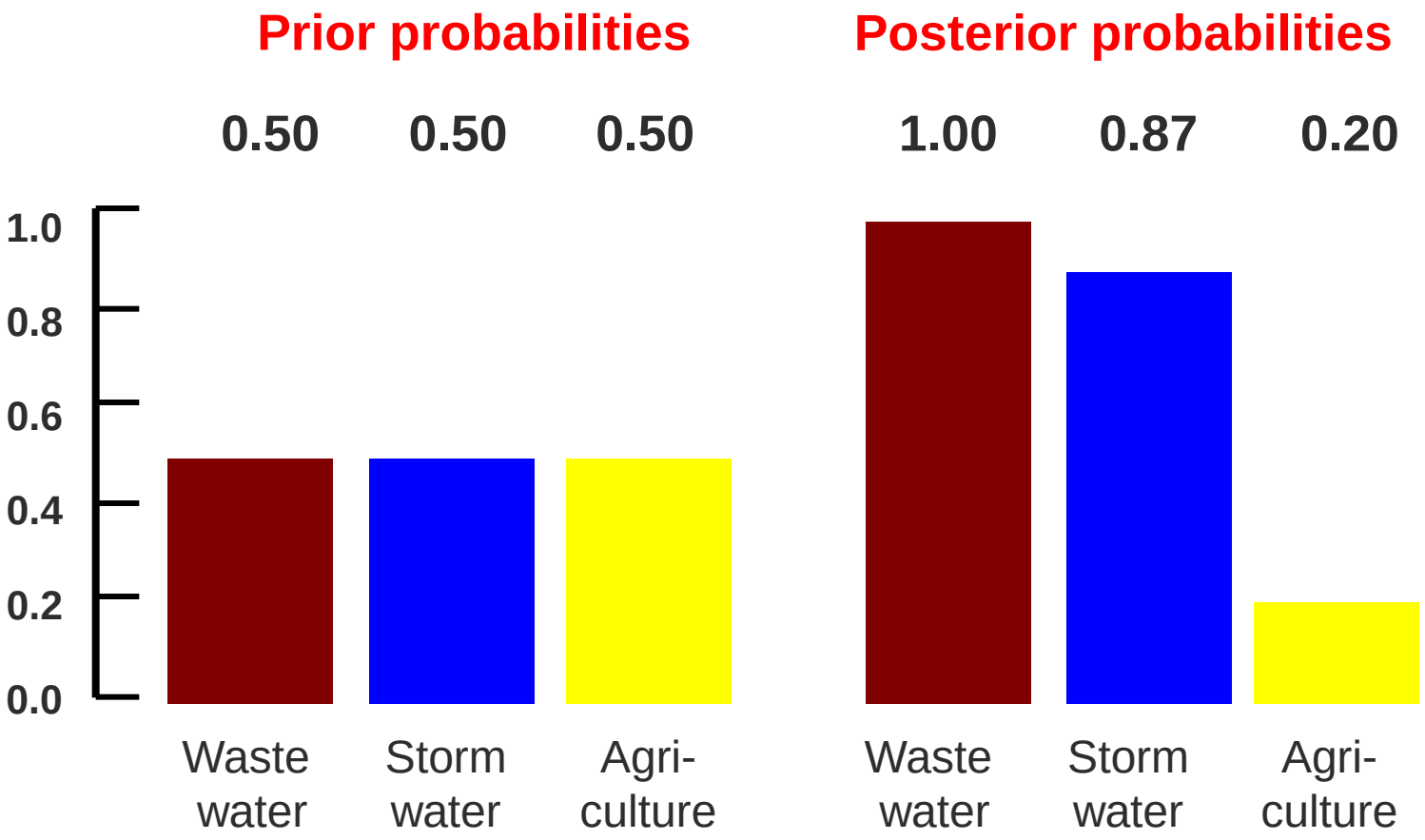
From [illegible] mples:

- 17 biocides,
- 17 pesticides,
- 16 pharmaceuticals,
- 6 personal care products,
- and 1 UV-light stabilizer

or their respective transformation products.

Results for the Mönchaltorfer Aa (Grüningen)

Prior and posterior probabilities of micropollutants sources



Conclusions

Advantages of our approach:

- **Cheap** and **fast** **first screening** to optimize future measurement campaigns
- **Promising** **approach:** usage of sediments as passive samplers of medium polar contaminants to trace their sources in surface water
- **Efficient:** allows locating the existence of the most probable pollutant sources within an urbanized watershed **based on a single sample.**
- **Practicable:** does not require expensive monitoring campaigns
- **Initiative:** support water management communities by pinpointing where within a catchment a problem with micropollutions most probably occurs and where detailed monitoring is required
- Readily **transferable**: to other catchments (priors can be adapted to local knowledge)

Conclusions

Limitations of the approach:

due to the **costs of the chemical analysis:**

- **Not yet optimal**:
  - chemical analysis is still labour-intensive
  - high analytical cost only allows the analysis of few samples
  - possible false negatives: some compounds might go undetected
  - number of detected substances may influence the robustness of the results

Qualitative analysis is much **cheaper** than **quantitative**:

→ fast and cheap screening method to get useful results

→ can be employed in great numbers - more samples (case studies) may be analyzed

Conclusions

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due to the **costs of the chemical analysis:**

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Perspectives:

→ Chemical analysis **cheaper** and **more accessible**

→ Including more **specific tracers**

→ **Tracing sediments** based on micropollutants

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