

# CONSTRUCTION MATERIALS SOURCE FOR BIOCIDES IN URBAN WATERS

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8 OCTOBER 2018

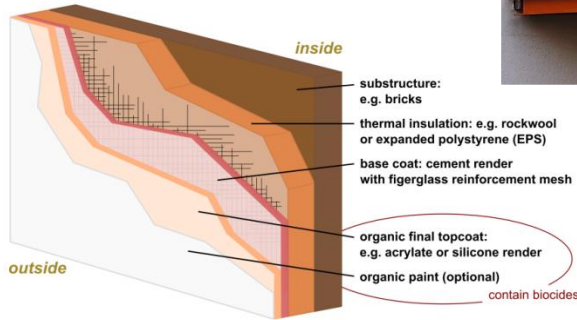
# BIOCIDES

“Active substances and preparations containing one or more active substances [...], intend to destroy, deter, render harmless, prevent action of, or otherwise exert a controlling effect on any harmful organism by chemical or biological means.”

Regulation (EU) No. 528/2012: Biocidal Product Regulation



# BIOCIDES IN CONSTRUCTION MATERIALS



Principal construction of external thermal insulation composite system (ETICS)

## Factors responsible for microbial growth:

Availability of water  
Temperature  
pH-value

state-of-the-art

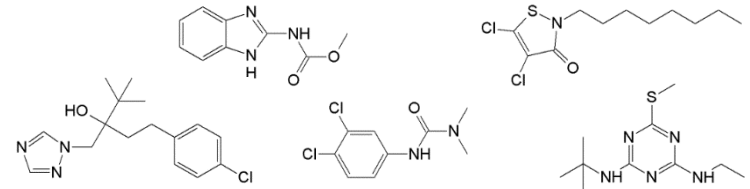
exterior renders and paints

2-4 different biocides

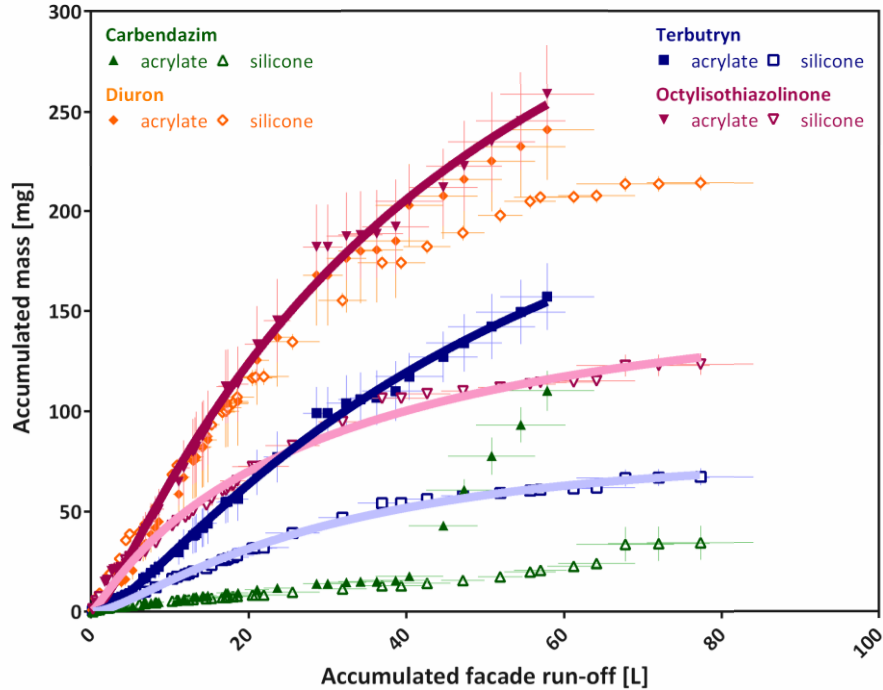
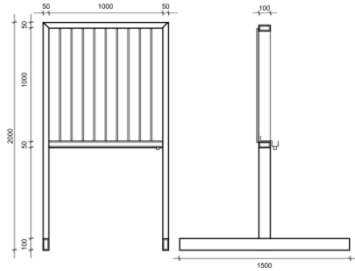
- 0.2% in render, 0.2-0.4% in exterior paints

## Different compounds with biocidal effects

- Isothiazolinones, carbamates, phenylureas, triazines, triazoles
- Hydrophilic molecules with toxic effects



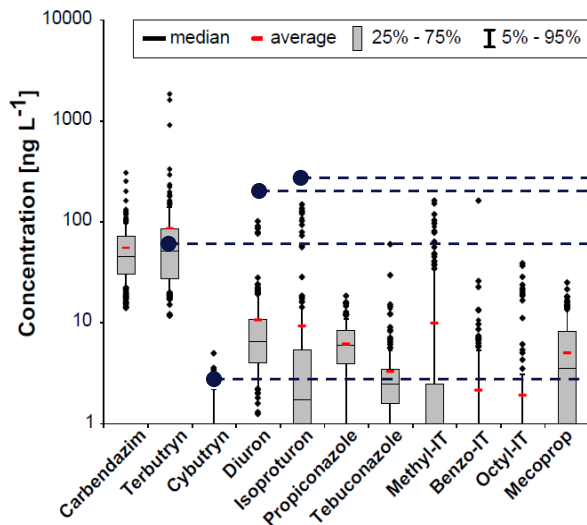
# EMISSION PATHWAYS



# EMISSION PATHWAYS

# CONCENTRATIONS IN STORMWATER

## Stormwater (Silkeborg)



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

Isoproturon: 300 ng L<sup>-1</sup>  
 Diuron: 200 ng L<sup>-1</sup>      20 ng L<sup>-1</sup>  
 Terbutryn: 65 ng L<sup>-1</sup>      34 ng L<sup>-1</sup>

Cybutryn: 2.5 ng L<sup>-1</sup>      1 ng L<sup>-1</sup>

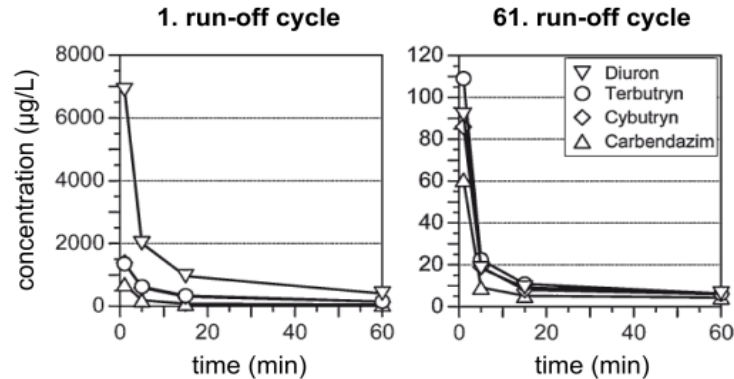
### PNEC

Burkhardt et al.,  
 UWSF 21 (2009) 36



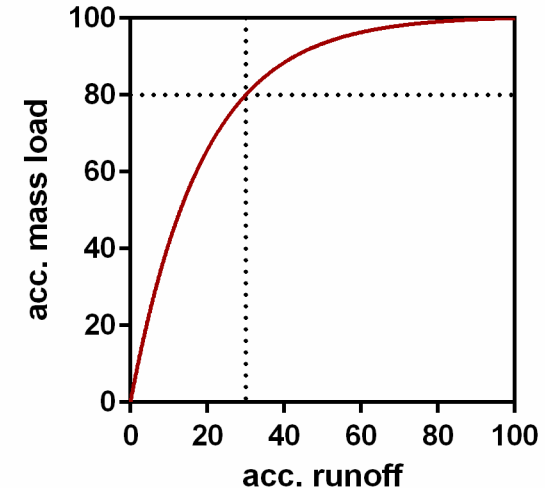
Fig. 2 – Concentrations of different biocides in the studied catchment from Oct. 2011 to June 2012. In order to enable the calculations, concentrations smaller than the LOD were set to zero (Abbreviation IT: Isothiazolinone).

# EMISSION DYNAMICS DURING RAIN EVENT



Runoff concentrations in first and 61<sup>st</sup> cycle of a forced rain experiment.

Particle mobilisation in road runoff with first flush

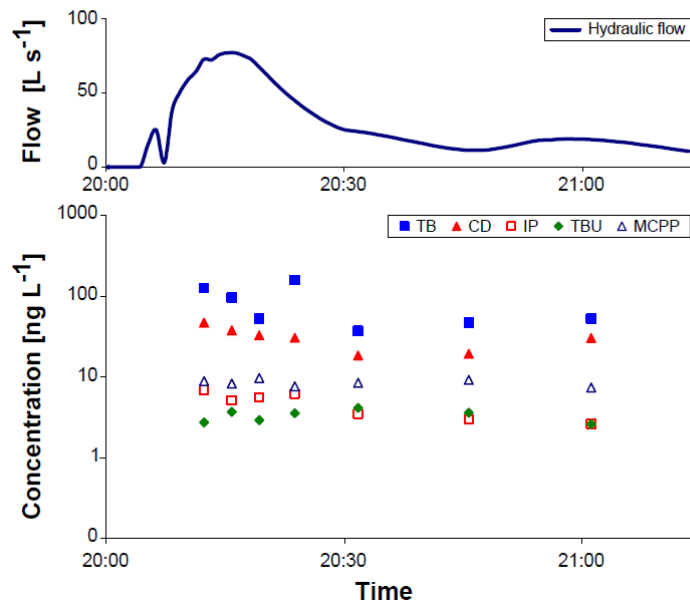


## First Flush

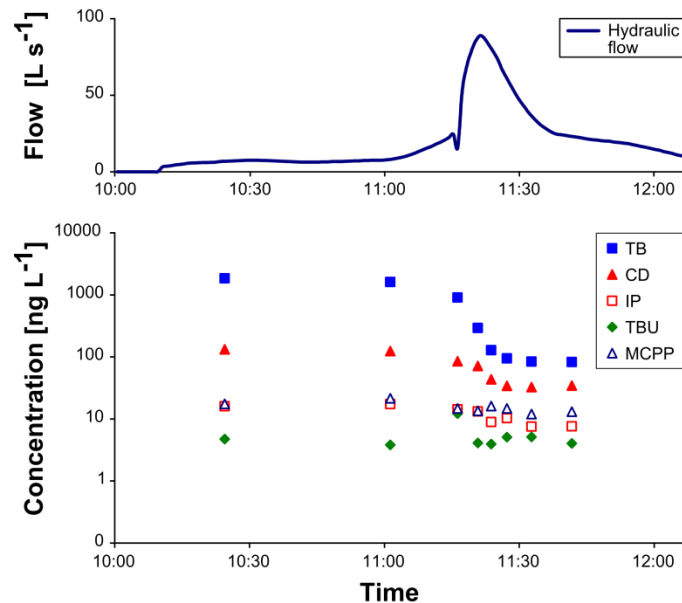
80% of the pollutant mass is transported in the first 30% of the volume of rainfall events

## EMISSION DYNAMICS DURING RAIN EVENT

(1)

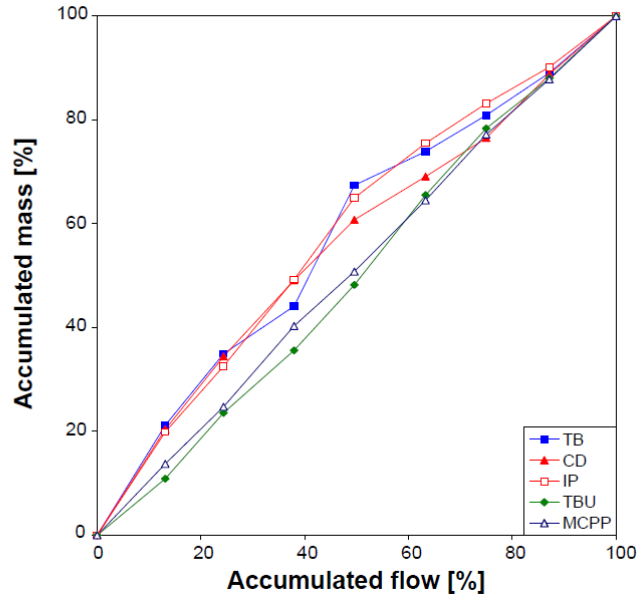


(2)

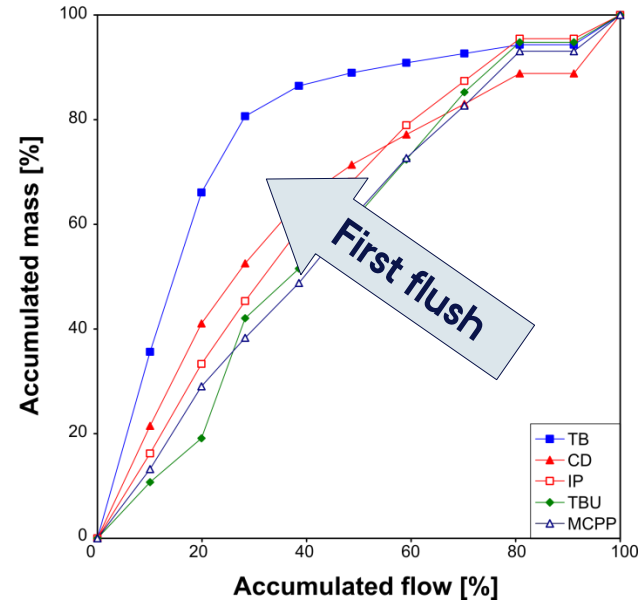


# EMISSION DYNAMICS DURING RAIN EVENT

## (1) Common event



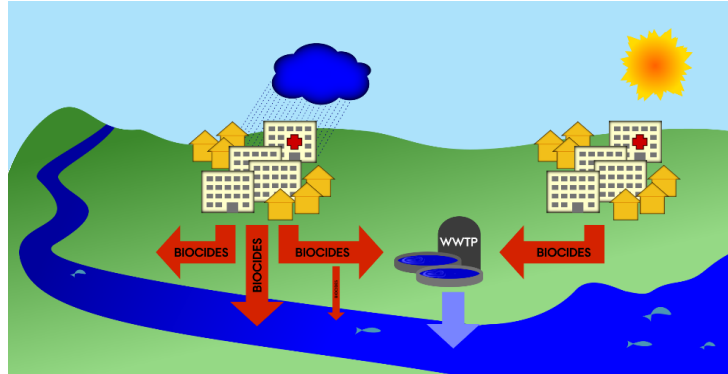
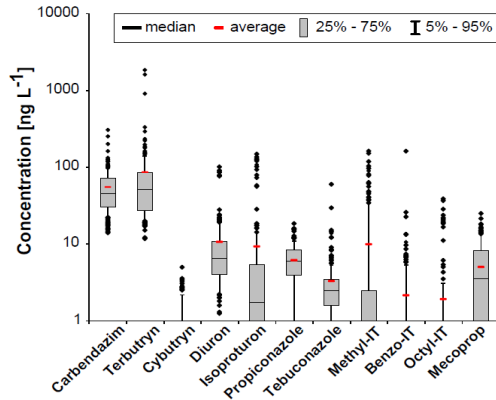
## (2) First-flush event



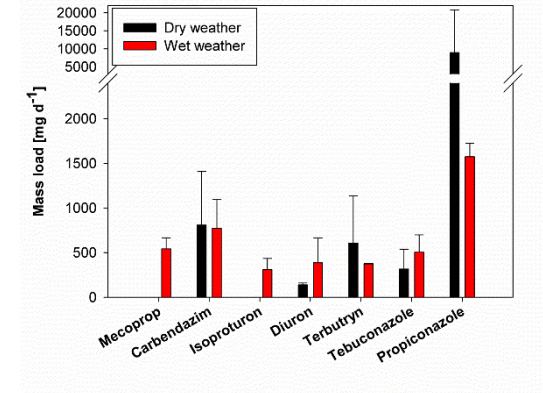


# EMISSIONS PATHWAYS

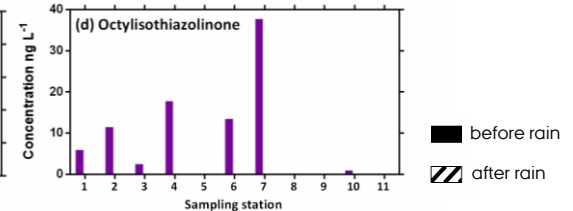
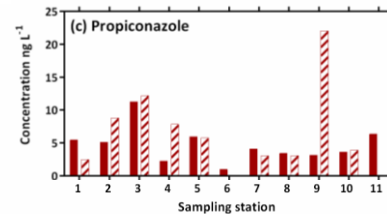
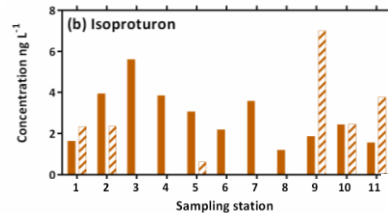
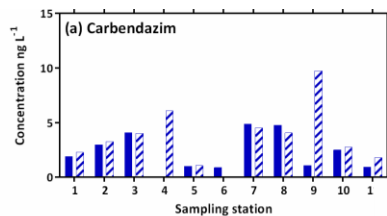
## Stormwater (Silkeborg)



## Combined sewer (Roskilde)



## Surface waters (Greater Copenhagen)



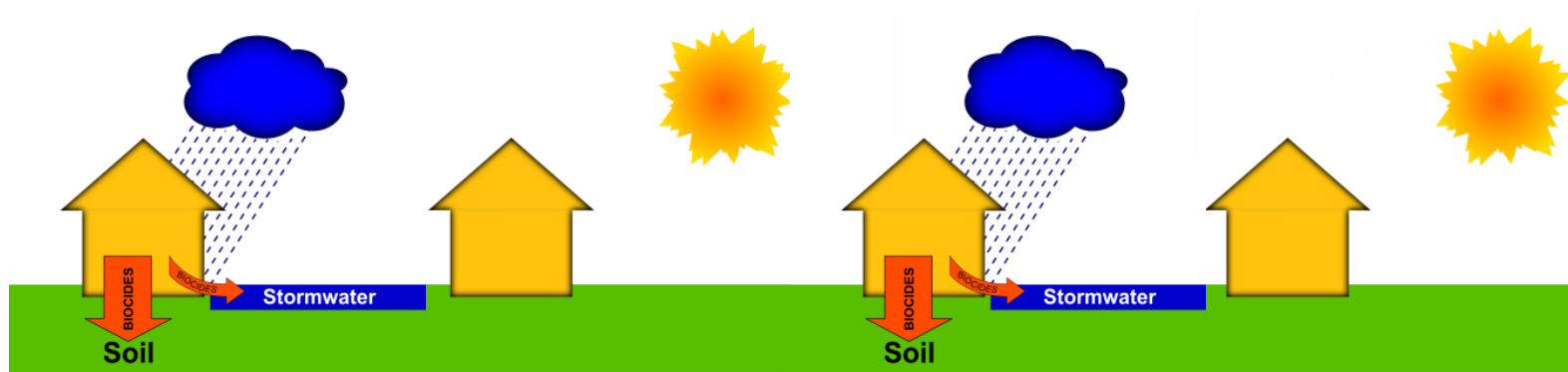
# FATE IN THE ENVIRONMENT

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Degradation on facade surfaces

Degradation in soil

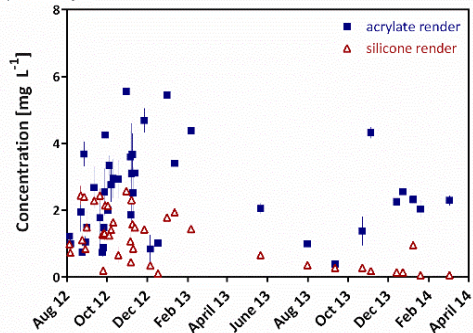
Degradation in stormwater ponds & surface waters



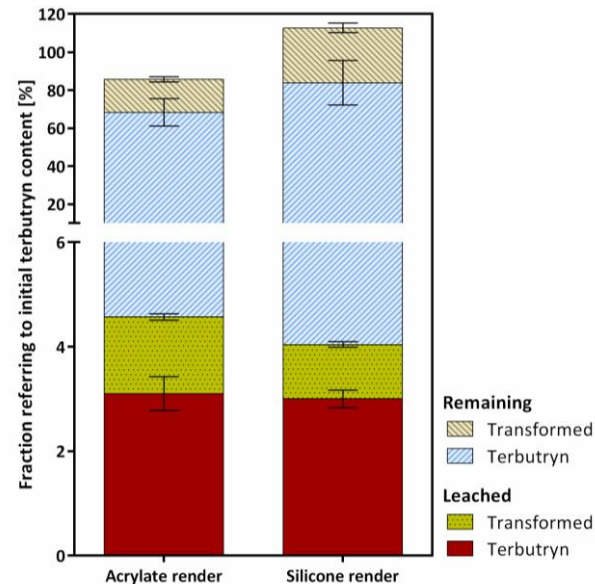
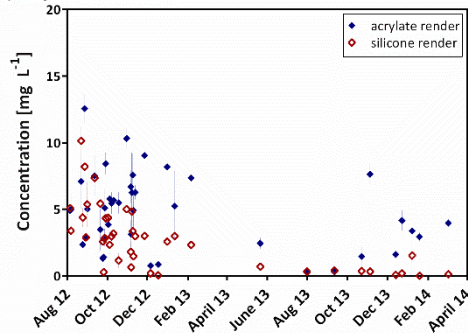
# FATE OF BIOCIDES DEGRADATION ON FACADES



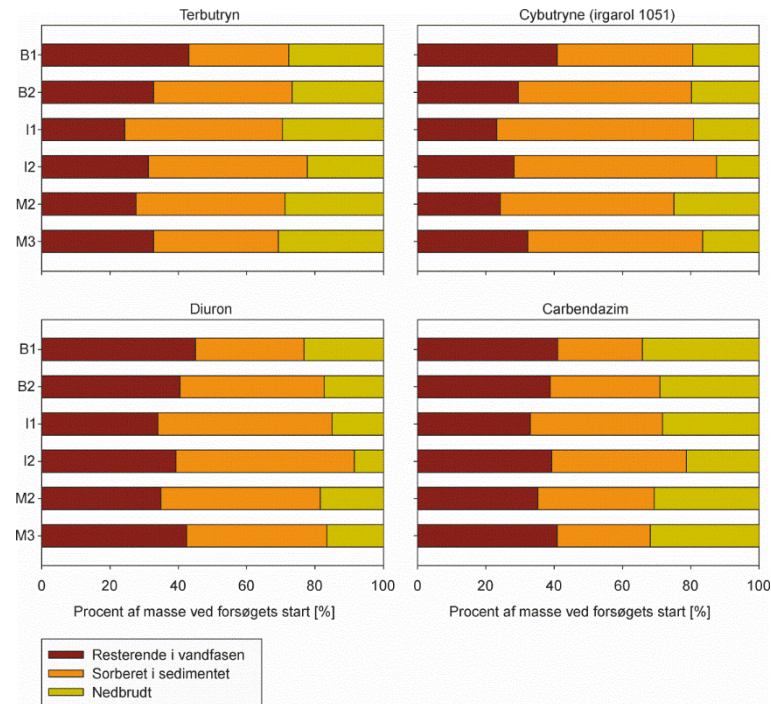
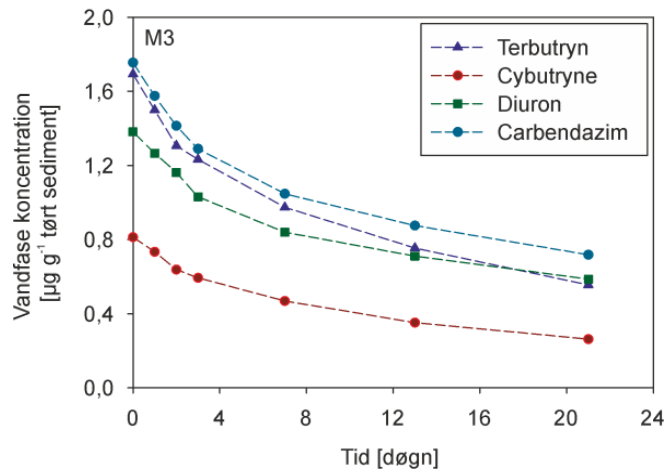
(a) Terbutryn



(a) Octylisothiazolinone

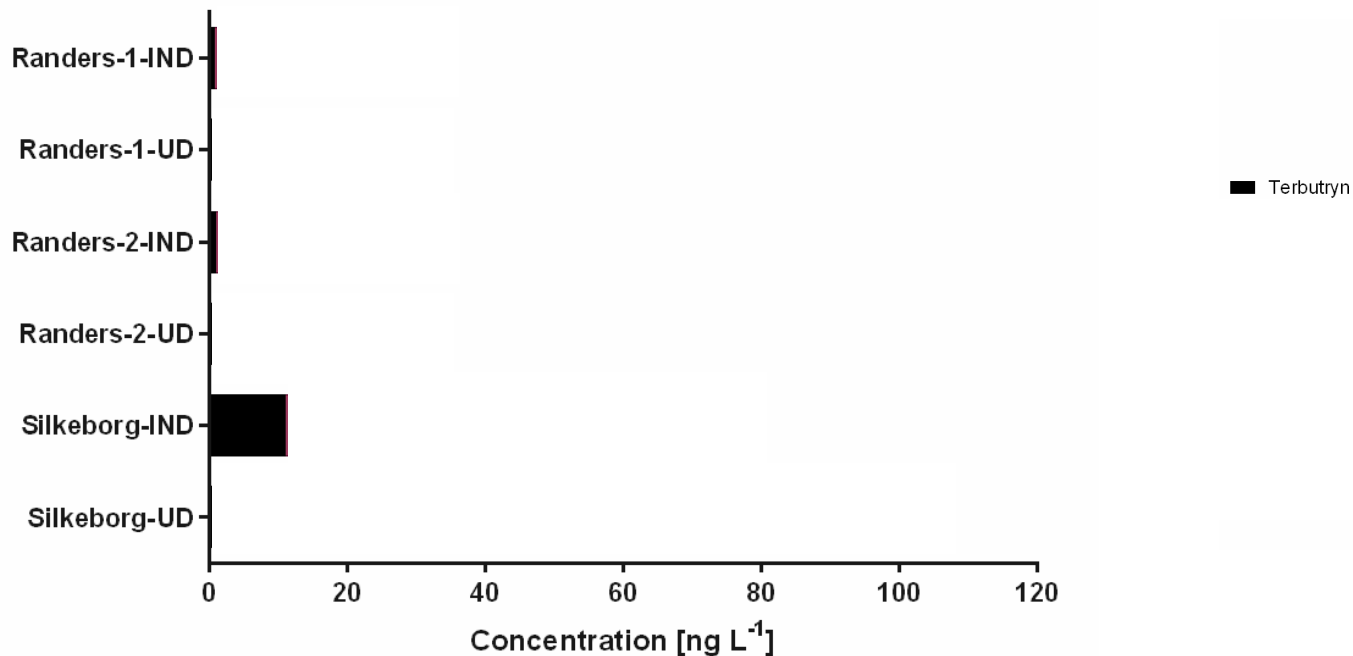


# FATE OF BIOCIDES STORMWATER POND MESOCOSMS

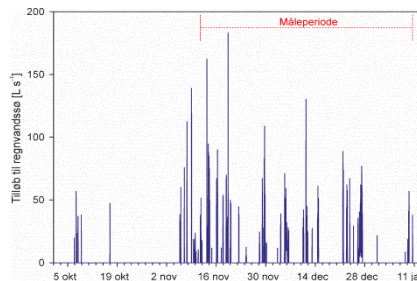
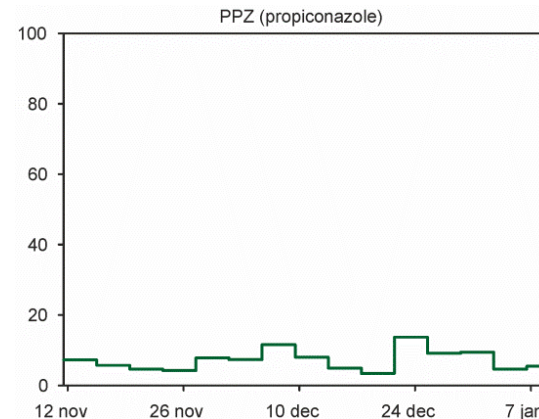
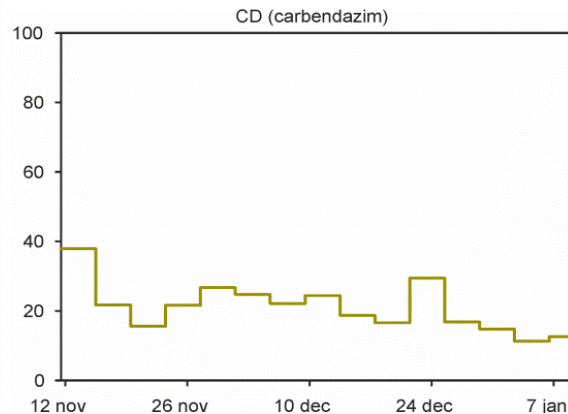
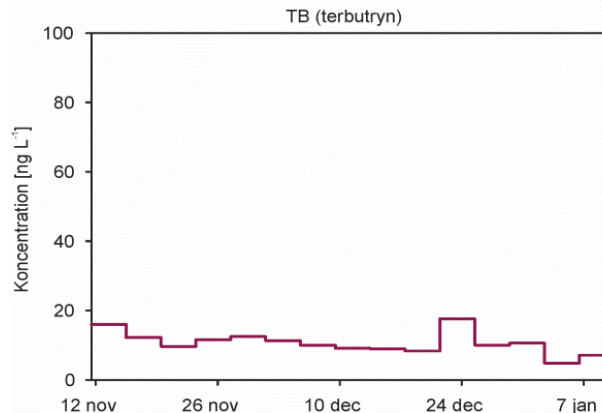


# FATE OF BIOCIDES STORMWATER PONDS (Oct 2017-Nov 2017)

(a) Terbutryn - Stormwater ponds

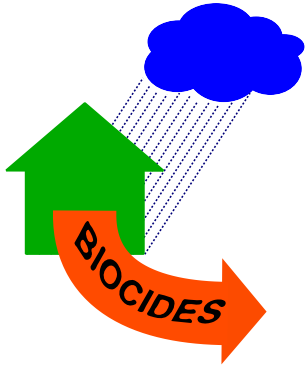


# FATE OF BIOCIDES STORMWATER PONDS (NOV 2015-JAN 2016)



# BIOCIDES IN CONSTRUCTION MATERIALS

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- Detectable not only close to source but also further away
- Degradable – abiotic and biotic processes
- Often high concentrations of degradation products
- Reoccurring emissions lead to ‘pseudo-persistence’



# CONSTRUCTION MATERIALS : SOURCE FOR BIOCIDES IN URBAN WATERS

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## Acknowledgment

Kai Bester, Aarhus University, Dep. Environ. Science  
Jes Vollertsen, Aalborg University, Dep. Civil Eng.  
...and all other co-workers

Danish EPA for founding



## Further reading: Reports Danish EPA

Bester et al., Water-driven leaching of biocides from paints and renders (2014)

Vollertsen et al., Biocider i urbane småsøer – effekt og skæbne (2017)

Bollmann et al., Transport and transformation of biocides in construction materials (in prep.)



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# MASS LOADS IN STORMWATER

Biocide	Mass load <sup>a</sup> $\pm$ standard deviation [mg event <sup>-1</sup> ] without peak events	Mass load of the highest peak event [mg event <sup>-1</sup> ] (number of peak events)
Carbendazim (CD)	7.0 $\pm$ 6.0	No peak event identified
Terbutryn (TB)	8.3 $\pm$ 5.6	77 (1)
Cybutryn (IRG)	0.02 $\pm$ 0.03	0.2 (1)
Diuron (DR)	0.8 $\pm$ 0.6	10.1 (1)
Isonroturon (IP)	0.4 $\pm$ 0.3	15.3 (2)

## Assessment for terbutryn emissions

New facade: 2-4 mg m<sup>-2</sup> event<sup>-1</sup>

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



peak event corresponds to 19 and 39 m<sup>2</sup> freshly treated wall about 1/4 of a normal house in the catchment

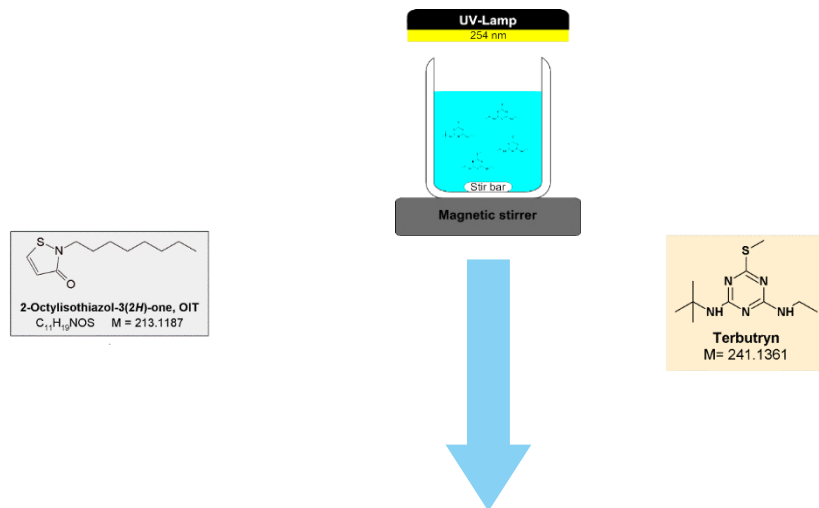
Aged facade: 0.1 mg m<sup>-2</sup> event<sup>-1</sup>

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



normal events represent about 80 m<sup>2</sup> treated facades one wall out of four exposed to driving rain: 3-4 houses

# DEGRADATION ON FACADES: PHOTOLYSIS

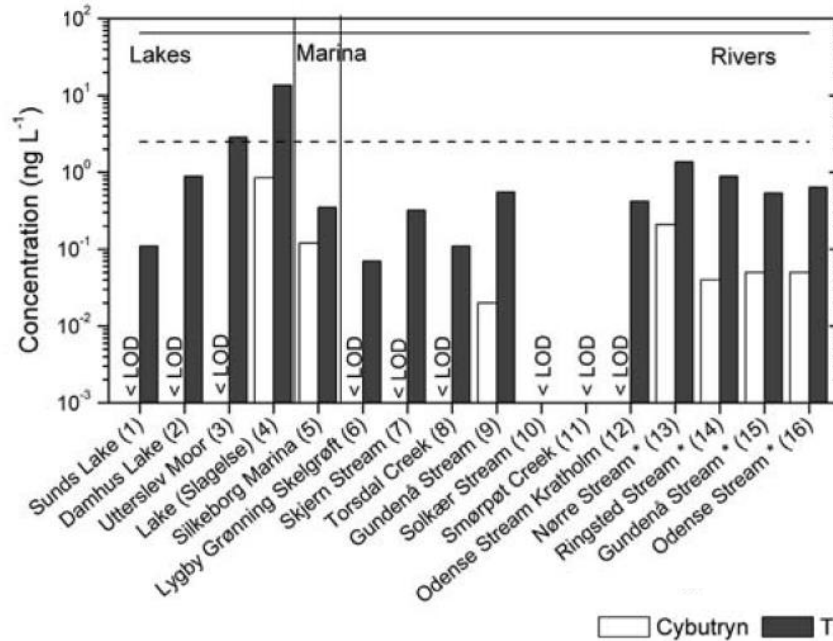


## HPLC-qTOF-MS

identification and validation with analytical standards

# SURFACE WATER SCREENING

## fresh waters



Oktober/November 2012  
 Grab samples, \* 24h combined samples