



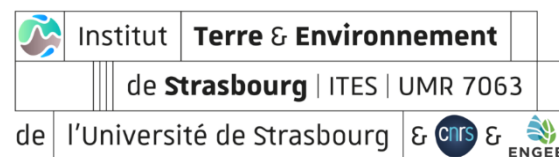
# The urban biocide terbutryn: field investigations to explore release and reactive transport under environmental conditions

EGU 2022

**Tobias Junginger, Sylvain Payraudeau and Gwenaël Imfeld**

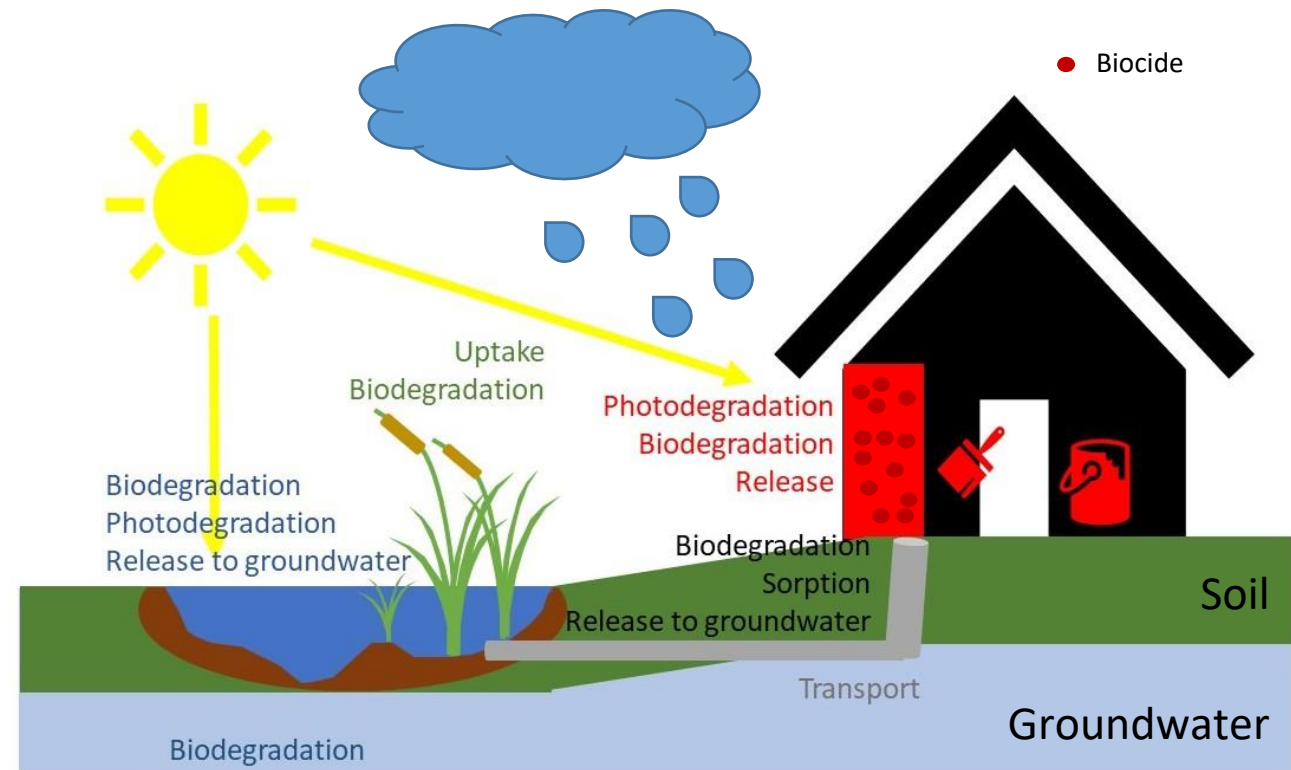
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# Why studying urban biocides?

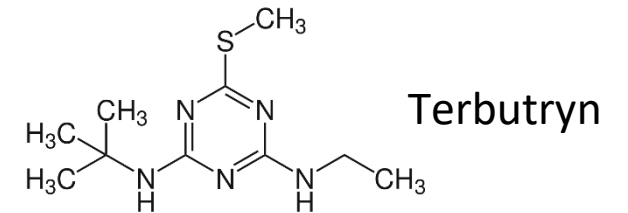
- Used in building materials like paint and render<sup>1</sup>
- Prevent growth of algae, funghi,...
- Leaching into environment with **wind driven rain** <sup>2,3,4</sup>



<sup>1</sup> Gartsier et al., 2015, <sup>2</sup> Bollmann et al., 2016, <sup>3</sup> Burkhardt et al., 2012, <sup>4</sup> Wittmer et al., 2011, Picture: [www.hausinfo.ch/](http://www.hausinfo.ch/)

# Why studying urban biocides?

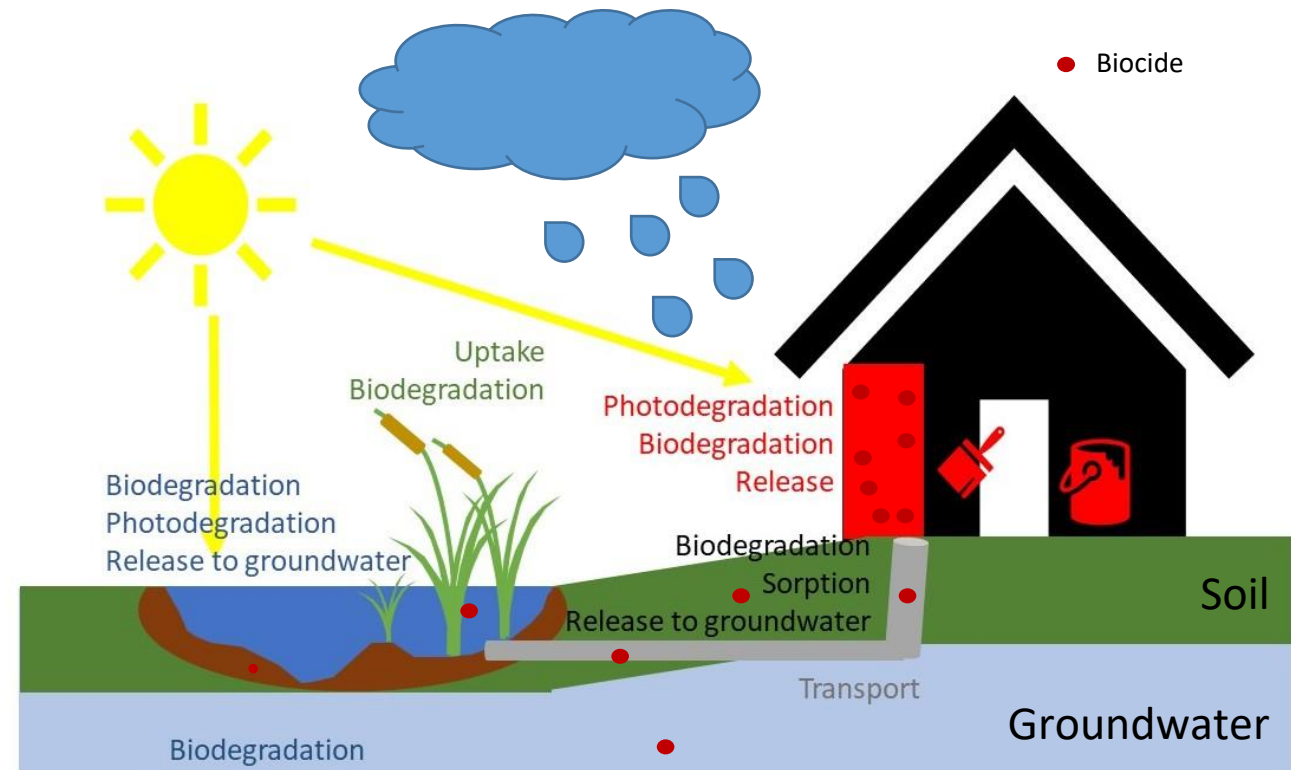
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## Terbutryn is of major concern!

- Prohibited in agriculture <sup>5</sup>
- PNEC towards aquatic organisms: 3 - 34 ng/L <sup>6,7</sup>
- Concentrations up to 5.6 µg/L (rivers) and 7.6 ng/L (groundwater) <sup>8,9</sup>
- Transformation products “probably toxic”<sup>10</sup>

## Reaction pathways from façade to soil and surface water still unknown



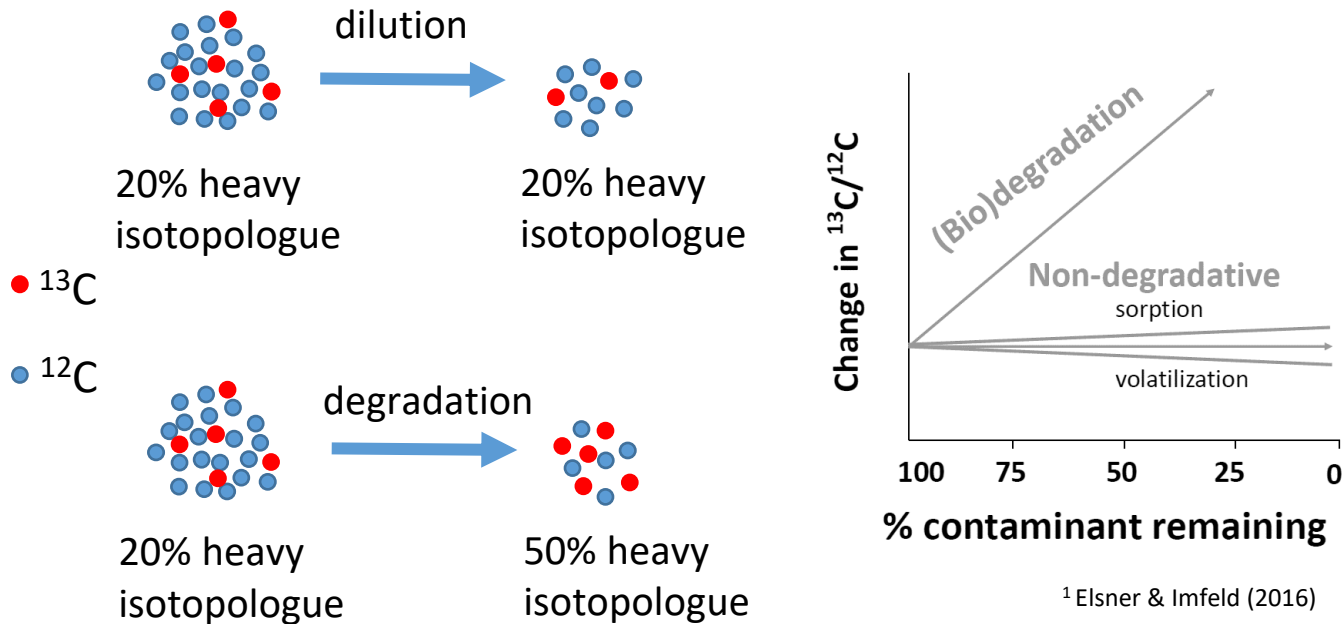
<sup>1</sup>Gartiser et al., 2015, <sup>2</sup>Bollmann et al., 2016, <sup>3</sup>Burkhardt et al., 2012, <sup>4</sup>Wittmer et al., 2011, <sup>5</sup>European council Directive 91/414/EEC, <sup>6</sup>Kresmann et al., 2018, <sup>7</sup>Burkhardt et al., 2009, <sup>8</sup>Quednow et al., 2007, <sup>9</sup>Hensen et al., 2018, <sup>10</sup>Hensen et al., 2020,



# Compound specific isotope analysis as a tool to differentiate degradation pathways

## Background: CSIA

- Each element in a compound has a distinct isotopic ratio
- Isotopic ratio can shift in systematic way (e.g. biodegradation / photodegradation)<sup>1</sup>
- Non-degradative processes usually don't cause isotope fractionation<sup>1</sup>

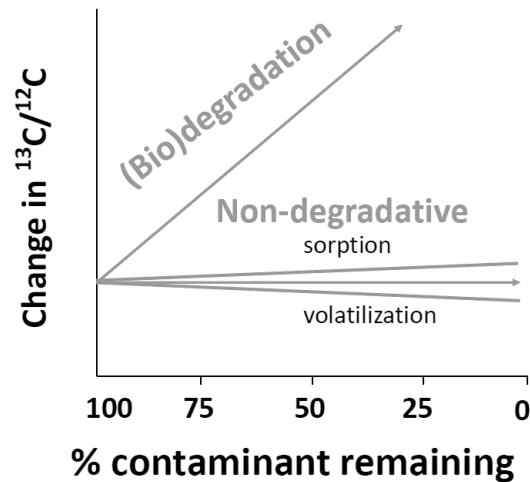
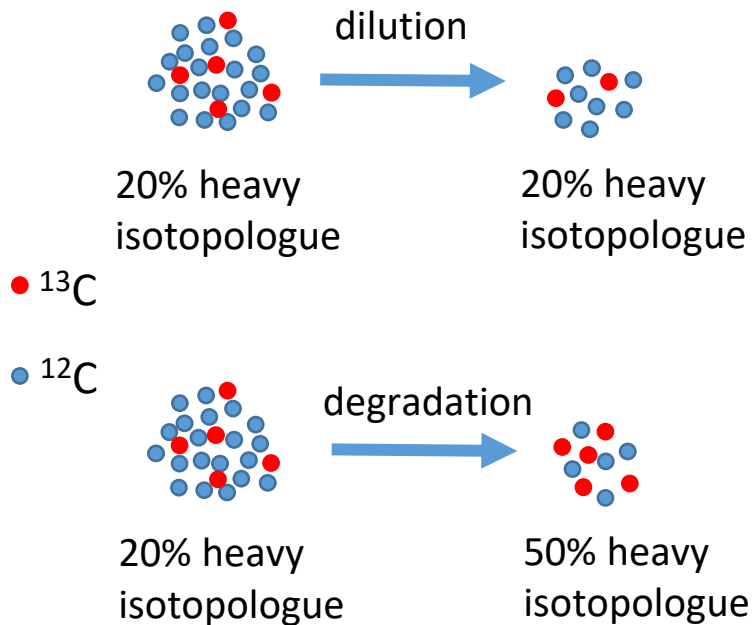




# Compound specific isotope analysis as a tool to differentiate degradation pathways

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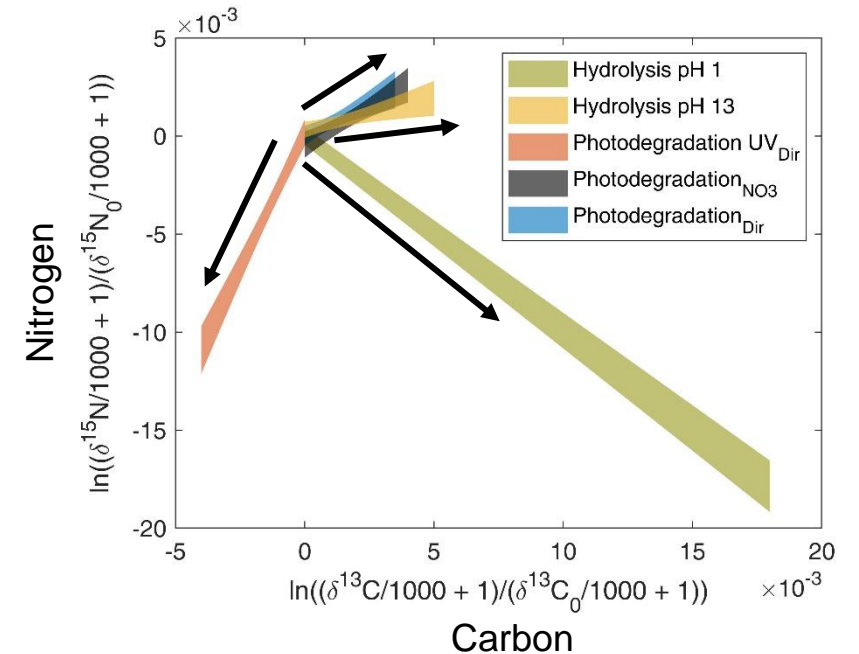
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<sup>1</sup> Elsner & Imfeld (2016)

## CSIA of terbutryn

- Degradation leads to distinct fractionation pattern dependant on degradation pathway
  - Reaction specific!
- No isotope fractionation during biodegradation





# Reactive transport of urban biocides: Leaching from facades

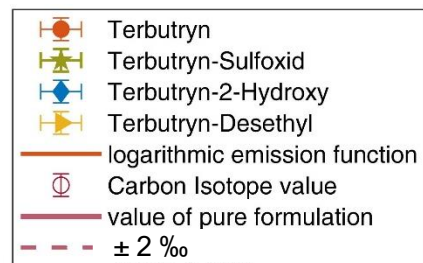
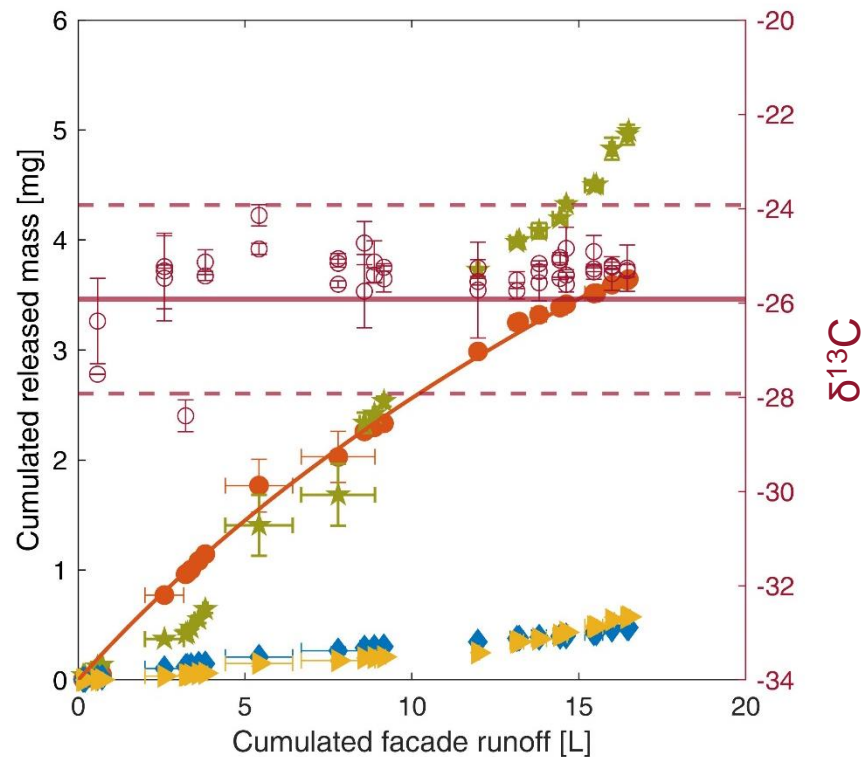


1. Release from facades?
2. Degradation on facades?
3. Applicability of CSIA to follow terbutryn degradation in the field?

- Facades built according to construction guidelines
- Encapsulated terbutryn in paint



# Reactive transport of urban biocides: Leaching from facades



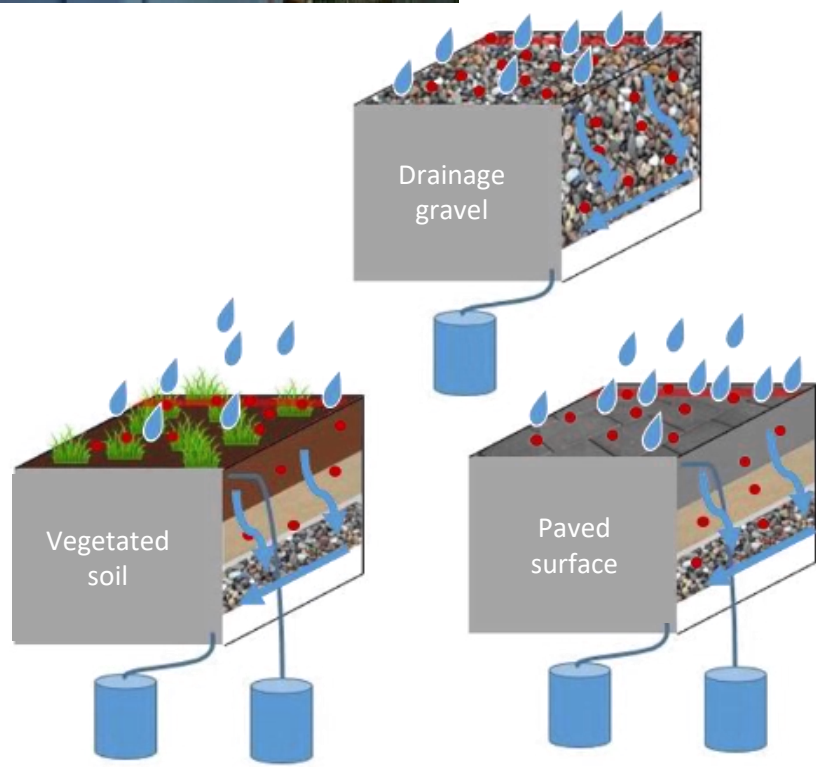
- leaching over 200 days (April – October)
- Less than 1 % of terbutryn released
- Release decreases over time
- Increasing release of terbutryn-sulfoxide → degradation already on facades
- **No isotope fractionation**
  - Photodegradation only at outer layer
  - Diffusion of non-degraded terbutryn to surface → dilution of “non-degraded fraction”

# Reactive transport of urban biocides: lysimeter experiment



1. Reactive transport and release towards groundwater
2. Application of CSIA?

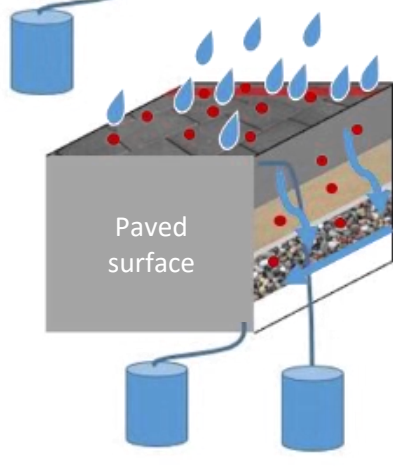
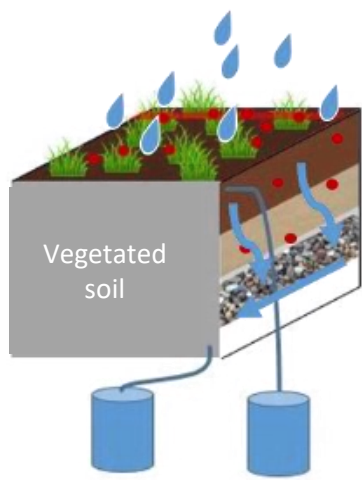
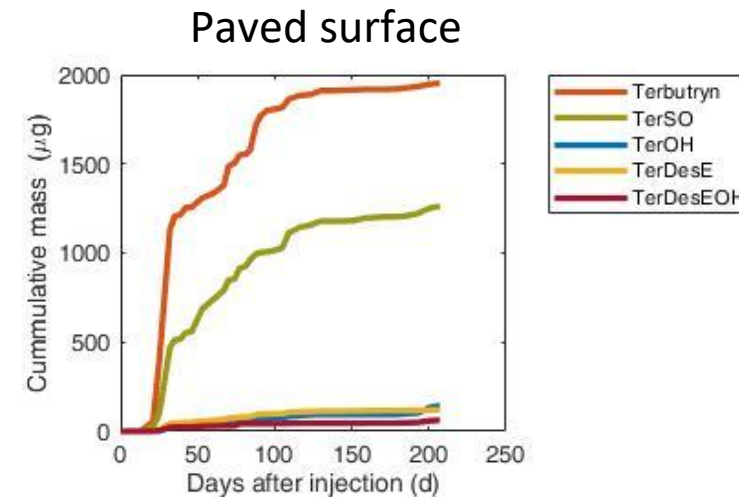
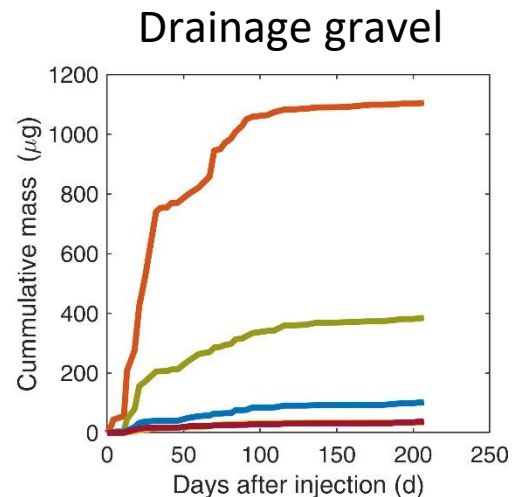
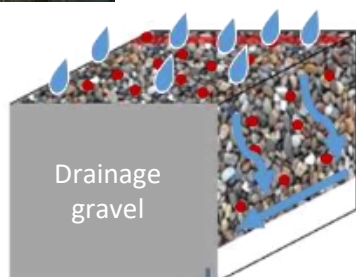
- Three types of materials
- Spiked with mixture of urban biocides
- Sampling at 40 cm depth, extraction (SPE) and analysis (LC-MS/MS)







# Reactive transport of urban biocides: lysimeter experiment

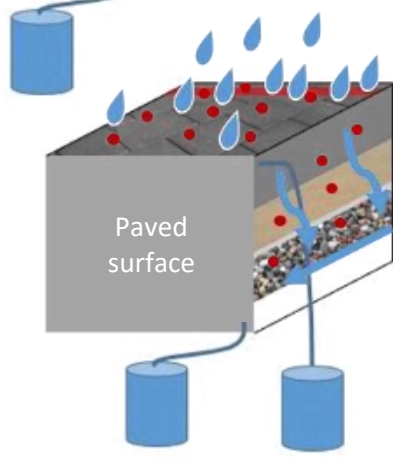
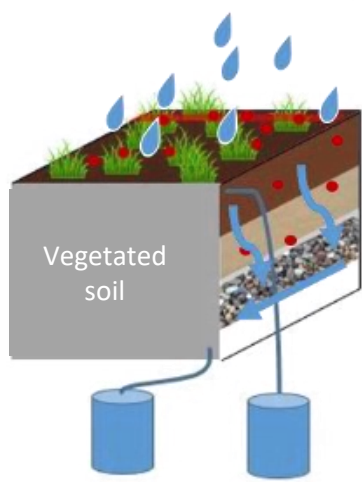
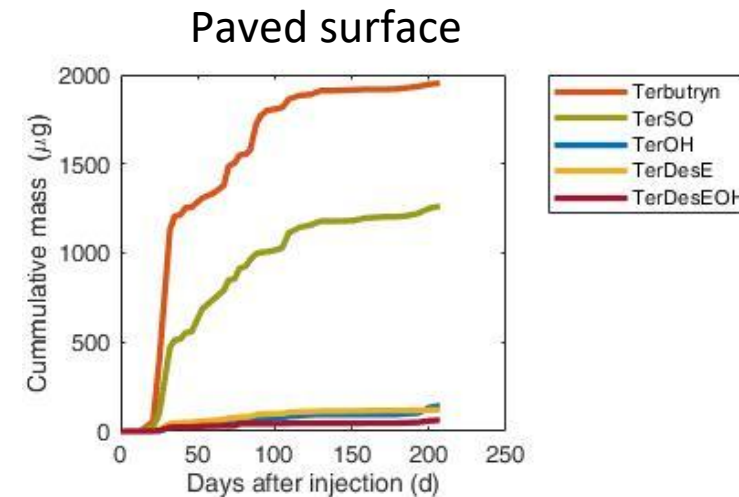
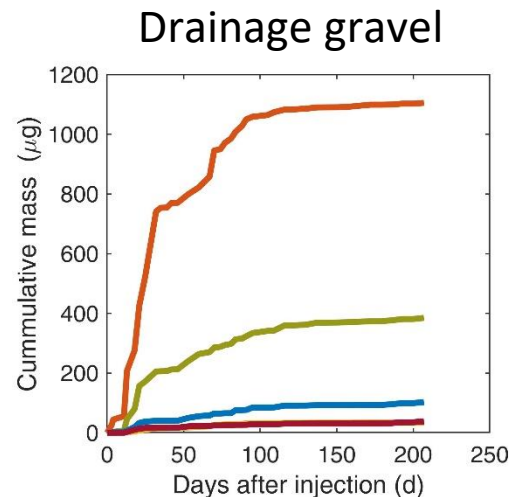
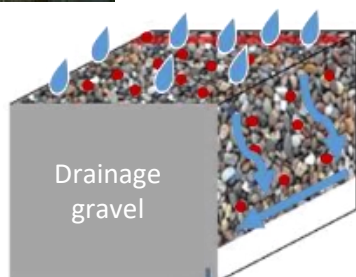


How much terbutryn leached within 207 days?

	Terbutryn leached [%]	Terbutryn TPs leached [%]	Total leached [%]
Gravel	7.4	3.8	11.2
Pavement	13.0	10.5	24.5
Grass	0.1	0.3	0.4



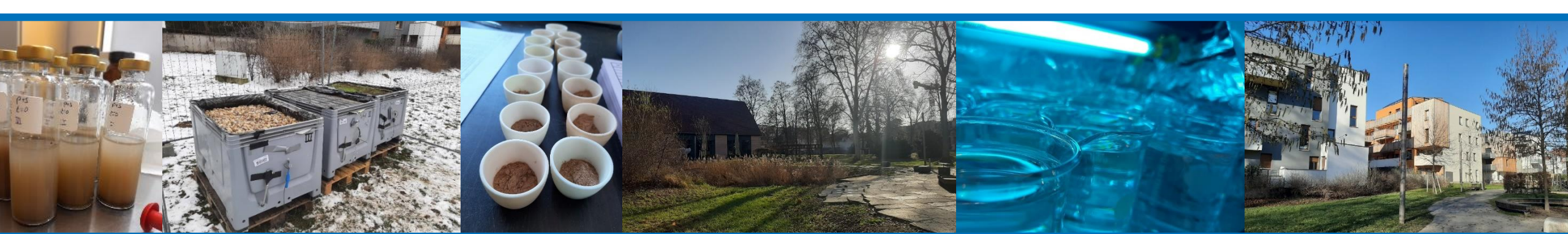
# Reactive transport of urban biocides: lysimeter experiment



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Where is the remaining fraction?



# Take home messages

1. Only slow terbutryn degradation in environment
2. Leaching from facades and towards groundwater for long time periods
3. Formation of transformation products → toxic?
4. CSIA as tool to follow degradation and differentiate degradation pathways:  
in laboratory ✓ in the environment (✓)



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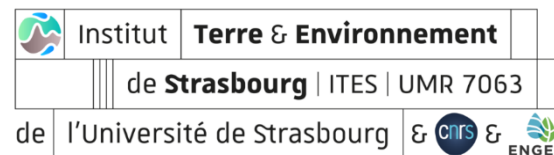
Eric Pernin

Francois Wallon

Comments? Suggestions? Questions?  
Contact me!

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or



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