Technical University of Denmark

Model based monitoring of stormwater runoff quality

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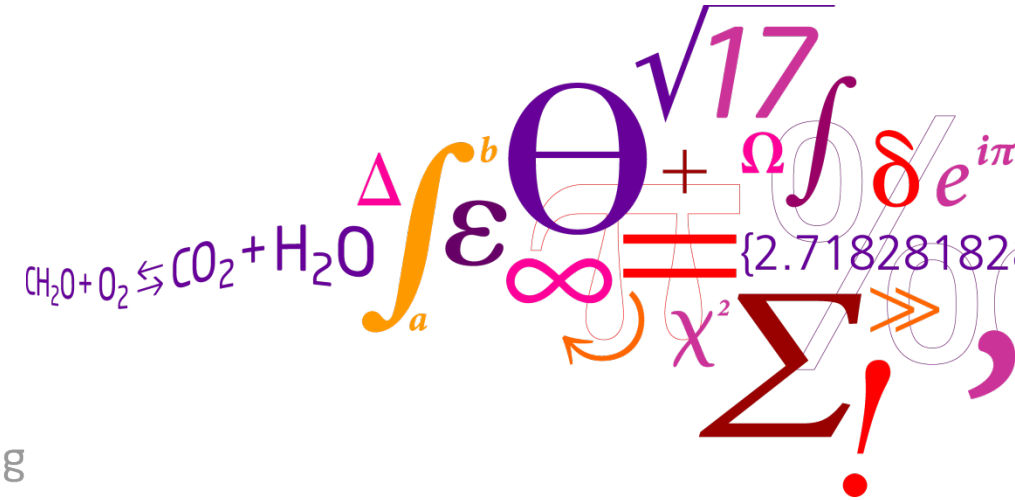


DTU Environment
Department of Environmental Engineering

Monitoring of stormwater

- European Water Framework Directive 2000
  - Obtaining a good chemical and ecological status of surface waters
  - Stormwater treatment is essential to meet environmental quality standards (EQS)
  - Stormwater monitoring is important to focus the effort

- Large variation in concentrations between sites
  - Different sources depending on the catchment

- Large variation over time

Volume-proportional sampling

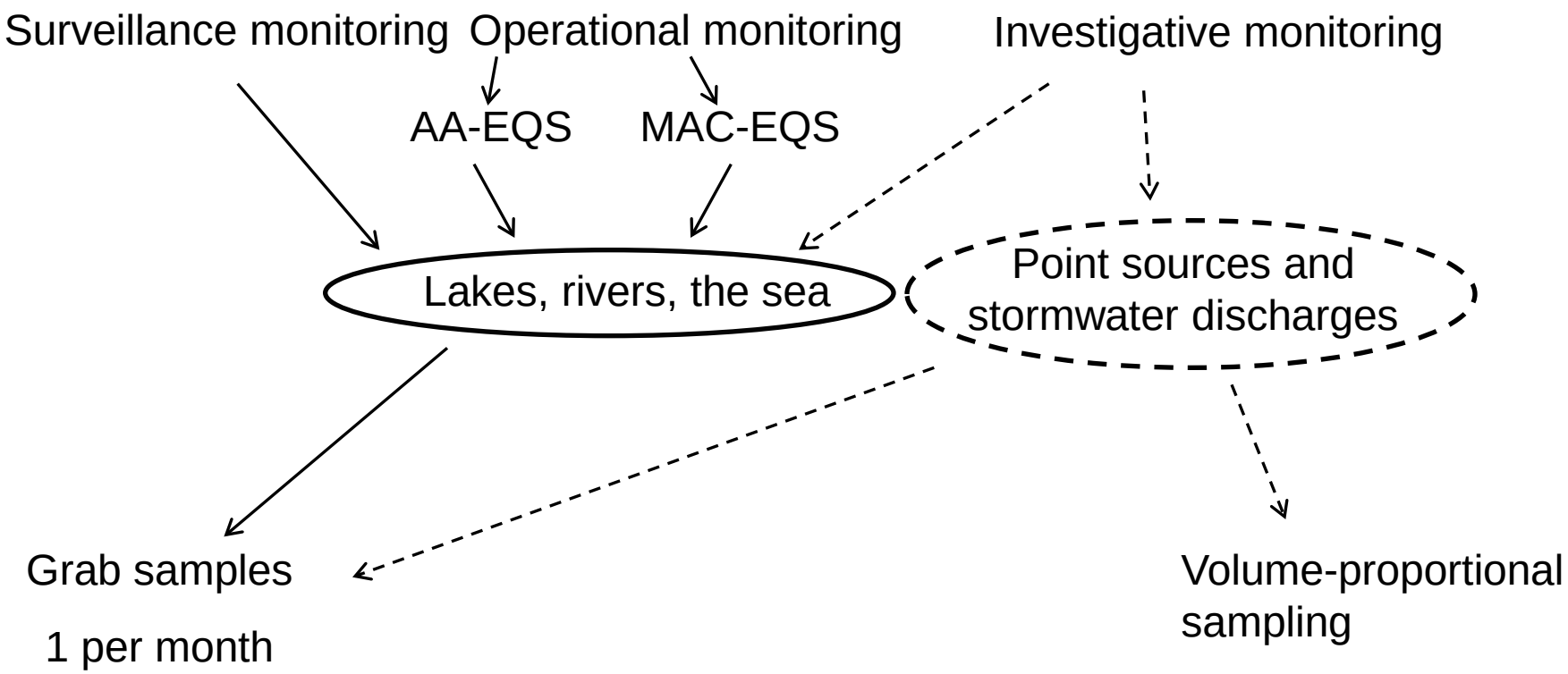
Many priority pollutants

Expensive analyses

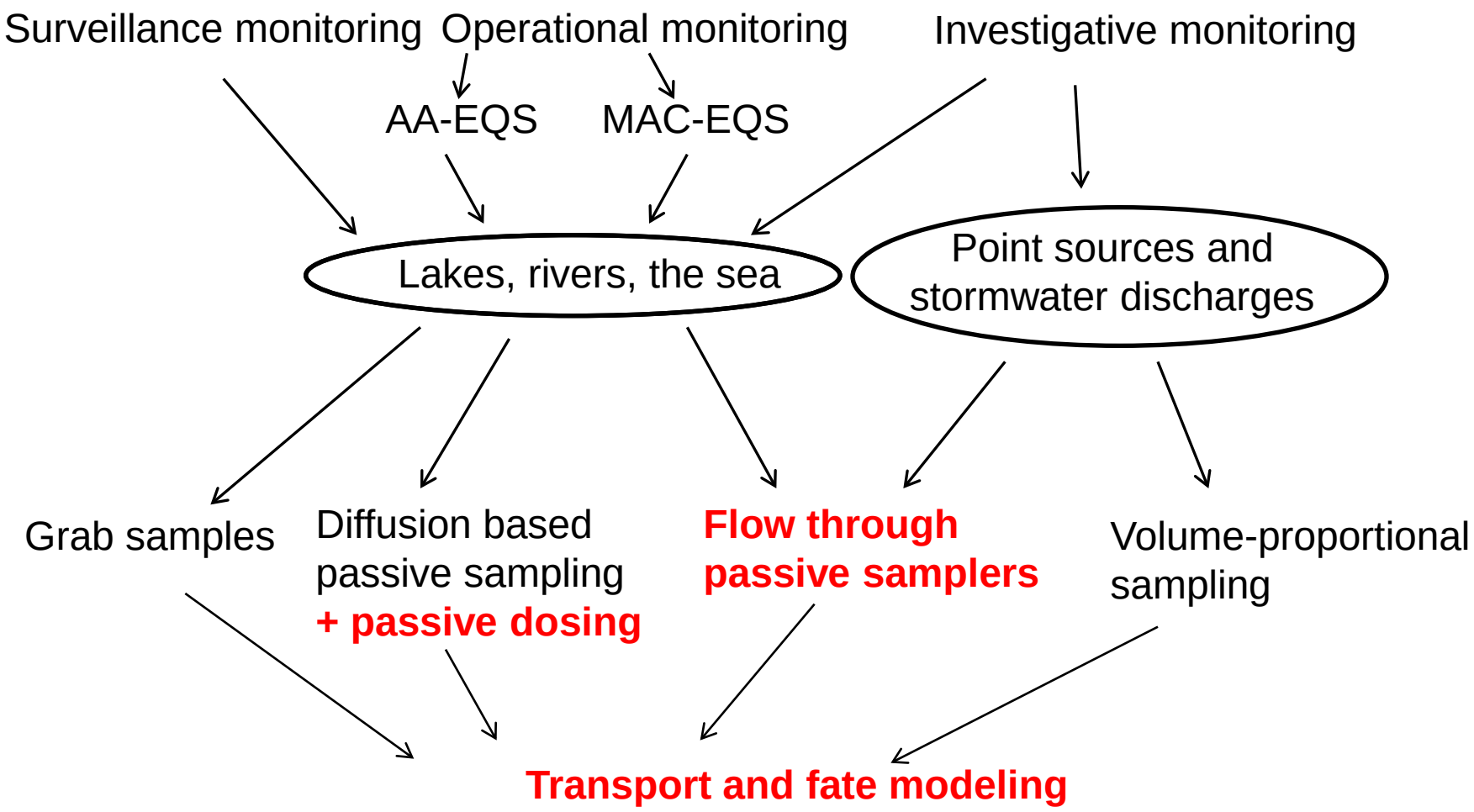
Large expenses

- Need for a smarter way of monitoring

EU-WFD perspectives on monitoring



Our perspectives on monitoring



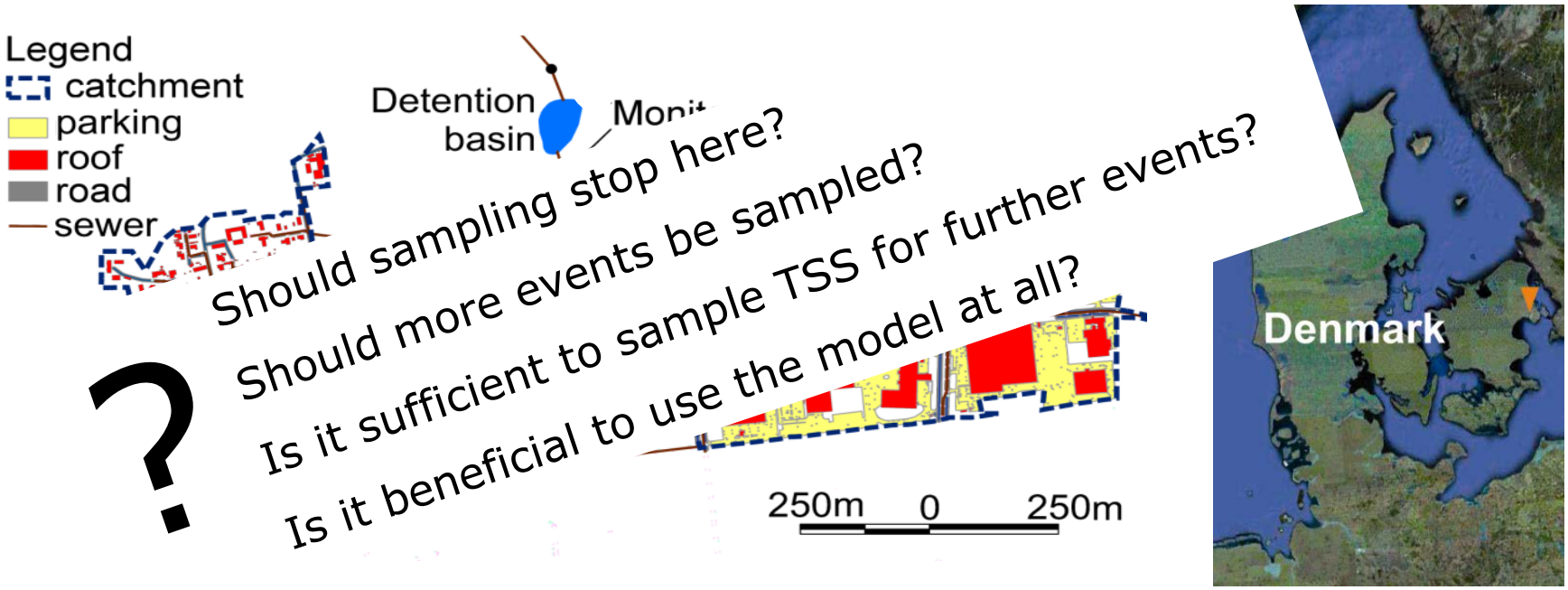
Aim

- Investigate how different monitoring strategies affect the information obtained through sampling campaigns

- Combinations of
  - Volume proportional sampling (TSS, Cu, Zn, Fluoranthene)
  - Passive samplers (Cu, Zn)
  - Dynamic stormwater quality model

- Annual average (AA) concentrations in discharges were evaluated as a measure which can be evaluated against AA-EQSs (when dilution at the actual site and rain periods has been taken into account).
- Maximum event mean concentrations (EMCs) were evaluated as a measure to compare to maximum allowable concentrations, MAC-EQS.

Case study - background

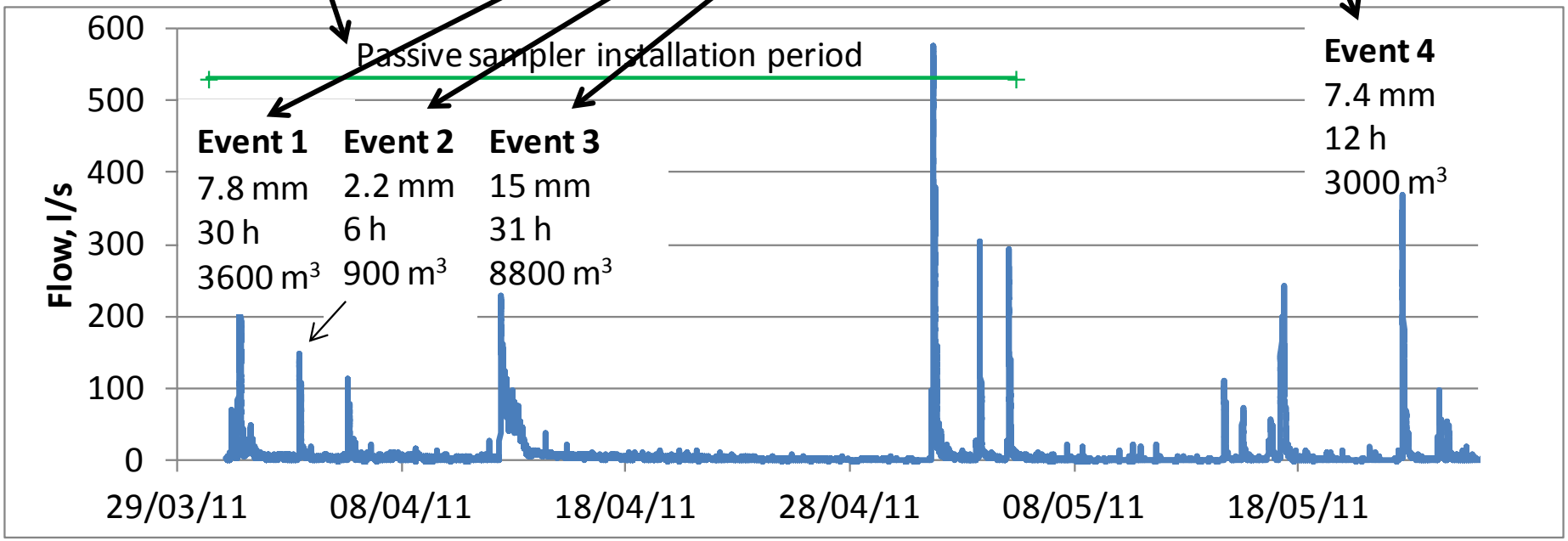


- Earlier monitoring at the site (2010) included flow measurements and volume-proportional sampling of Cu and Zn (6 events) and fluoranthene (2 events)
- The data was used to calibrate a dynamic stormwater quality model

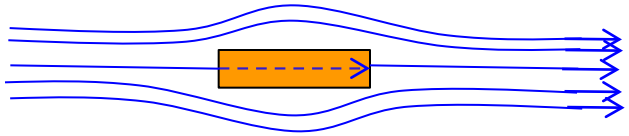
Sampling 2011

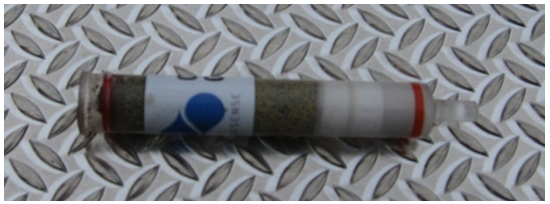
Flow-through passive samplers

Volume proportional sampling



Flow-through passive sampler

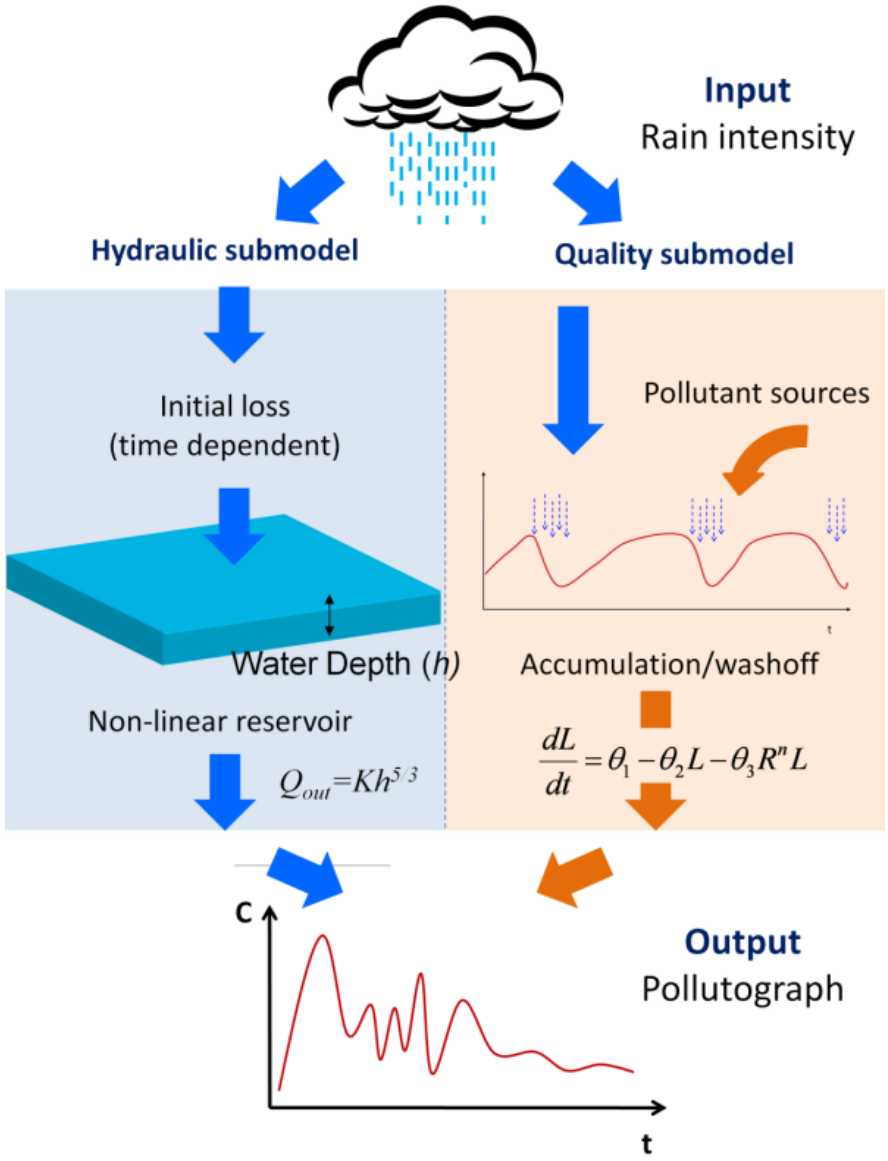




SorbiCell

- Built-in tracer measure how much water has passed the sampler
- Accumulates analytes when water is pressed through

Dynamic stormwater quality model



- Calibrated using the GLUE method
- Informal likelihood:

$$L_{quality} = L_{TSS} \cdot L_{MP},$$

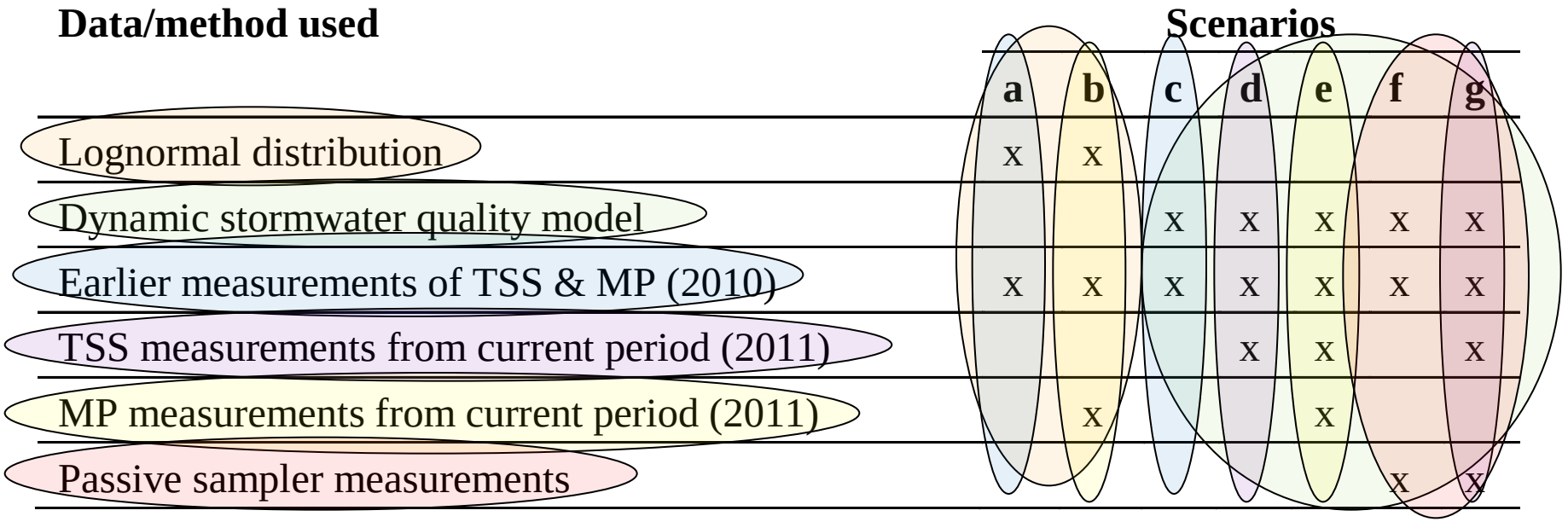
or:

$$L_{quality} = 0.25 \cdot L_{TSS} + 0.75 \cdot L_{Cu}$$

where:

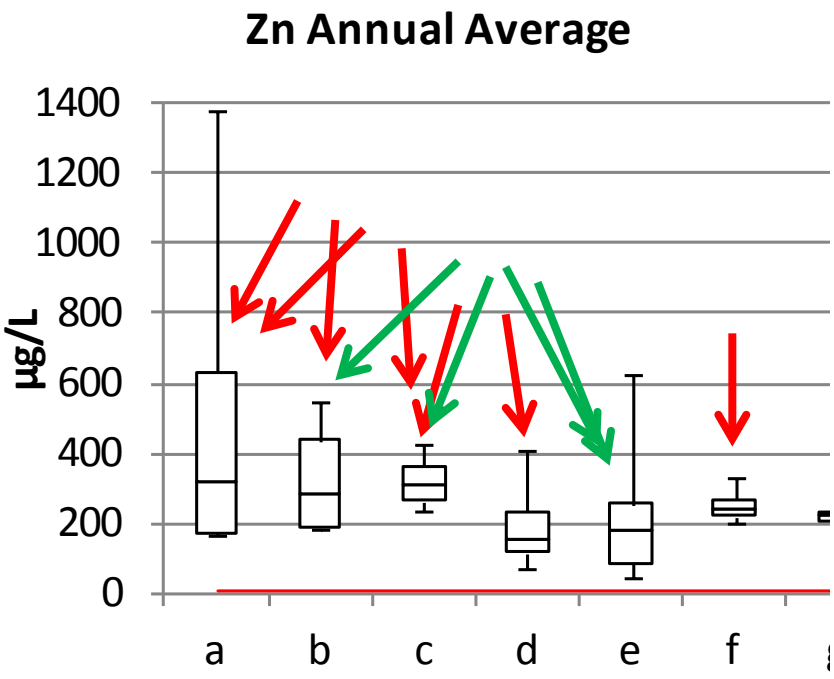
$$L = \frac{1}{\sigma_e^2}$$

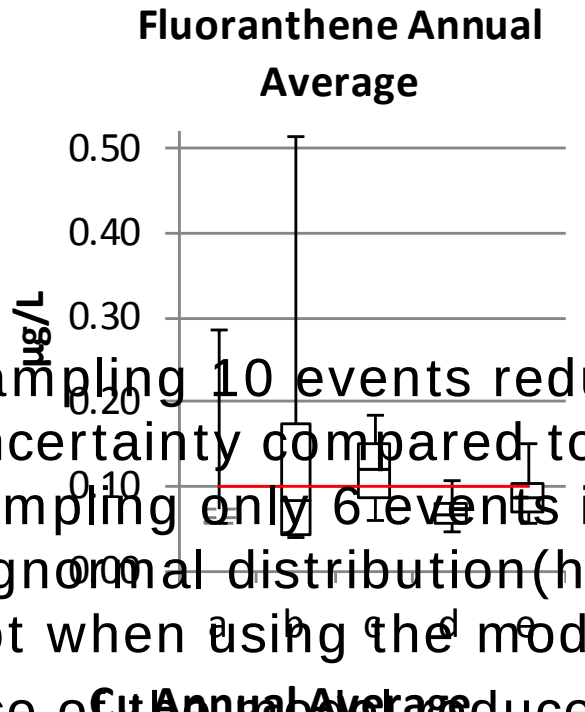
Monitoring scenarios



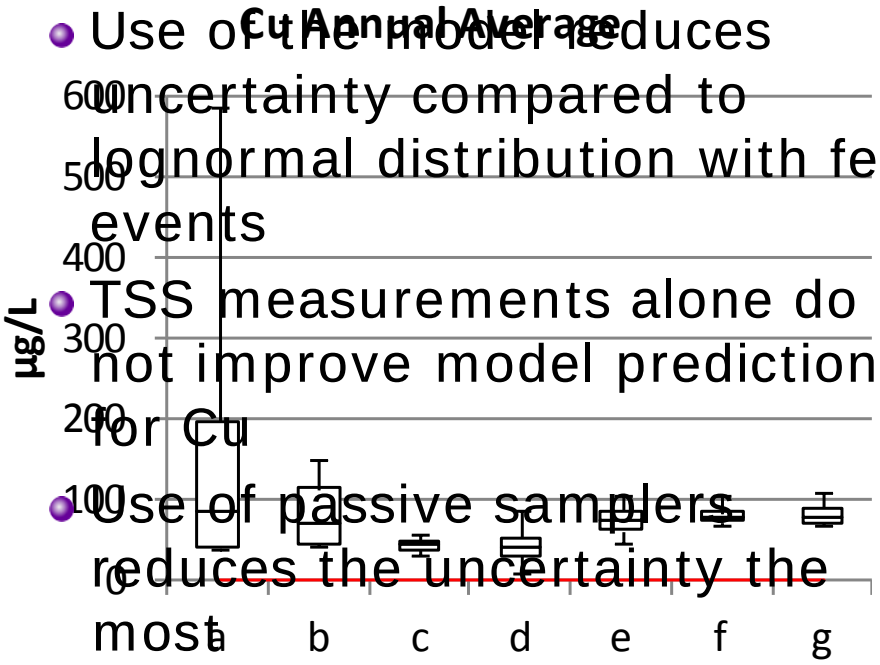
Annual average

- AA evaluated based on a 10 year rainfall series and the identified 'behavioral' parameter sets



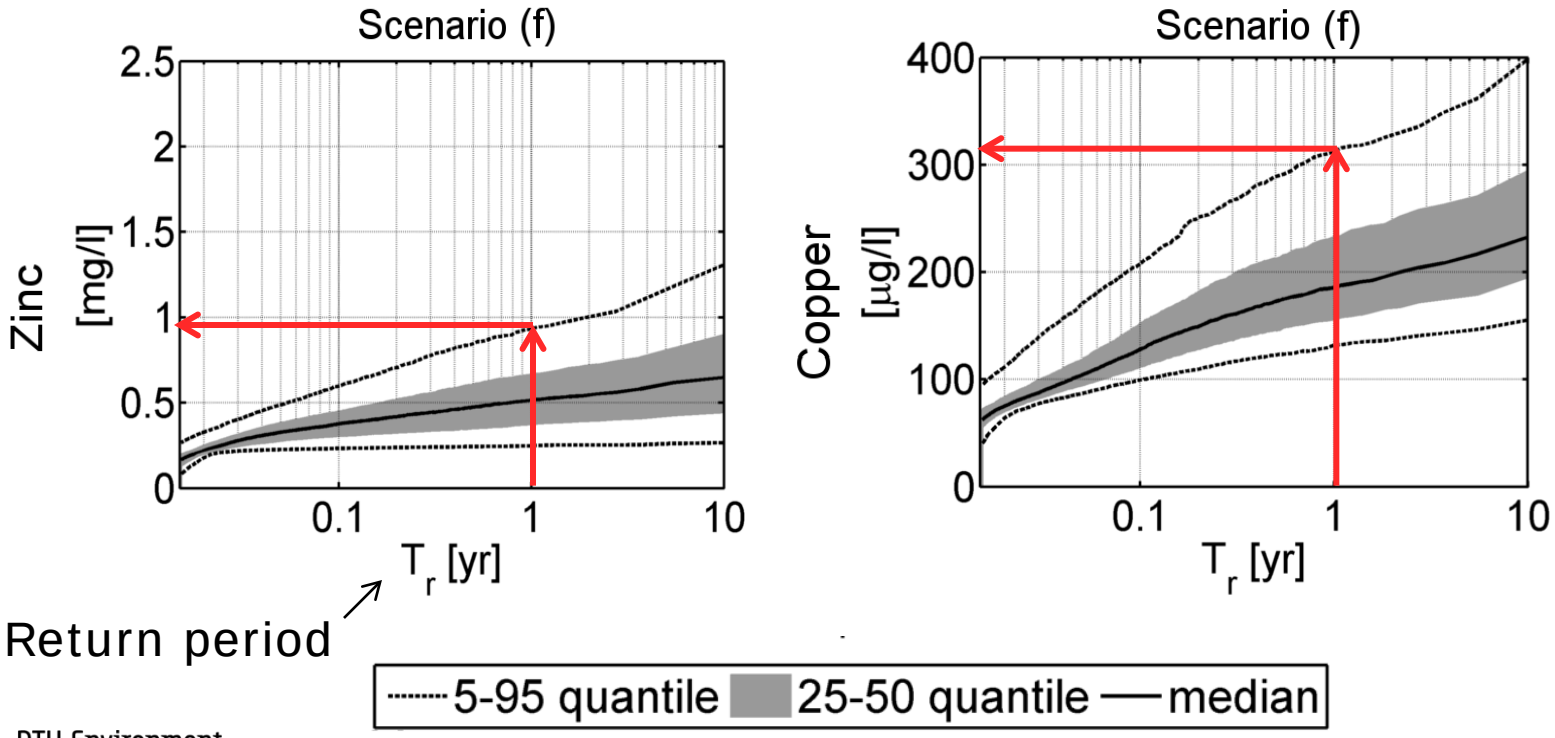


- Sampling 10 events reduces uncertainty compared to sampling only 6 events in the lognormal distribution (however not when using the model)
- Use of the model reduces uncertainty compared to lognormal distribution with few events
- TSS measurements alone do not improve model prediction for Cu
- Use of passive samplers reduces the uncertainty the most

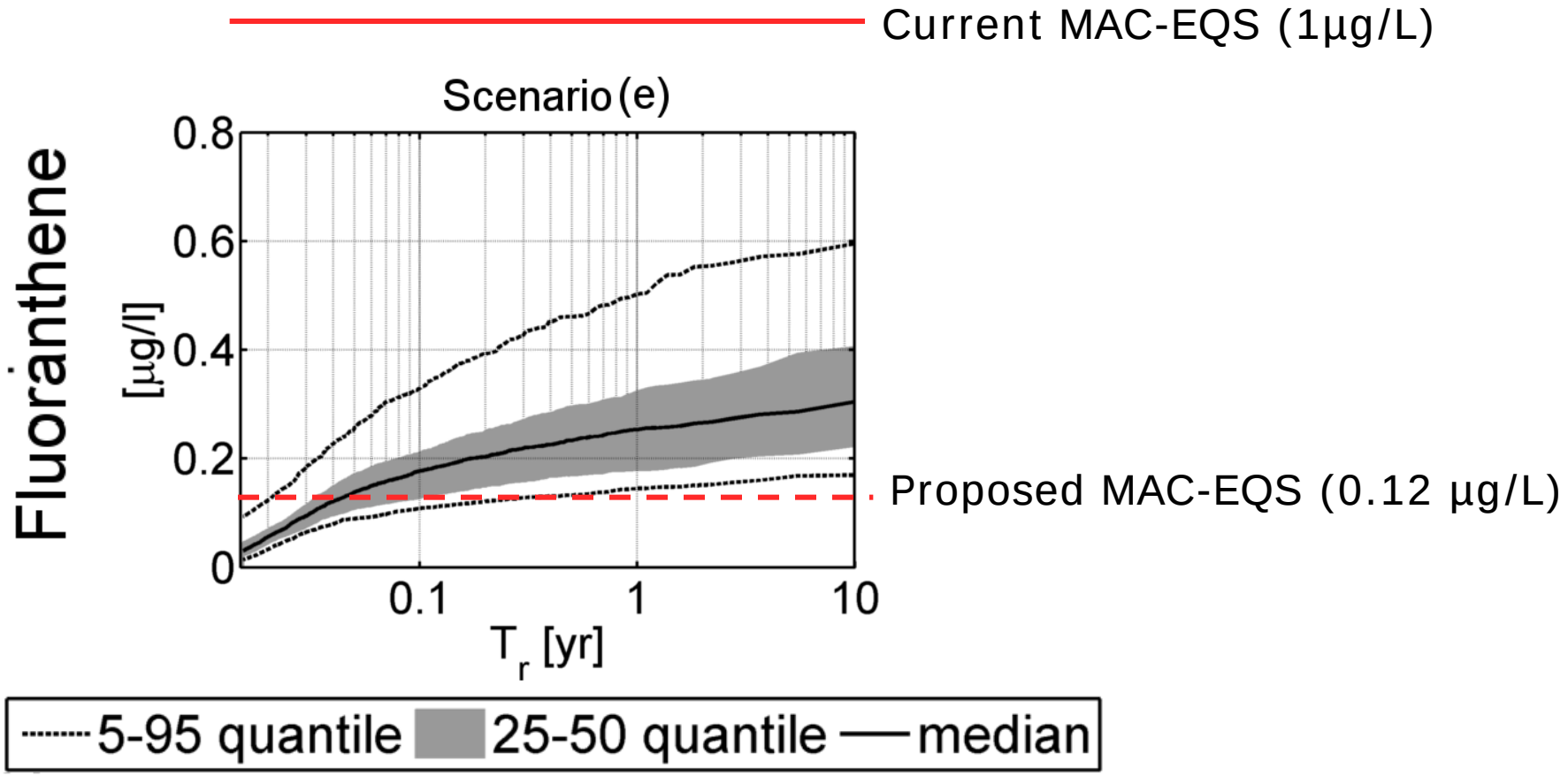


Maximum event mean concentrations

- Models can be used to evaluate return periods for event mean concentrations (EMCs)
- Model uncertainty bounds show that 95% of EMCs for a 1 year event is below 950 µg/L for Zn and 310 µg/L for Cu.



Maximum event mean concentrations



Conclusions

- Use of a dynamic stormwater quality model reduced model uncertainty on predicted annual average concentrations compared to uncertainty on the mean of a lognormal distribution of EMCs

- A combination of using one passive sampler measurement and 6 EMCs for calibration reduced model uncertainty compared to using 10 EMCs for calibration.

- Including passive samplers and modelling in monitoring can potentially reduce costs and give information about averages as well as dynamics in the system.

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