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UNIVERSITY
DEPARTMENT OF ENVIRONMENTAL SCIENCE

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Dynamics of Biocide Emissions from Buildings in a Suburban Stormwater Catchment

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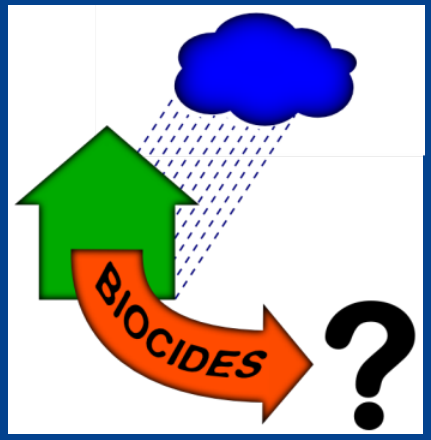
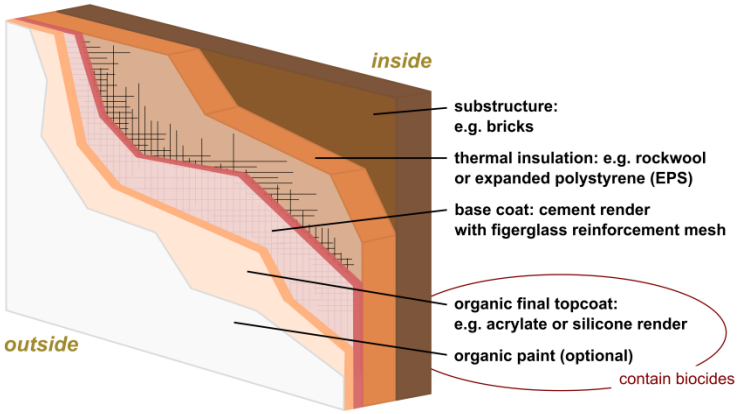


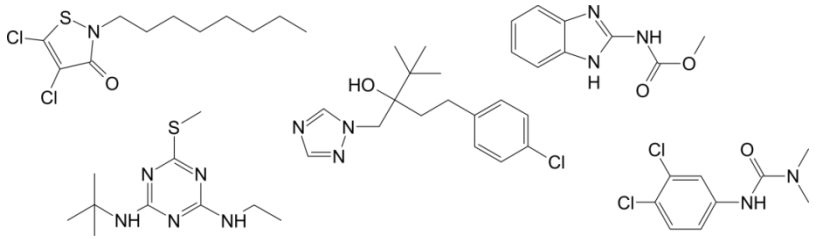
Biocides in building material

- State-of-the-art in material protection
  - In-can preservatives (Product type 6)
  - Film preservatives (Product type 7)
  - Wood protection (Product type 8)
  - Masonry preservatives (Product type 10)
  - Roof protection (flat roofs)
- Content in exterior renders and paints
  - 2-4 different biocides
  - 0.2% in render, 0.2-0.4% in exterior paints



Principal construction of external thermal insulation composite system (ETICS)

- Different compounds with biocidal effects
  - Isothiazolinones, carbamates, phenylureas, triazines, triazoles



» Hydrophilic molecules with toxic effects

Biocides in building material

leaching

Catchment
Sampling & Analysis

Catchment

- Silkeborg (Denmark)
  - 21.5 ha, 7 ha connected to sewer, separated sewer system
  - Suburban, residential, 140 well-kept single family houses
  - 5 % equipped with renders/paints, 20 % (painted) wood, 75 % brick-facades

Sampling and Analysis

- Flow proportional high resolution sampling with automatic water sampler
  - October 2011-June 2012
- Solid phase extraction
- High performance liquid chromatography tandem mass spectrometry (HPLC-MS/MS)

Bollmann et al., Wat Res 56 (2014) 66

Biocides in building material

leaching

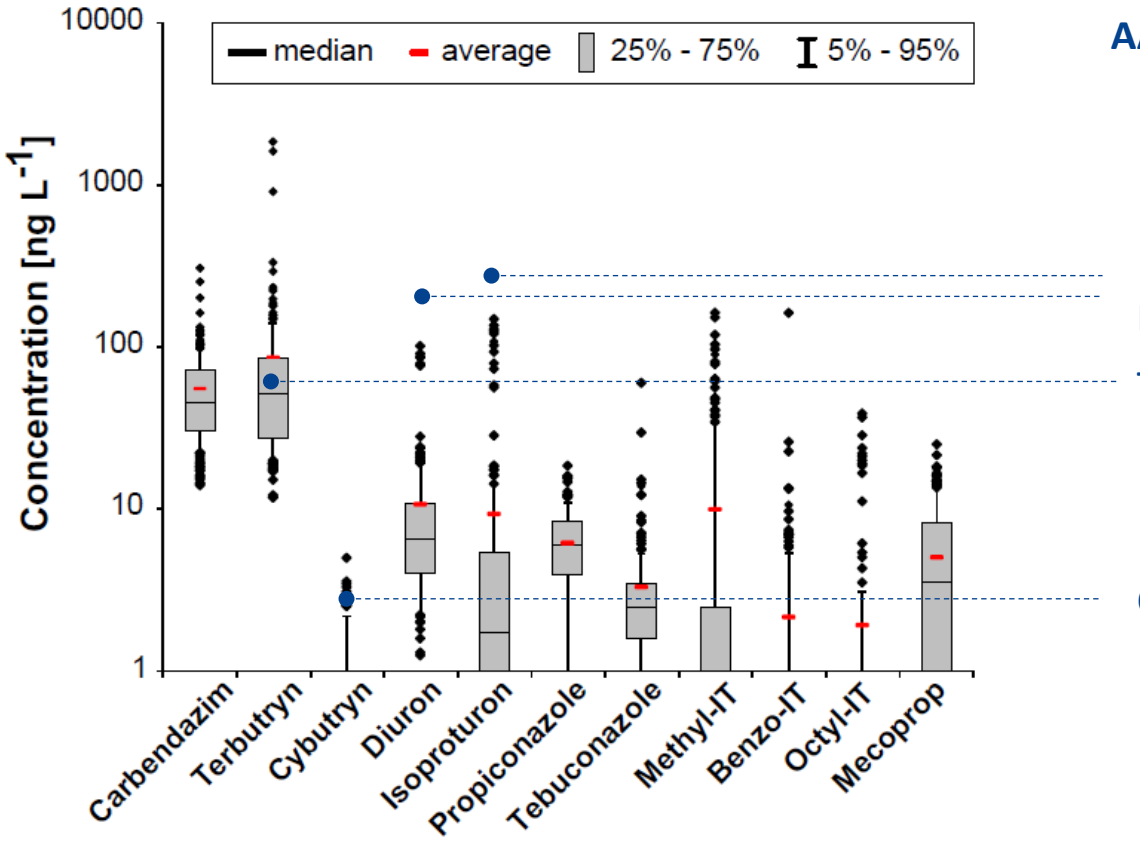
Which compounds? Concentrations?

Emission scenarios correct?

Dynamics? First flush emissions?

?

Concentrations in stormwater runoff



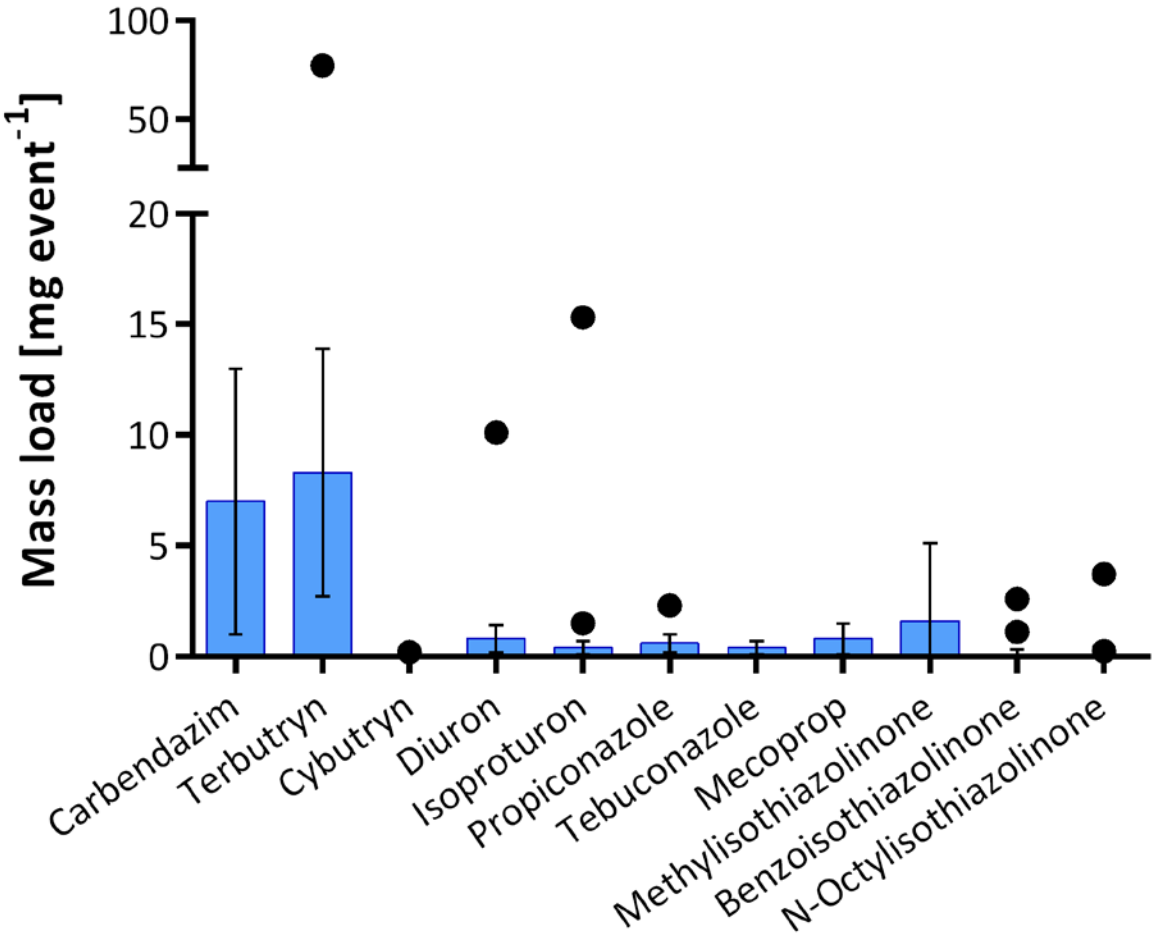
AA-EQS for fresh water DIRECTIVE 2013/39/EU

Isoproturon: 300 ng L^{-1}
Diuron: 200 ng L^{-1}
Terbutryn: 65 ng L^{-1}
Cybutryn: 2.5 ng L^{-1}

Oct. 2011-June 2012; 191 flow controlled samples, IT: Isothiazolinone

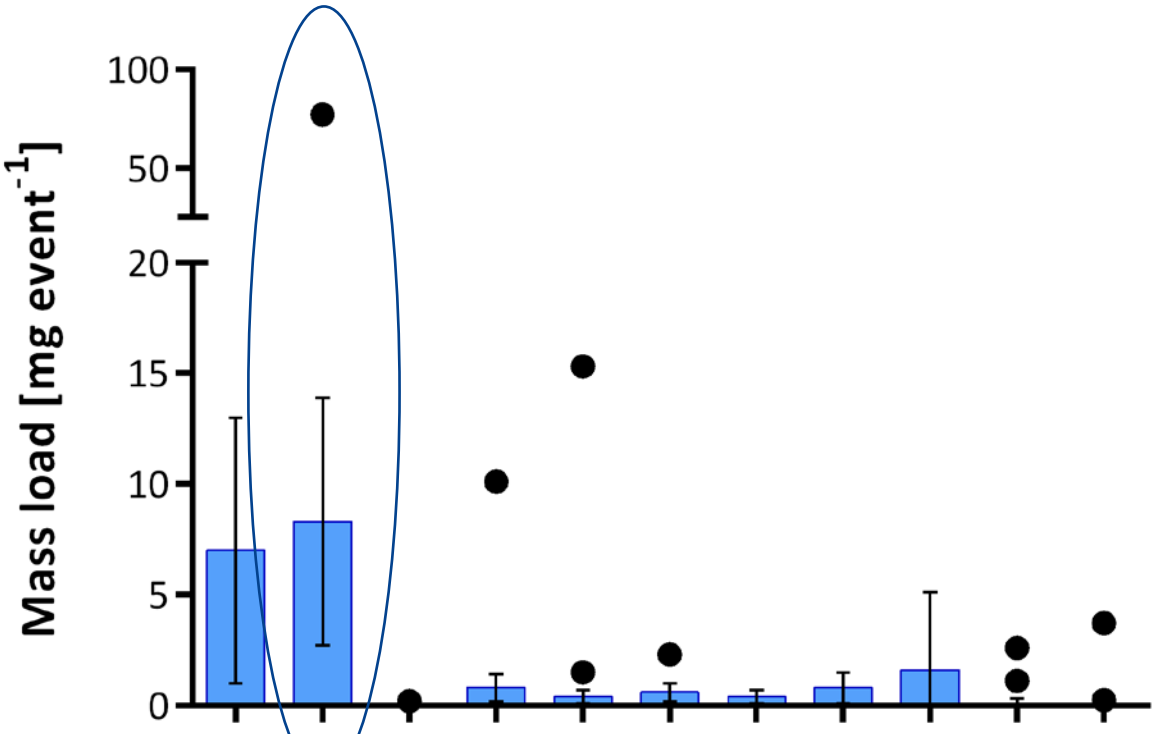
Bollmann et al., Wat Res 56 (2014) 66

Mass loads in stormwater runoff



Bollmann et al., Wat Res 56 (2014) 66

Mass loads in stormwater runoff



Assessment for terbutryn emissions

New facade: 2-4 mg m^{-2} event^{-1} ⇒ peak event corresponds to 19 and 39 m^2 freshly treated wall about ¼ of a normal house in the catchment

Burkhardt et al., ES&T 46 (2012) 5497

Aged facade: 0.1 mg m^{-2} event^{-1} ⇒ normal events represent about 80 m^2 treated facades one wall out of four exposed to driving rain: 3-4 houses

Burkhardt et al., ES&T 46 (2012) 5497

Bollmann et al., Wat Res 56 (2014) 66

Biocides in building material

leaching

Which compounds? Concentrations?

Emission scenarios correct?

Dynamics? First flush emissions?

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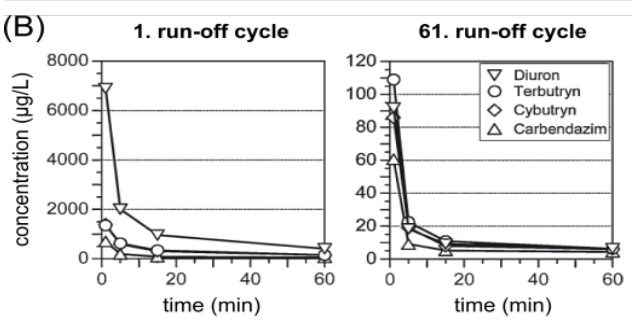
Emission dynamics

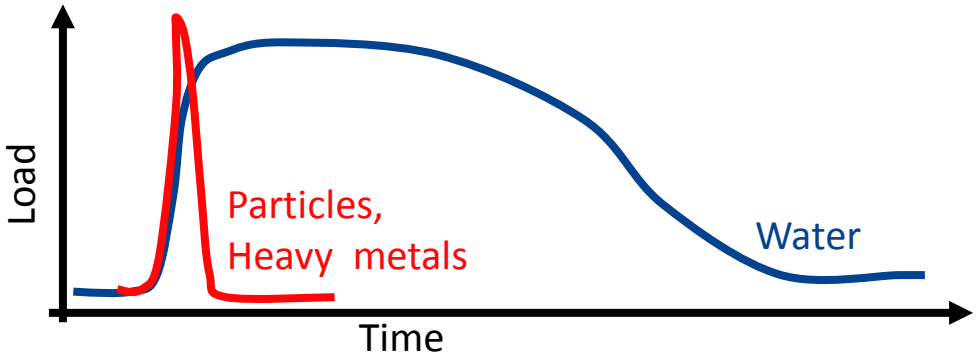
Biocide leaching in the weather chamber



Runoff concentrations in first and 61st cycle of a forced rain experiment.

Burkhardt et al., UWSF 21 (2009) 36

Particle mobilisation in road runoff with first flush



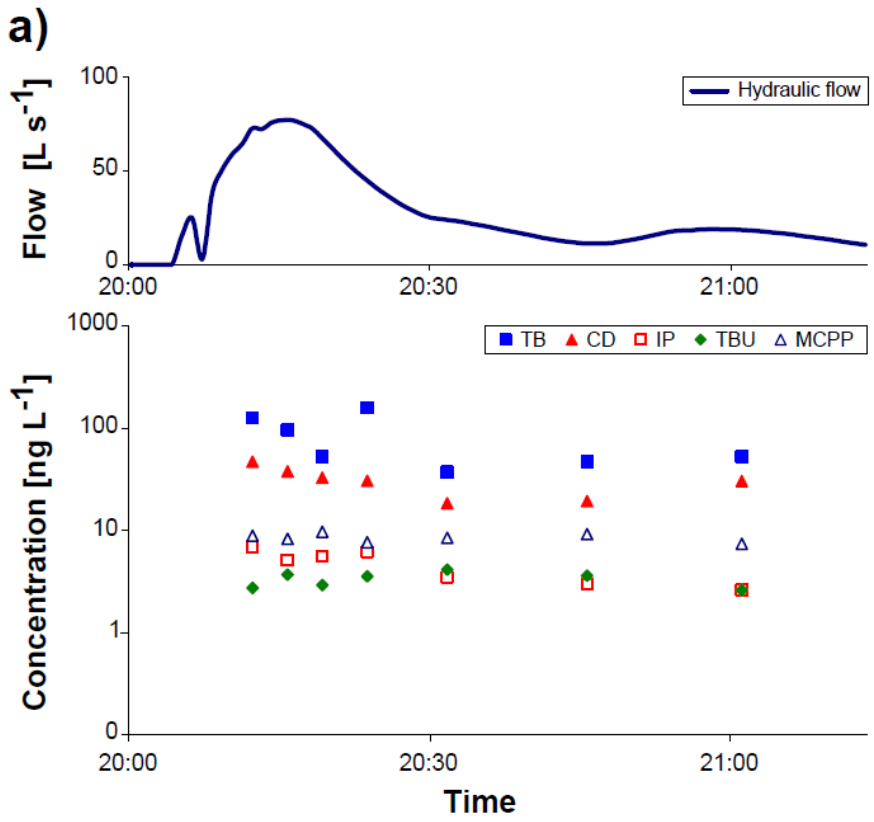
First Flush

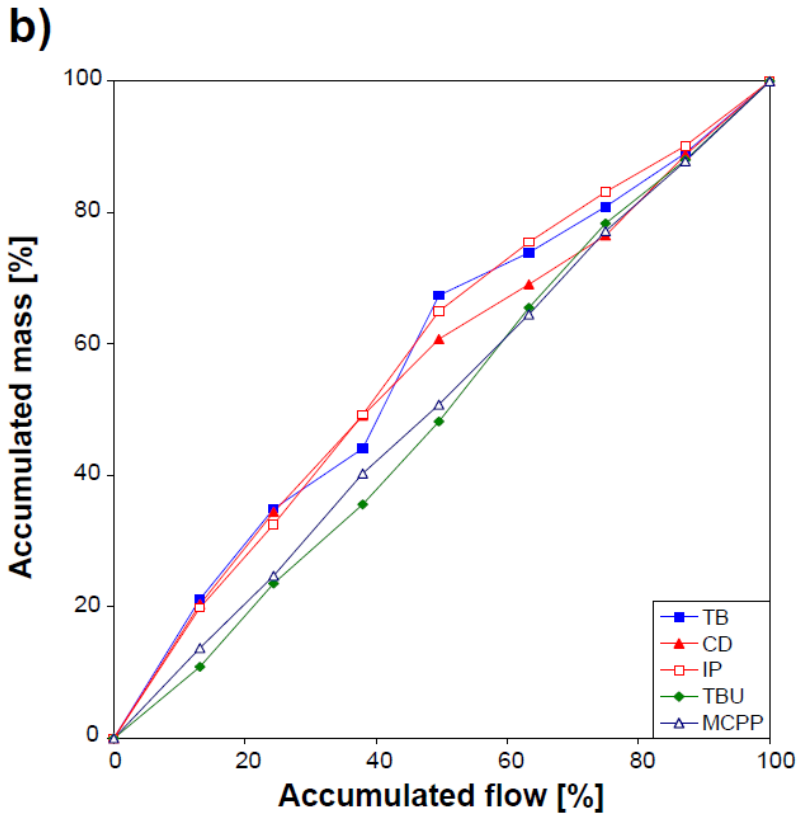
80% of the pollutant mass is transported in the first 30% of the volume of rainfall events

Bertrand-Krajewski et al., Wat Res 32 (1998) 2341

Emission dynamics

>> Common events



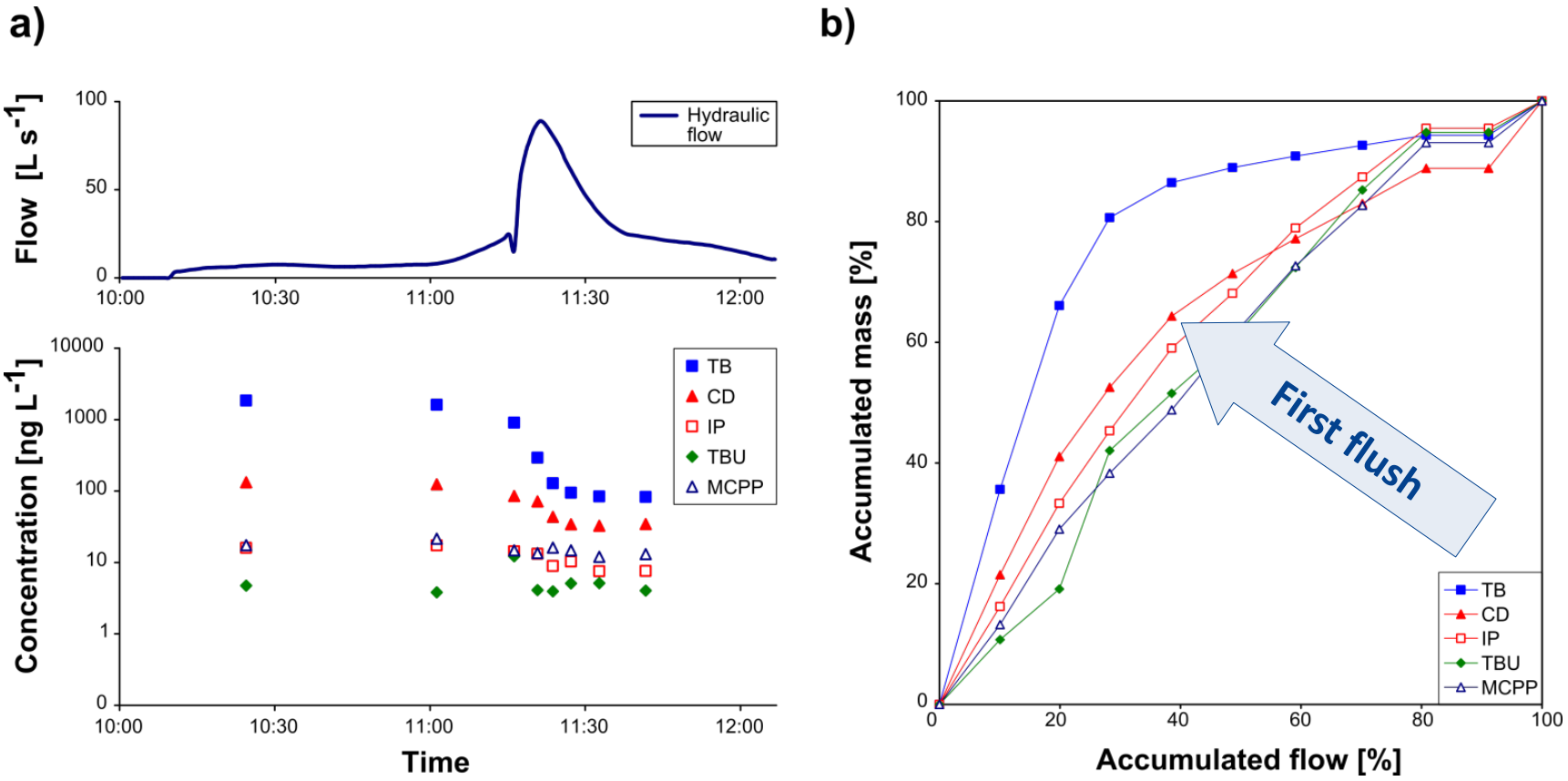


Flow controlled samples; TB: Terbutryn , CD: Carbendazim, IP: Isoproturon, TBU: Tebuconazole, MCPP: Mecoprop

Bollmann et al., Wat Res 56 (2014) 66

Emission dynamics

>> First flush: occurs irregularly

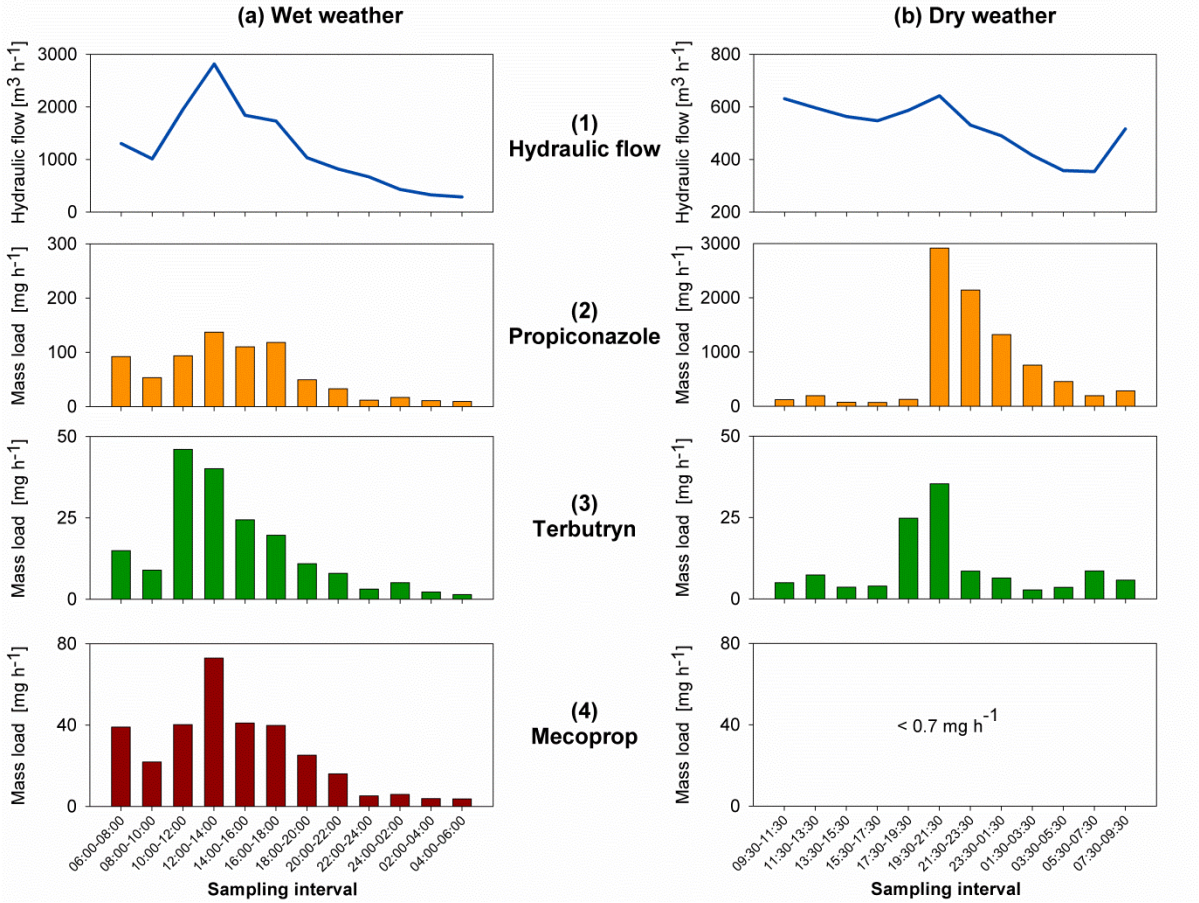


Flow controlled samples; TB: Terbutryn , CD: Carbendazim, IP: Isoproturon, TBU: Tebuconazole, MCPP: Mecoprop

Bollmann et al., Wat Res 56 (2014) 66

Emission dynamics – combined sewer

>> Diurnal cycle



WWTP Bjermarken (Roskilde , Denmark),
12x 2h combined samples of the influent

Poster
Biocides in combined sewer systems

Bollmann et al., Wat Res 60 (2014) 64

Weather as influencing parameter

Bollmann et al., Wat Res 56 (2014) 66

Weather as influencing parameter

- What is influencing the leaching?

- Correlation of the concentration or acc. mass load per event with:
  - Rain amount / accumulated flow
  - Length of the event
  - Rain intensity
  - Length of the dry period prior to the event

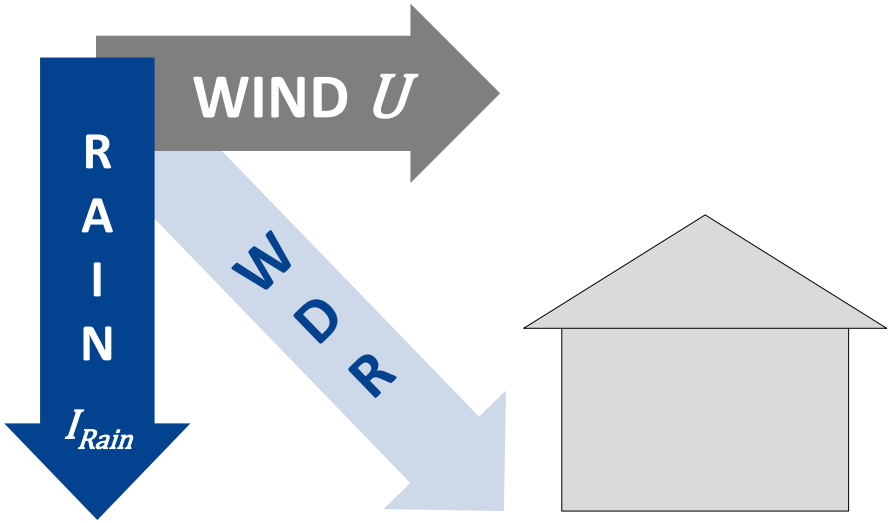
  

  - Wind driven rain intensity

Weather as influencing parameter

>> Run-off volume ∝ Wind-driven rain (WDR)



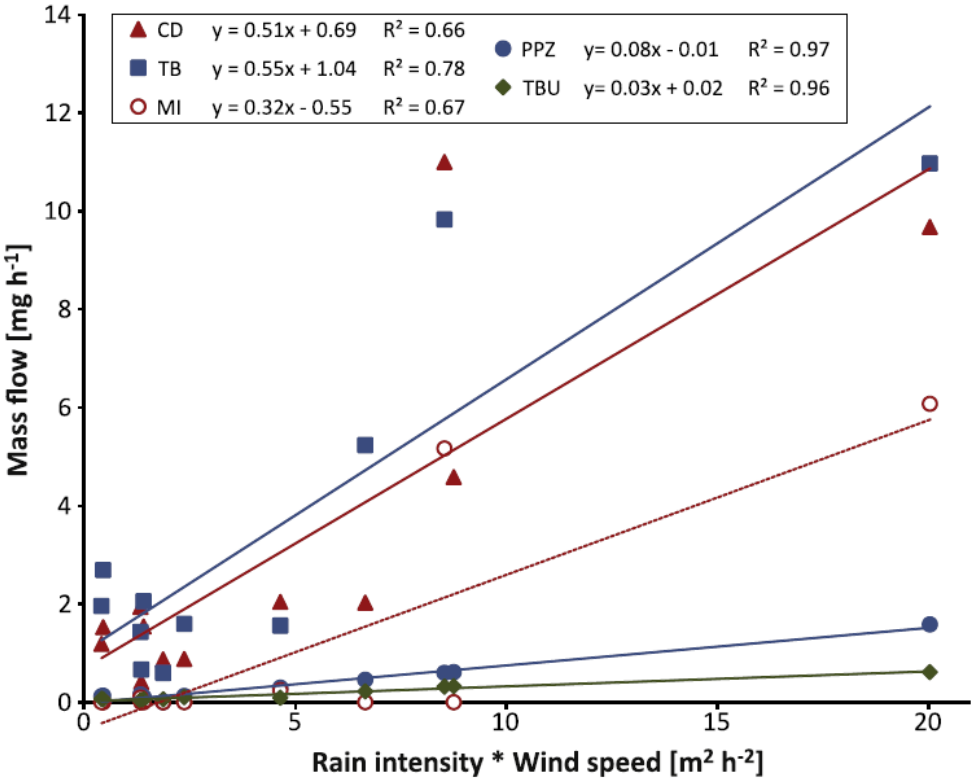
Mass flow *M* during respective event

$$M_{WDR} = C_C C_S I_{Rain} U$$

with C_S = substance specific constant
C_C = catchment specific constant

Weather as influencing parameter

>> Wind-driven rain causes leaching of biocides from stormwater catchment



Stormwater catchment Silkeborg North, average mass flow per event
CD: Carbendazim, TB: Terbutryn, MI: Methylisothiazolinone, PPZ: Propiconazole, TBU: Tebuconazole

Bollmann et al., Wat Res 56 (2014) 66

Biocides in building material

leaching

Conclusions

Conclusions

- Monitoring
  - Direct emissions via stormwater in suburban areas
  - Biocides in urban areas can exceed quality standards
  - Different footprint than in other European countries

Stormwater treatment necessary!

- Emission dynamics
  - Usually rather constant throughout an event
  - Irregular first flush phenomena
  - Indication for correlation between occurrence in stormwater and wind driven rain
  - No first-flush stormwater treatment possible
  - Unnecessary loss of substance
    Fine tune application?

Acknowledgement

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  - AUFF grant: *Advanced water purification using bio-inorganic nano catalysts and soil filters* (www.waterpurification.au.dk)

Thank you for your attention!

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