Application of Particle Transport Modeling and Chemical Forensic Analysis in Sediment Contamination Source Evaluation

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Why This Topic?

- Contaminated sediment is viewed as a problem in many (not all) countries in the EU and elsewhere around the world
- Remediation of the contaminated water bodies is technically complex and costly
- Two questions always rise to the top of the discussion:
  - What is the best approach to cleanup?
  - Who should or will pay?
- Application of particle transport modeling and chemical forensic analysis help to answer these questions

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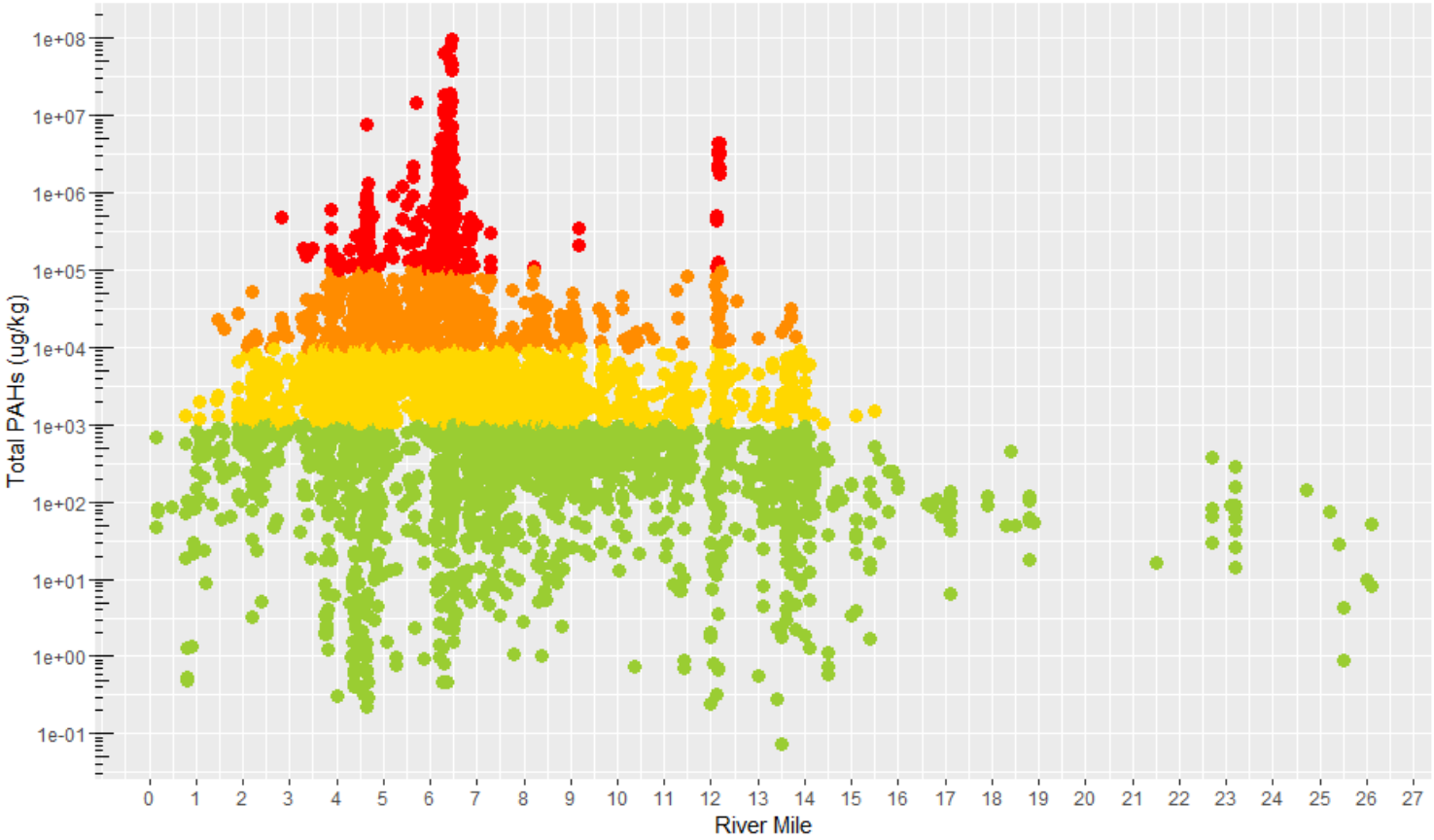
The management questions

- These techniques can be combined to investigate the following management questions:
  - **1. Presence of hotspots and vulnerability of exposure**
  - 2. Contamination footprint from discharges e.g. runoff, stormwater, riverine loads
  - 3. Effects of remediation – evaluation of cap; scour; dredging etc.
  - 4. Potential for recontamination – transport between sources/hotspots/historical contamination
  - Identifying hotspots and discharges is easy….

How to identify hotspots



- Observation of sediment quality data will inform us of the location of todays hot spots
- But what is the potential for transport?
- Particle transport modeling and chemical forensics provide insight

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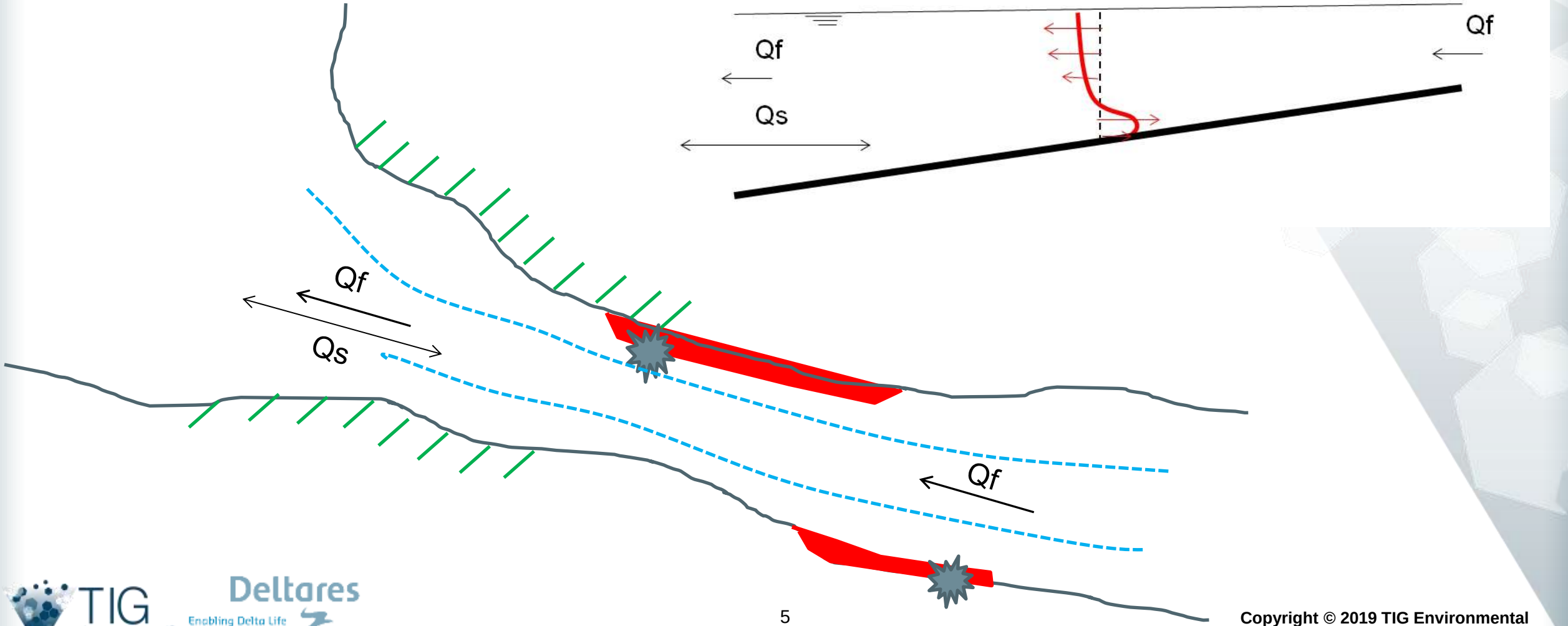
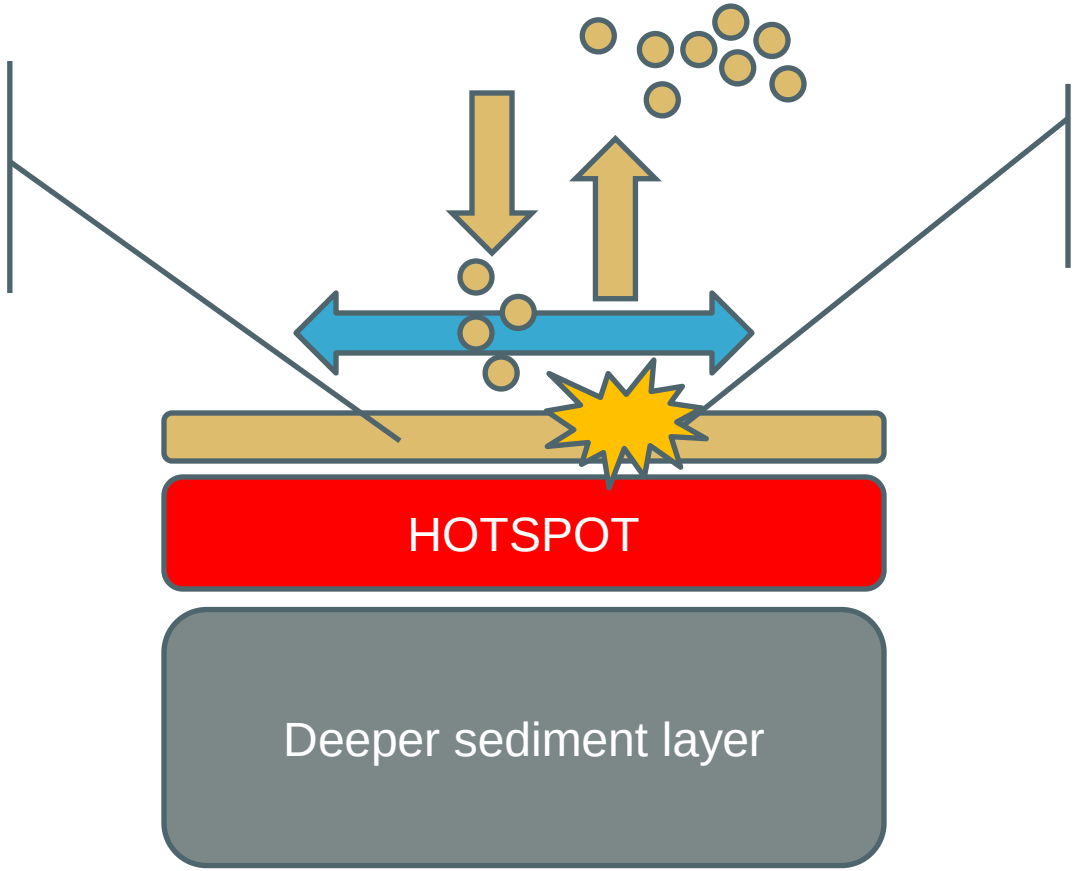
Conceptual hotspot transport model



Conceptual hotspot transport model

Deposition properties

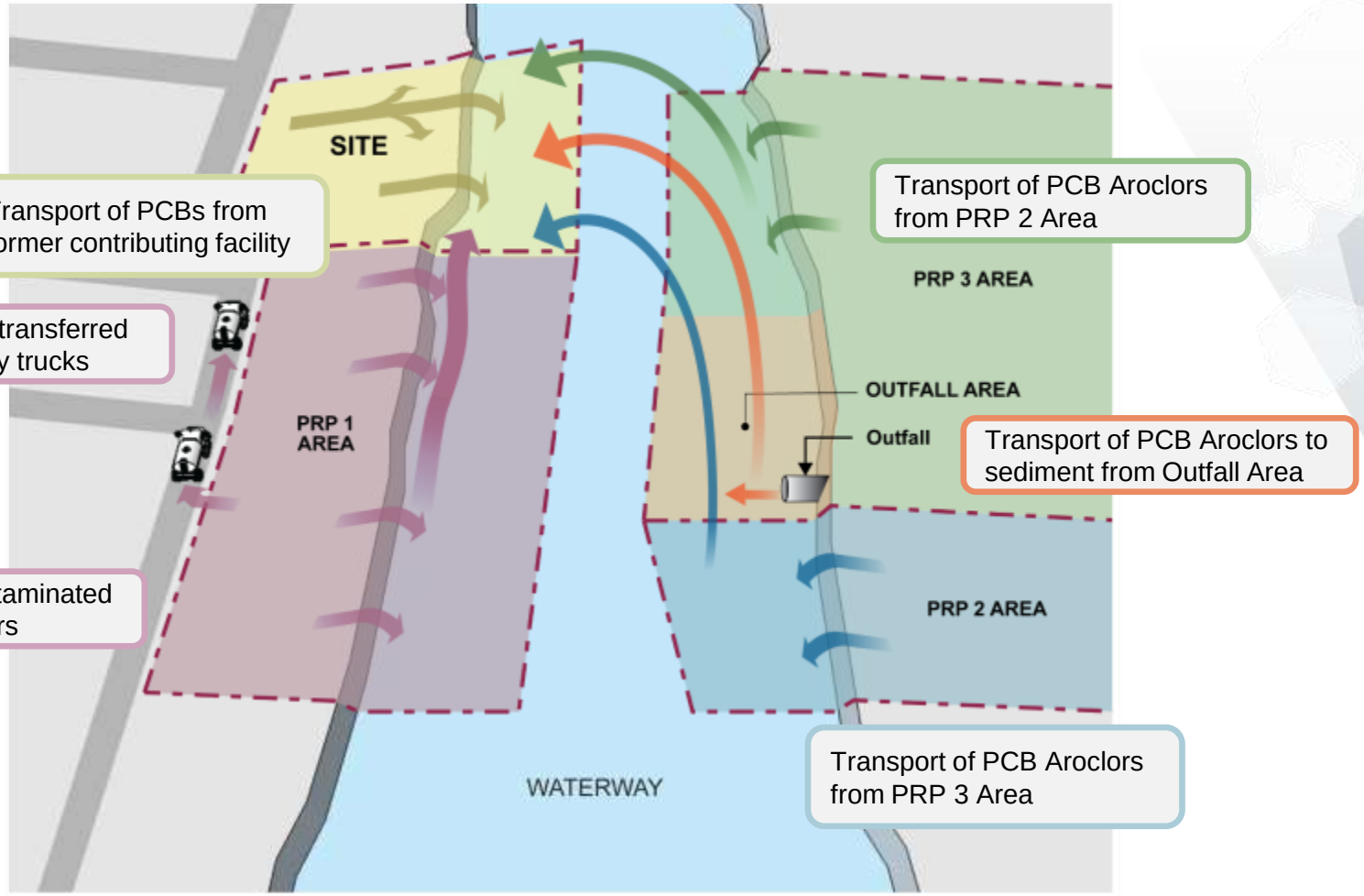
- Settling velocity
- Flocculation
- Consolidation rate



Erosion properties

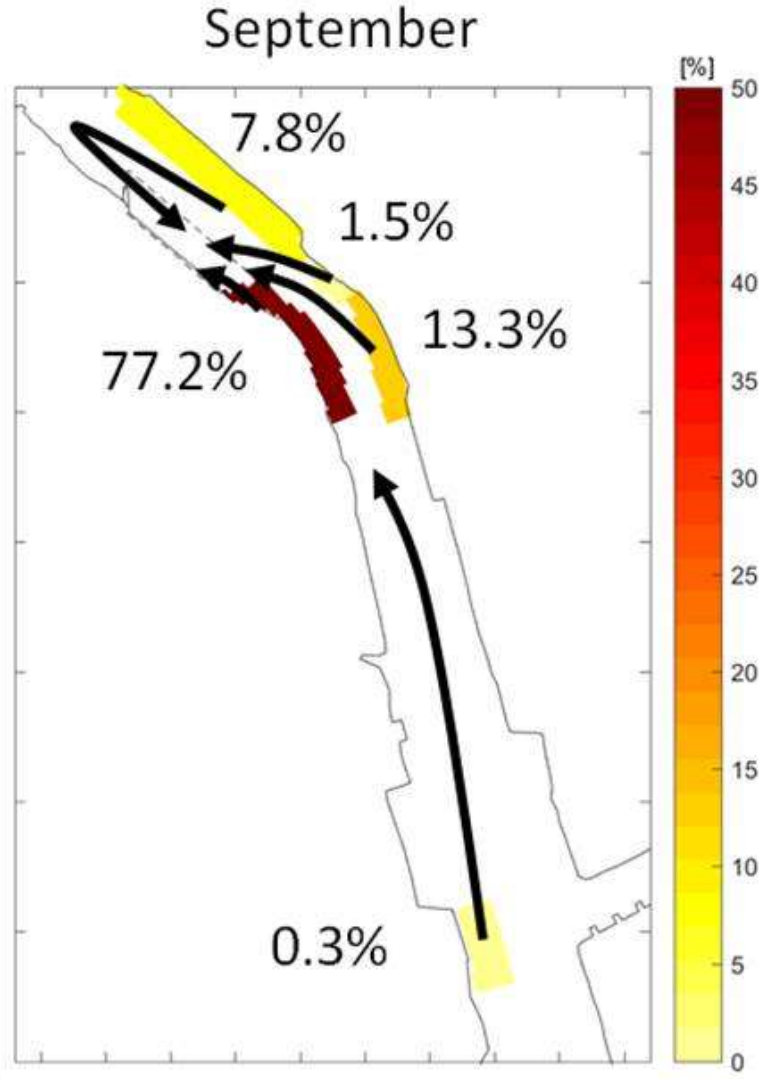
- Particle size and % mud
- Erosion rate
- Critical bed shear stress
- Shear Strength
- Atterberg limits

Conceptual Model of the Pathways



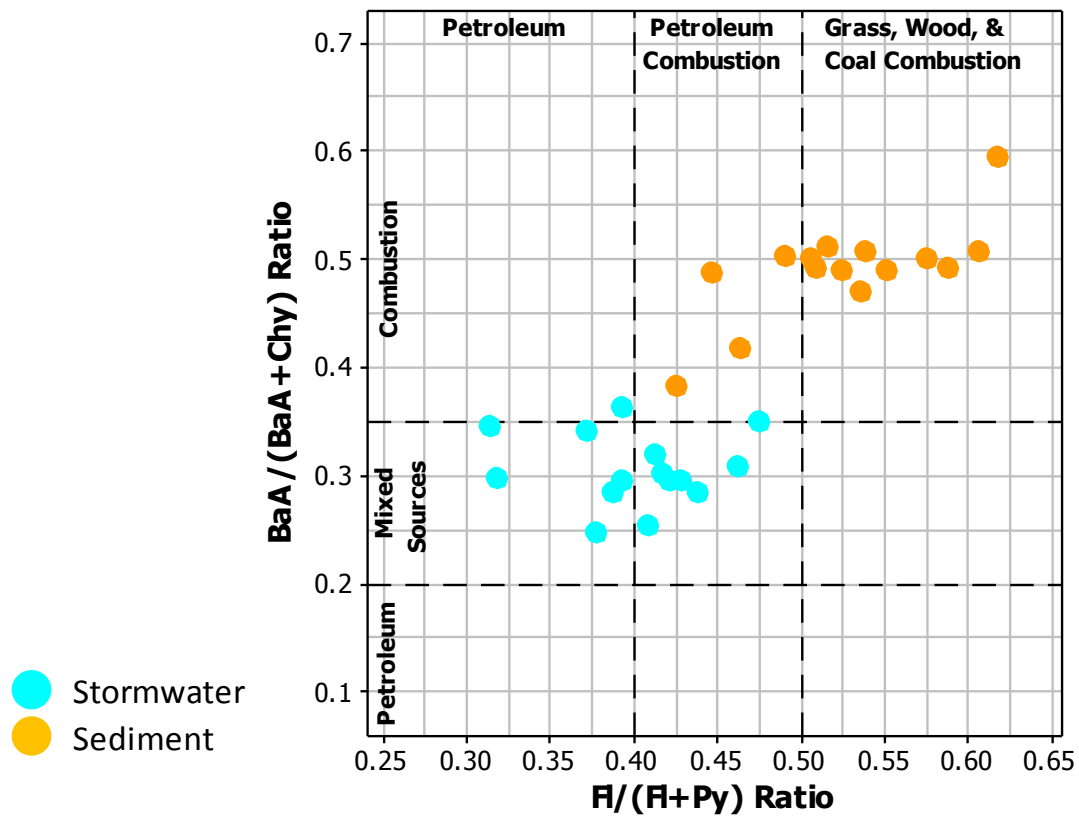
Model results

- 3D hydrodynamic and sediment transport model in Delft3D
- Analyzed erosion and transport of sediments from hotspots
- Calculated relative contribution of the different source areas to Site 1
- Different scenarios



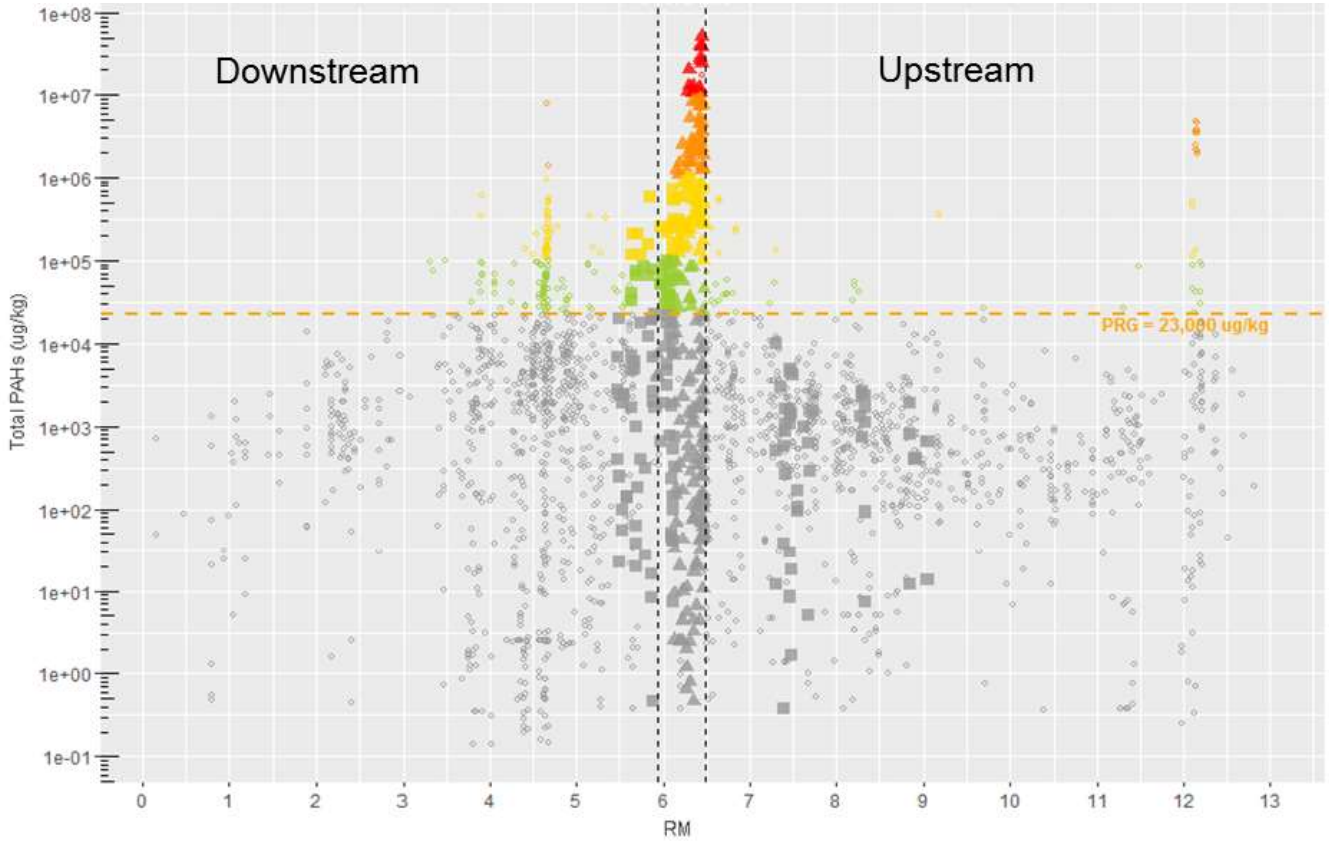
Why Environmental Forensics? (Fingerprinting)

- Well established techniques for source identification and fingerprinting include:
  - polycyclic aromatic hydrocarbon (PAH) diagnostic ratios
  - chemical fingerprinting of PAHs (alkylation profiles)
  - Principal Component Analysis (PCA) for source fingerprinting
  - Analysis of PCB aroclor and congener source signatures
  - Statistical analysis to support source identification
- These techniques must be combined with historic site research, financial viability analysis, and corporate succession details to:
  - Identify appropriate parties for participation
  - Begin the process of cost allocation



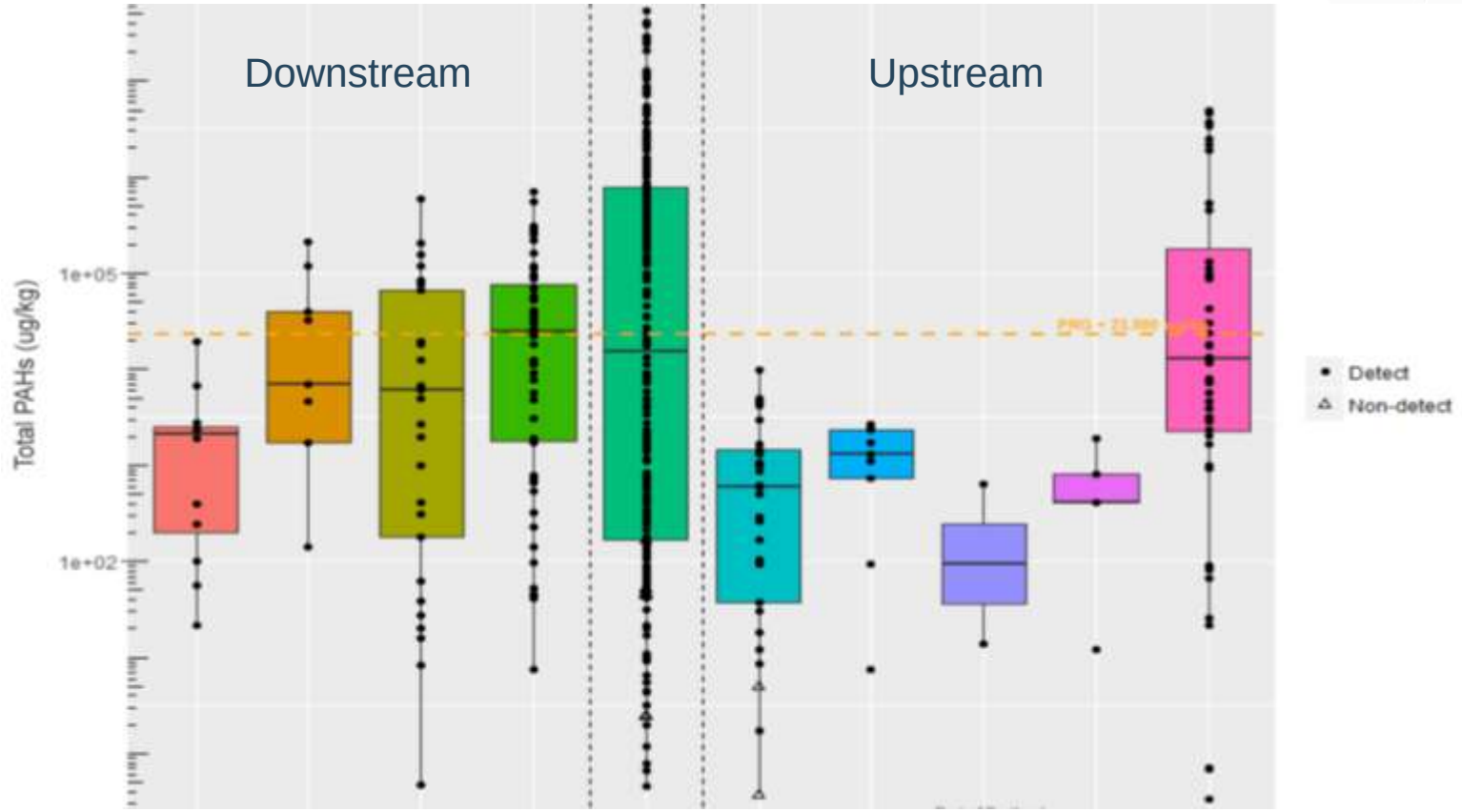
PAH Source Identification

- Example: Polycyclic Aromatic Hydrocarbon (PAH) source was identified by plotting concentration versus river mile (RM)



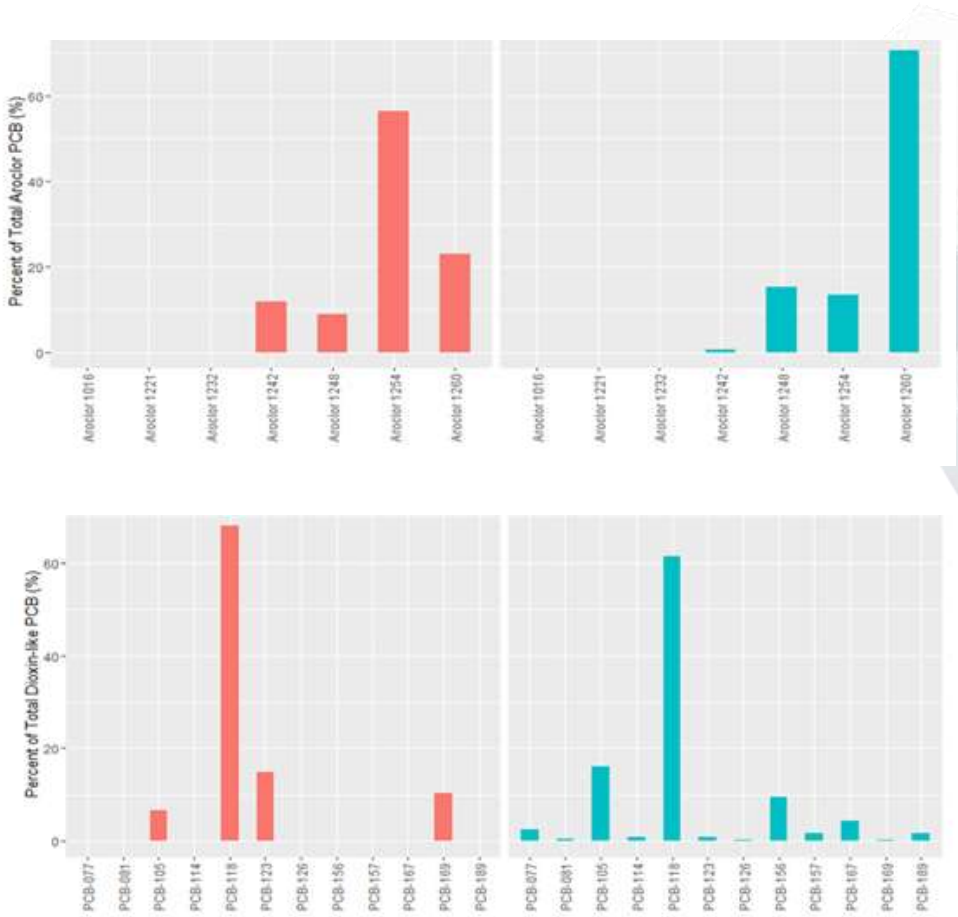
PAH Source Identification

- The same PAH sediment sampling data presented differently



PCB Aroclor and Congener Signatures

- Aroclor and congener signatures can be used to compare sources of sediment contamination
- Example: certain industrial operations or processes are tied to certain Aroclors; signatures can pinpoint the source of contamination



Summary

- Use of models
  - What are the drivers behind sediment erosion and deposition
  - How are particles moving in the system?
  - Model scenarios can be used in many ways
- Use of forensics
  - What are the sources of the contamination present?
- We need both to get the full picture
  - Models used to help understand the transport of sediments + contaminants (also for other moments in time)
  - Forensic analysis looks at the source and distribution of contaminants over time

Thank You

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