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Modeling the behavior of façade biocides in the urban hydrological runoff

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Motivation

- Framework: Quantify Micropollutant load to Lake Geneva
- Focus on Biocides: substances used for material protection
- Impact ecosystems even at low concentrations

(Kleijer and Chèvre 2008)

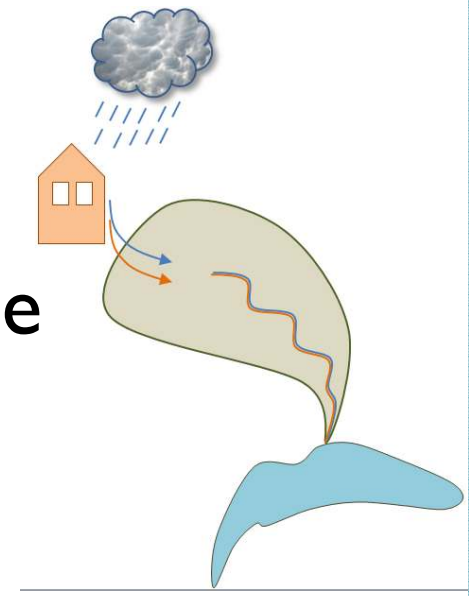
Source: Burkhardt, 2006

Objective

- To predict the dynamics and impact of biocides on rivers

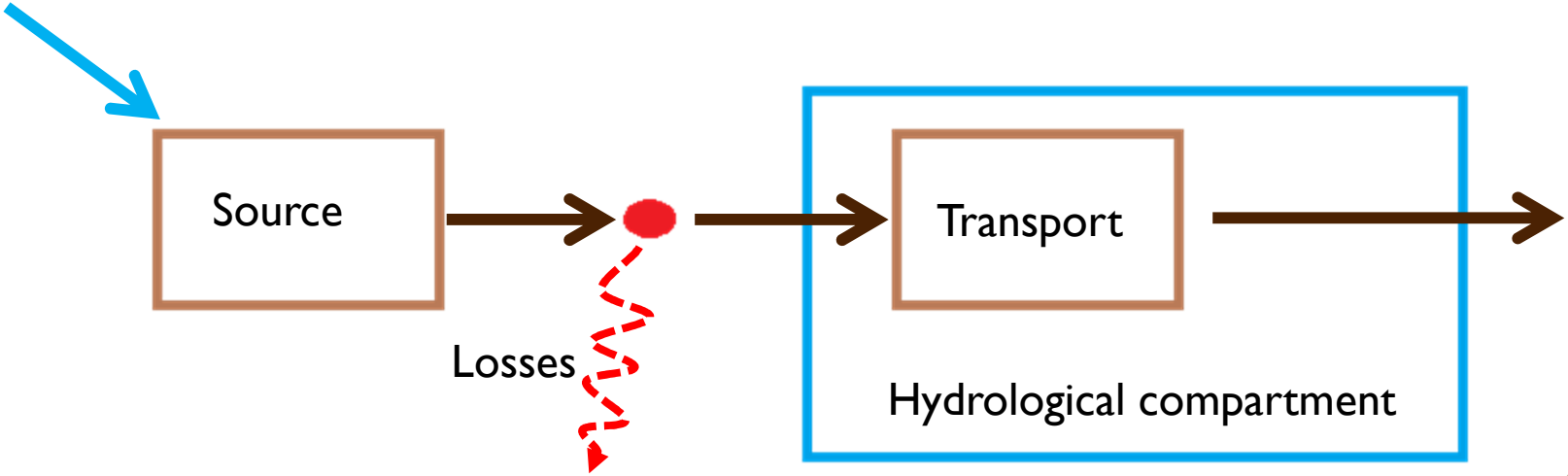
  but so far…

- Experimental studies on their leaching
  (e.g. Burkhardt *et al.*, 2012, Wittmer *et al.*, 2011a)
- Models at façade scale
  (e.g. Coutu *et al.*, 2012a, Wittmer *et al.*, 2011b)
- We needed a model for biocide transport at basin scale!



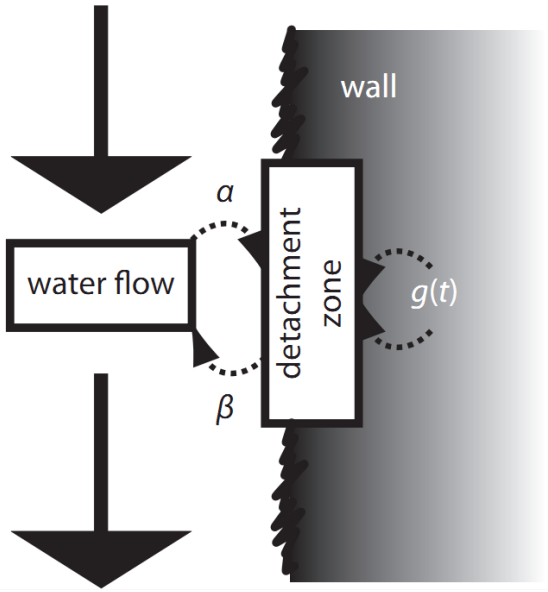
Integrated modeling method

i. Biocide source
ii. Biocide losses (from the system)
iii. Hydrological compartment
iv. Biocide transport



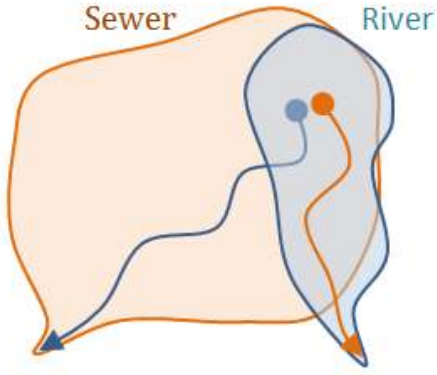
i. Biocide source

- Model describing rain-driven wash-off
  (Coutu *et al.*, 2012a)
- Extrapolation at catchment scale assuming façade homogeneity

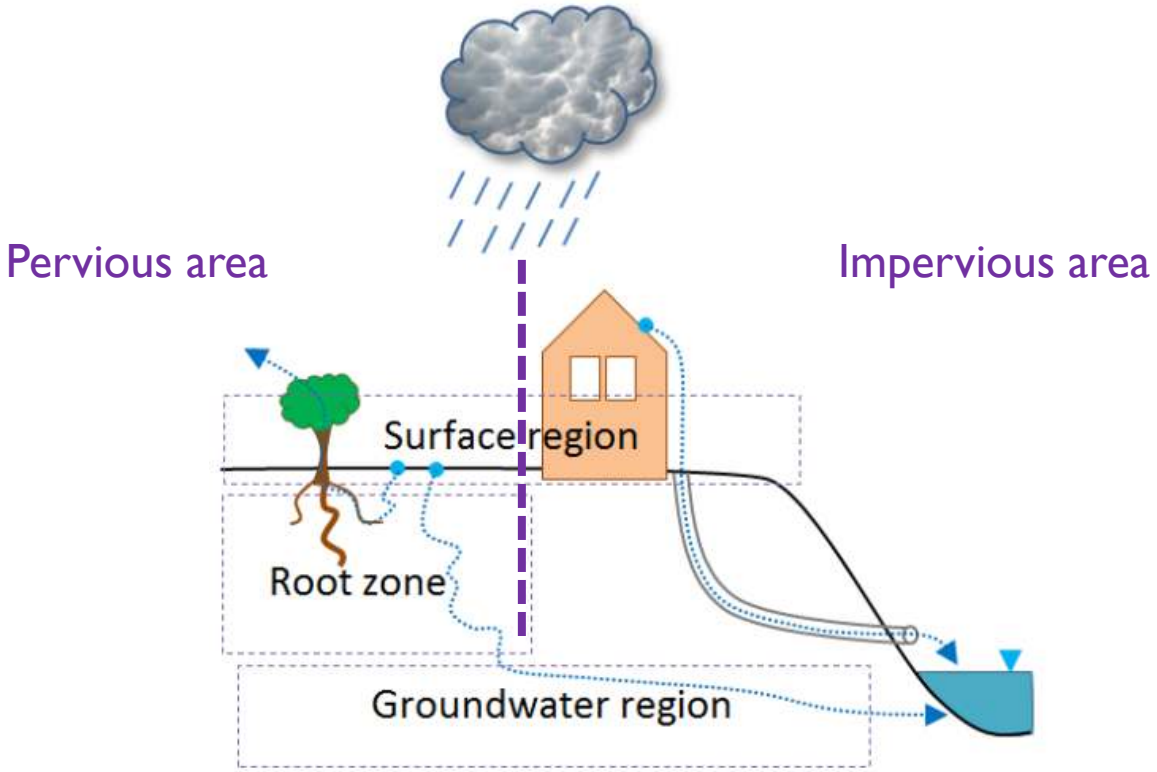


ii. Biocide Losses

- Losses after release modeled with scaling factors k_{hyb} & k_{isd}
- k_{hyb} fraction drained into sanitary sewer
- k_{isd} lumps: infiltration, sorption, evaporation, oxidation, uptaking, etc. (calibration parameter)



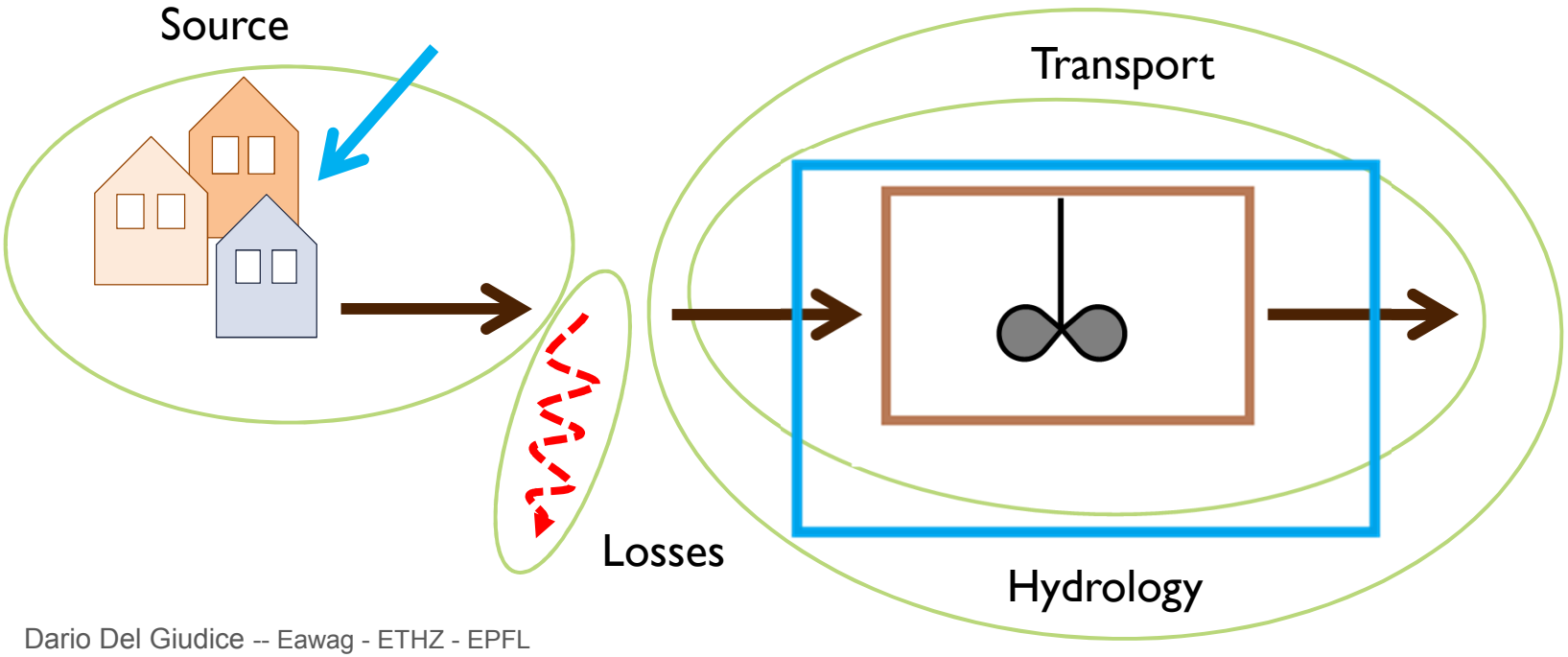
iii. Hydrological component



Coutu, S., Del Giudice, D. et al.. Journal of Hydrology (2012)

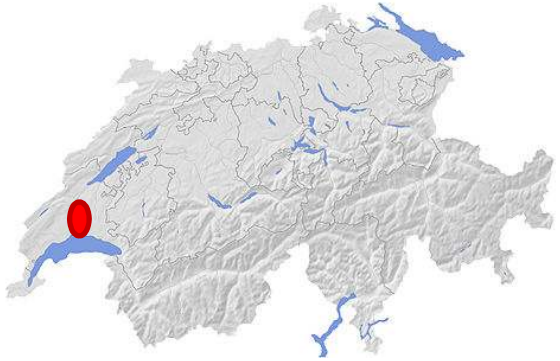
iv. Biocide transport

- Transport on impervious surfaces →
  Linear well-mixed reactor
- Integrated model:



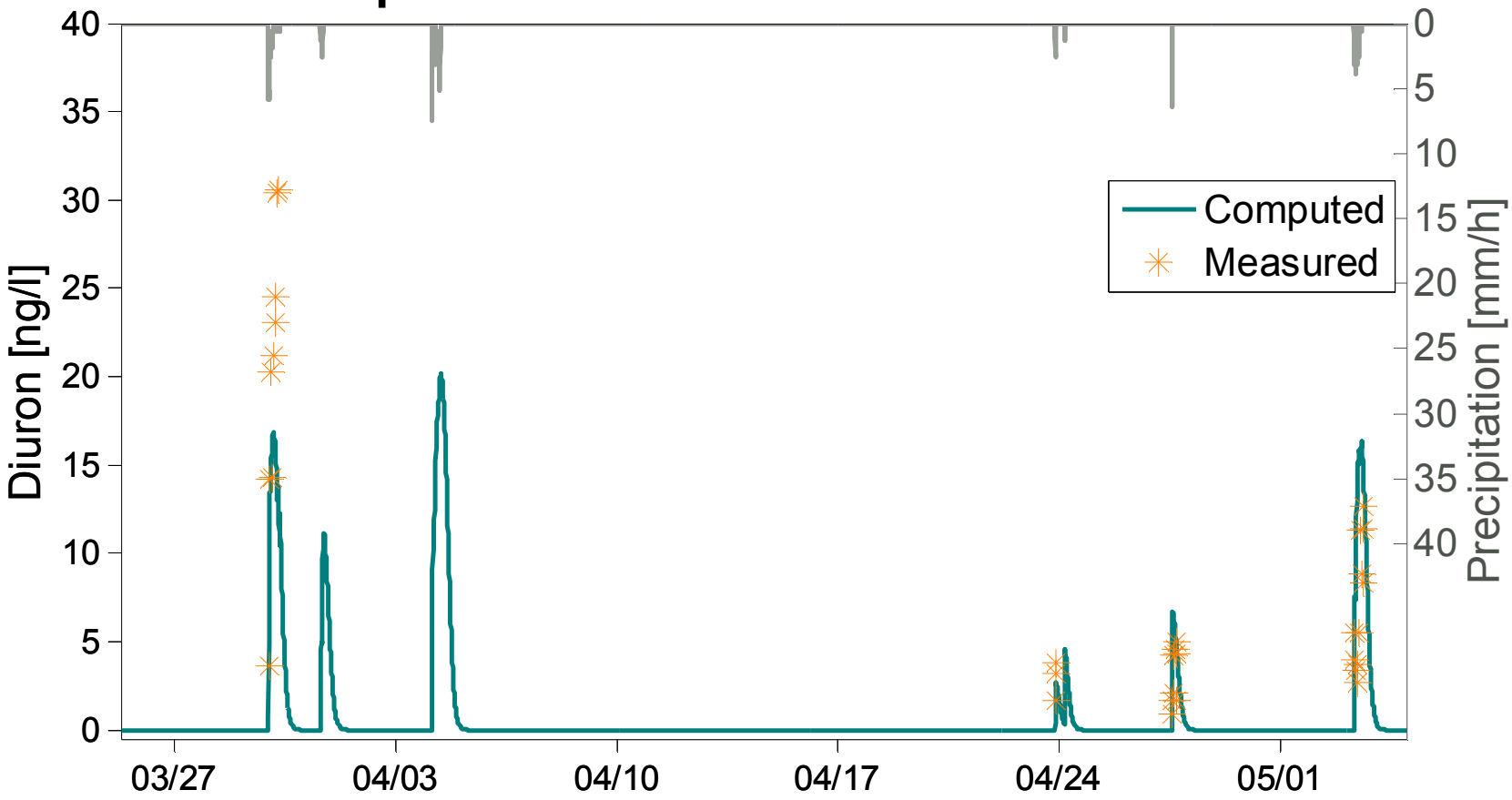
Case study

- Most important facade biocides in urban waters (Wittmer & Burkhardt 2009):
- Diuron: Herbicide, Algaecide ← facades, preservatives
- Carbendazim: Fungicide ← facades, bathrooms…
- Terbutryn: Herbicide, Algaecide ← facades, bathrooms
- Semi-urbanized Swiss river basin (15km^2)

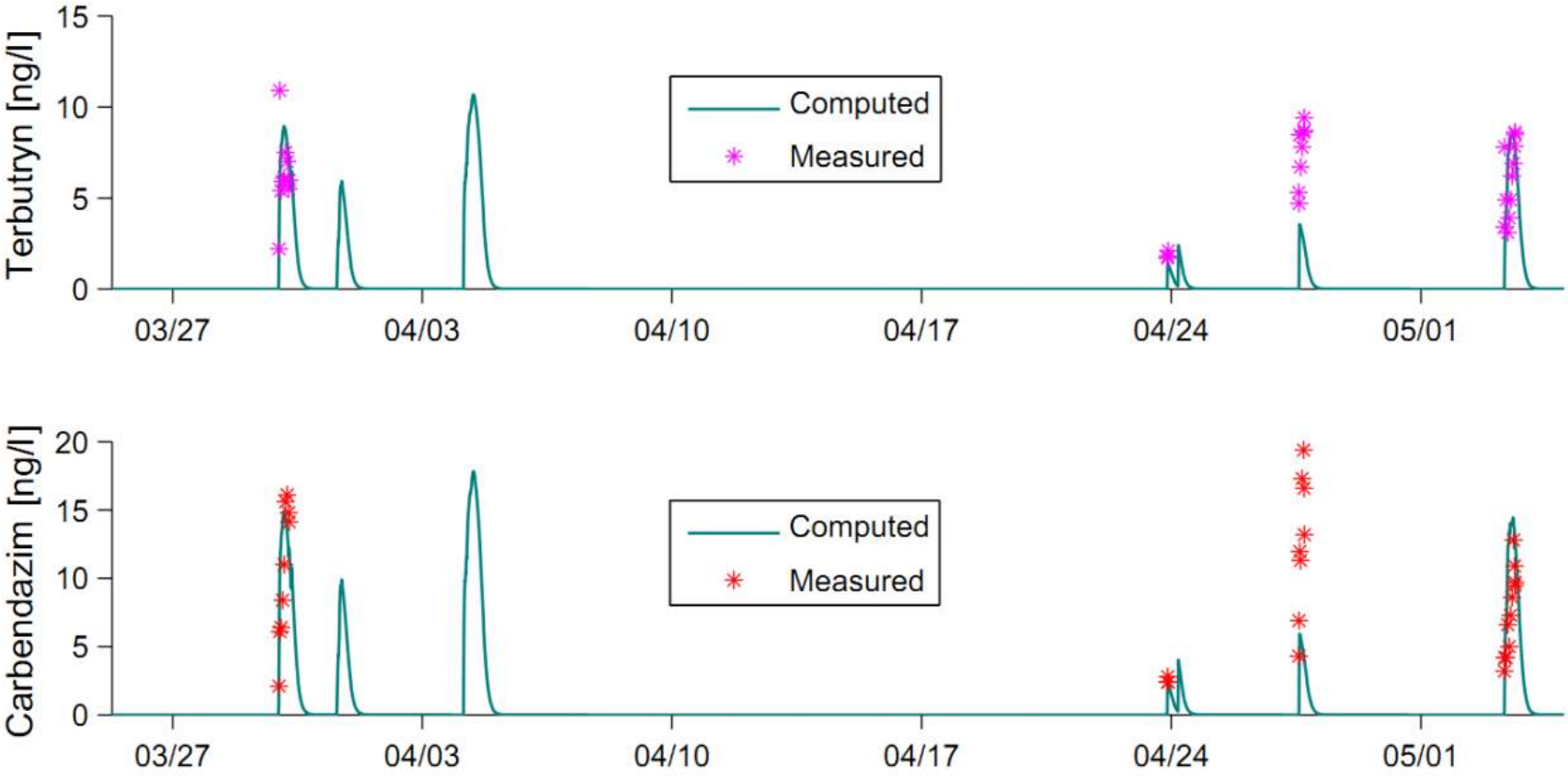


Results: River Concentrations

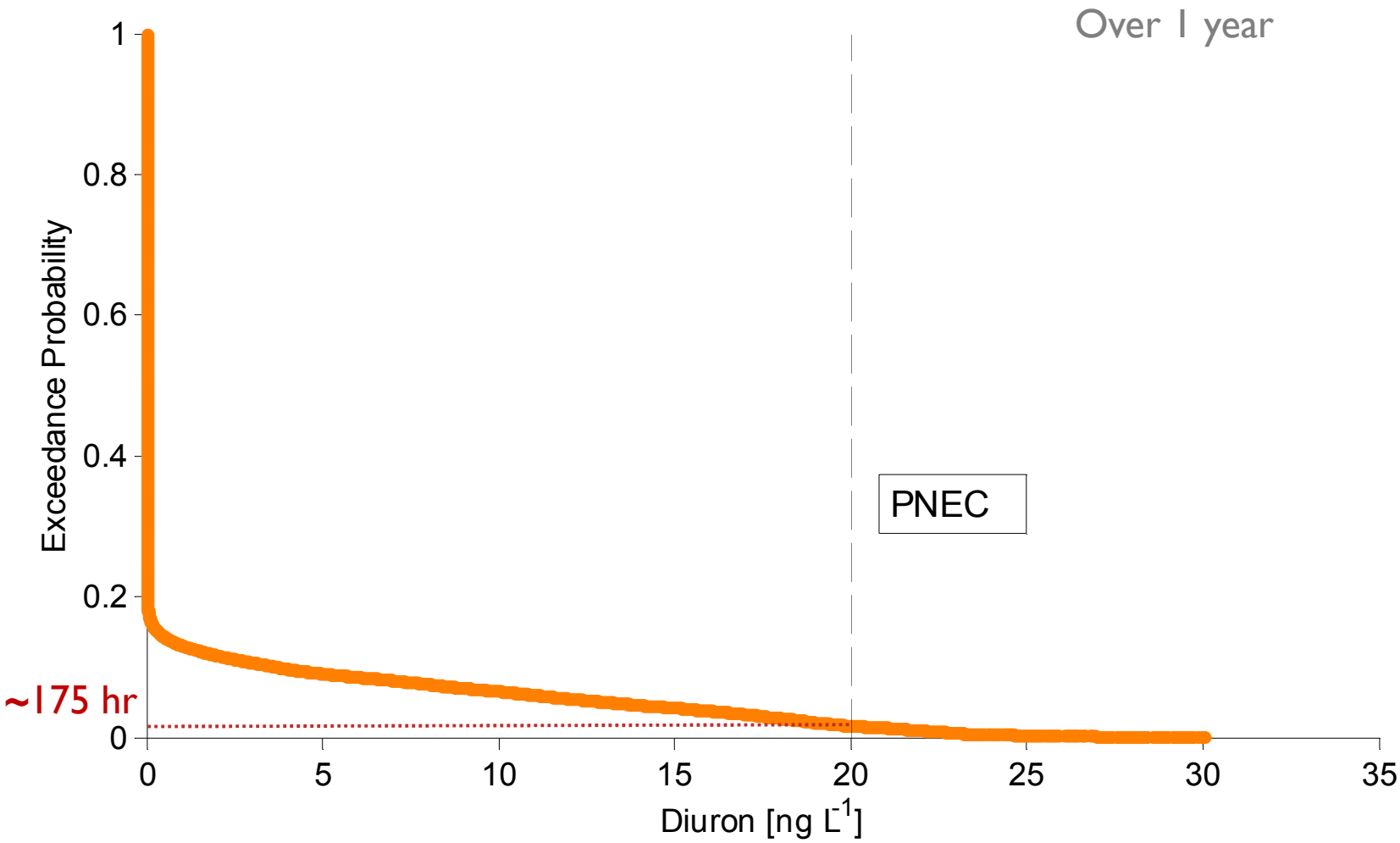
- Samples collected for 4 events
- Least-squares calibration



Results: River Concentrations



Results: Environmental Impact



PNEC = Predicted No-Effect Concentration

Discussion

- In this system façade leaching produced hazardous concentrations for limited time
- To **transfer** it one needs to **recalibrate** the hydrological and quality model
- The effect of **uncertainties needs further study** (coming soon…)
- For more info: *Coutu, S., Del Giudice, D. et al.. Water Resour. Res.(in correction)*

Conclusions

- For the first time we **developed** and calibrated a **biocide transport model** for an urban watershed
- Our **model efficiently reproduced** rain-driven **biocide dynamics**
- It can be used to **assess impact on ecosystems** & optimize protection strategies