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

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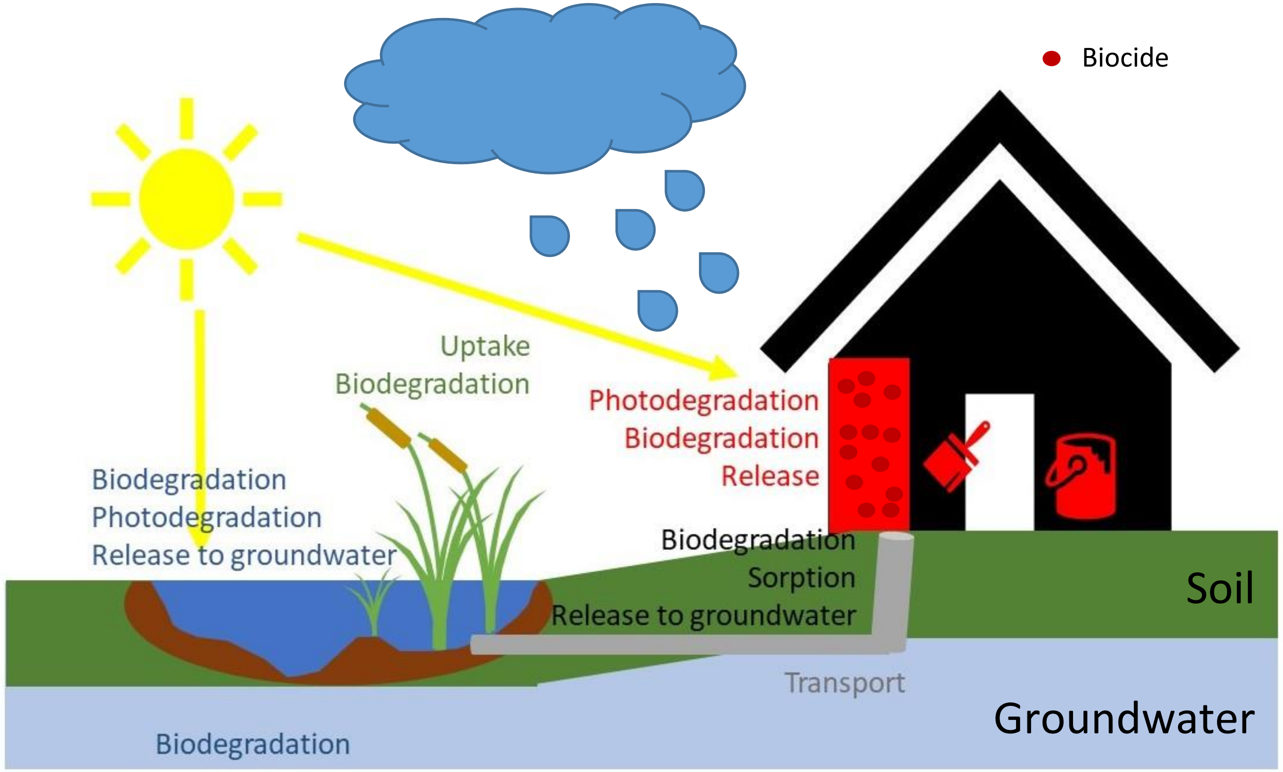
Why studying urban biocides?

- Used in building materials like paint and render[1]
- Prevent growth of algae, funghi,…
- Leaching into environment with **wind driven rain** [2,3,4]



[1] Gartiser et al., 2015, [2] Bollmann et al., 2016, [3] Burkhardt et al., 2012, [4] Wittmer et al., 2011, Picture: www.hausinfo.ch/

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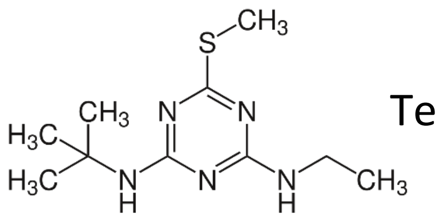
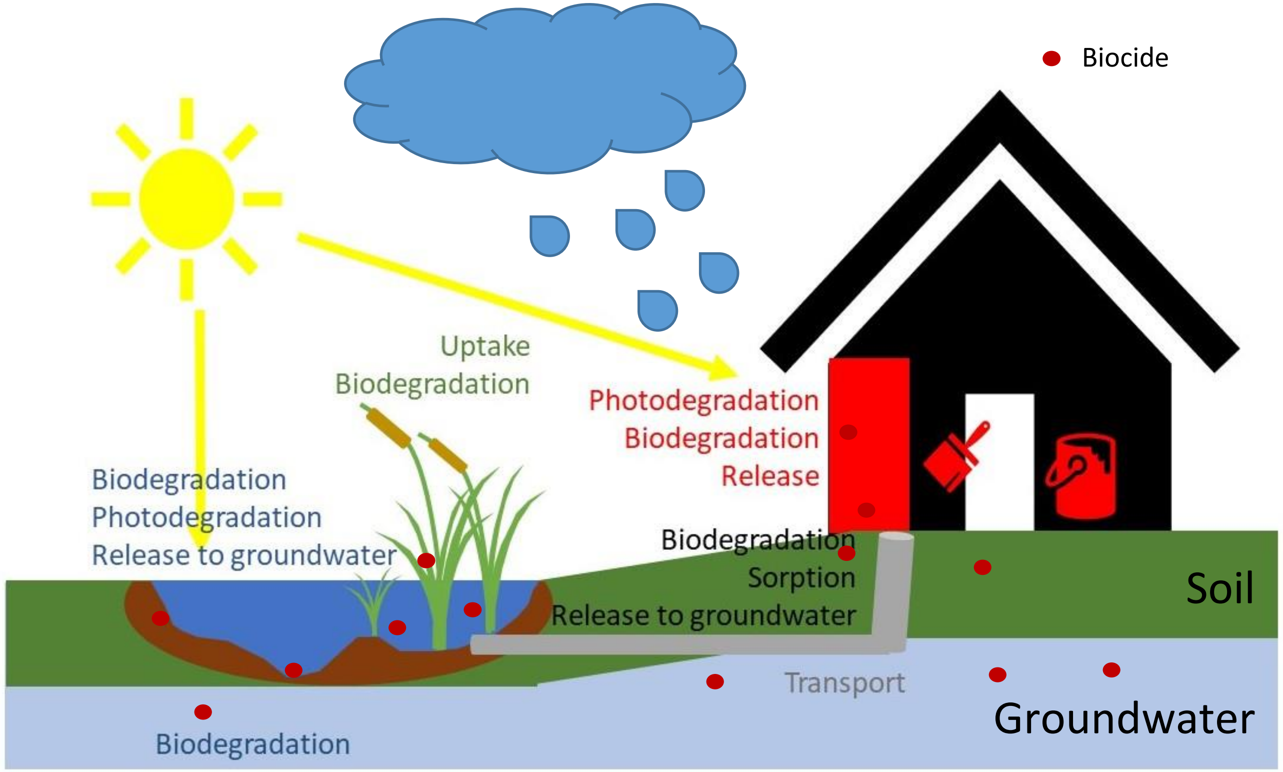


- **Terbutryn** is of major concern!
  - Prohibited in agriculture [5]
  - PNEC towards aquatic organisms: 3 - 34 ng/L [6,7]
  - Concentrations up to 5.6 µg/L (rivers) and 7.6 ng/L (groundwater) [8,9]
  - Transformation products “probably toxic”[10]

Reaction pathways from façade to soil and surface water still unknown



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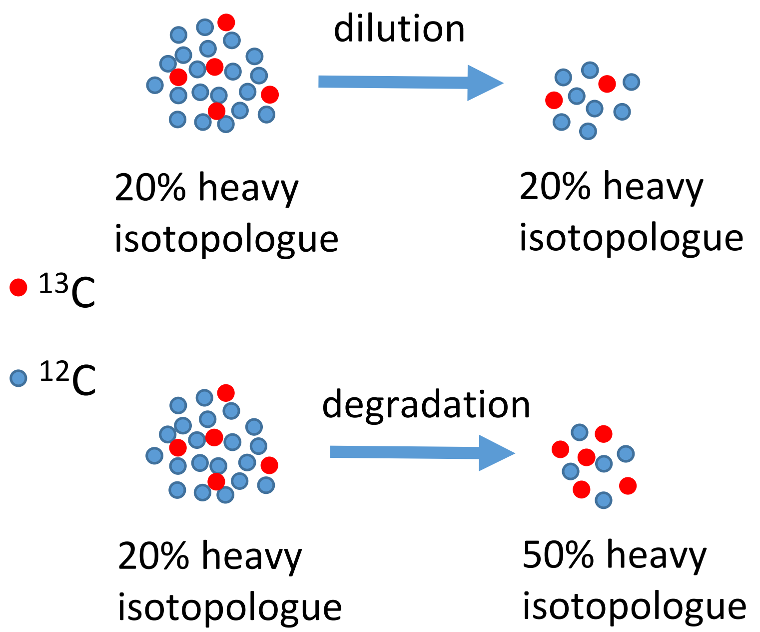
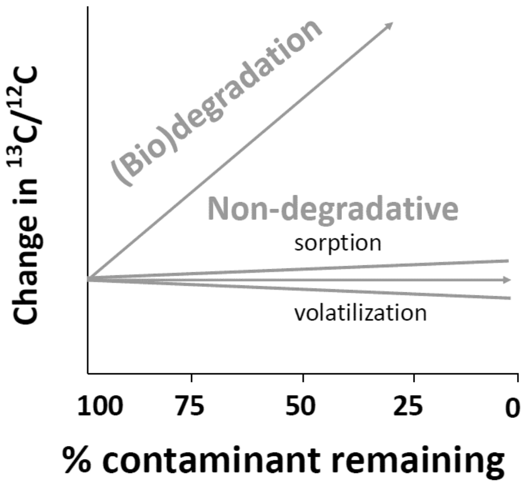
Compound specific isotope analysis as a tool to differentiate degradation pathways

Background: CSIA

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





[1] Elsner & Imfeld (2016)

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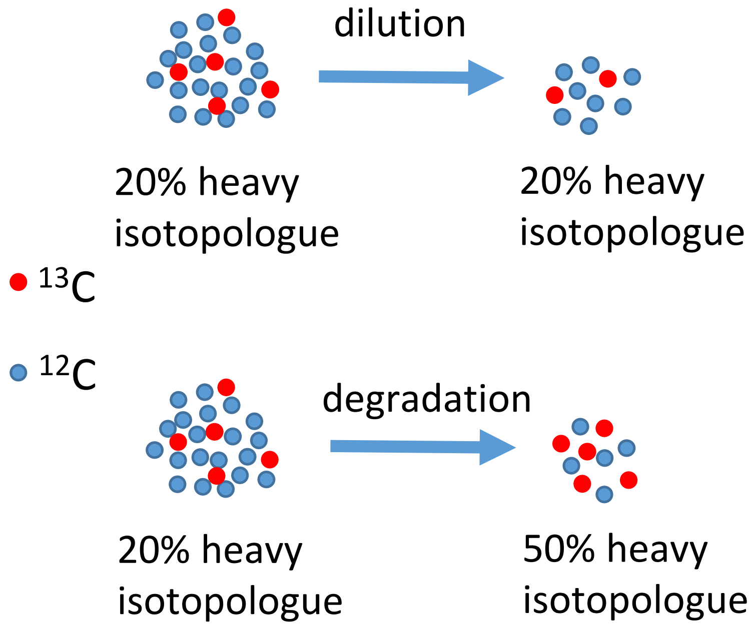

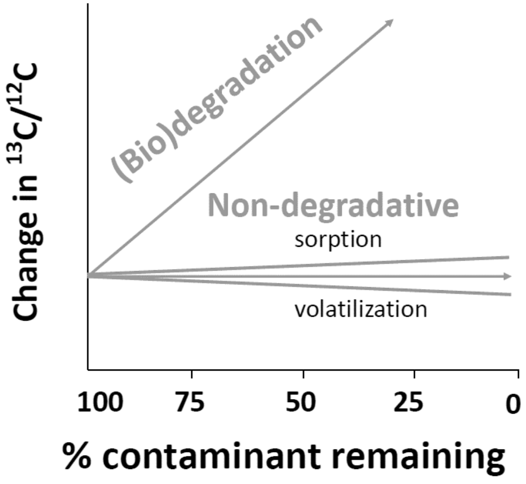

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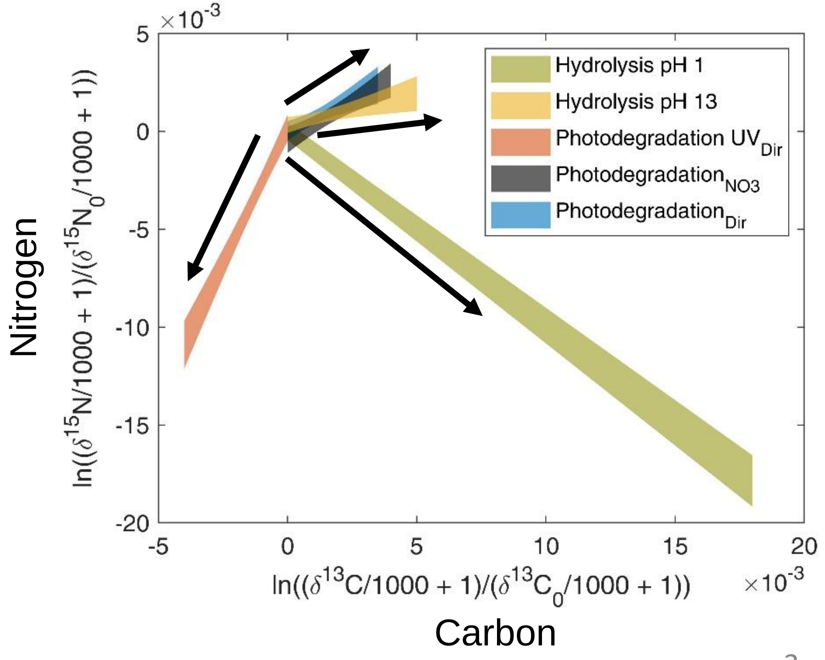
CSIA of terbutryn

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

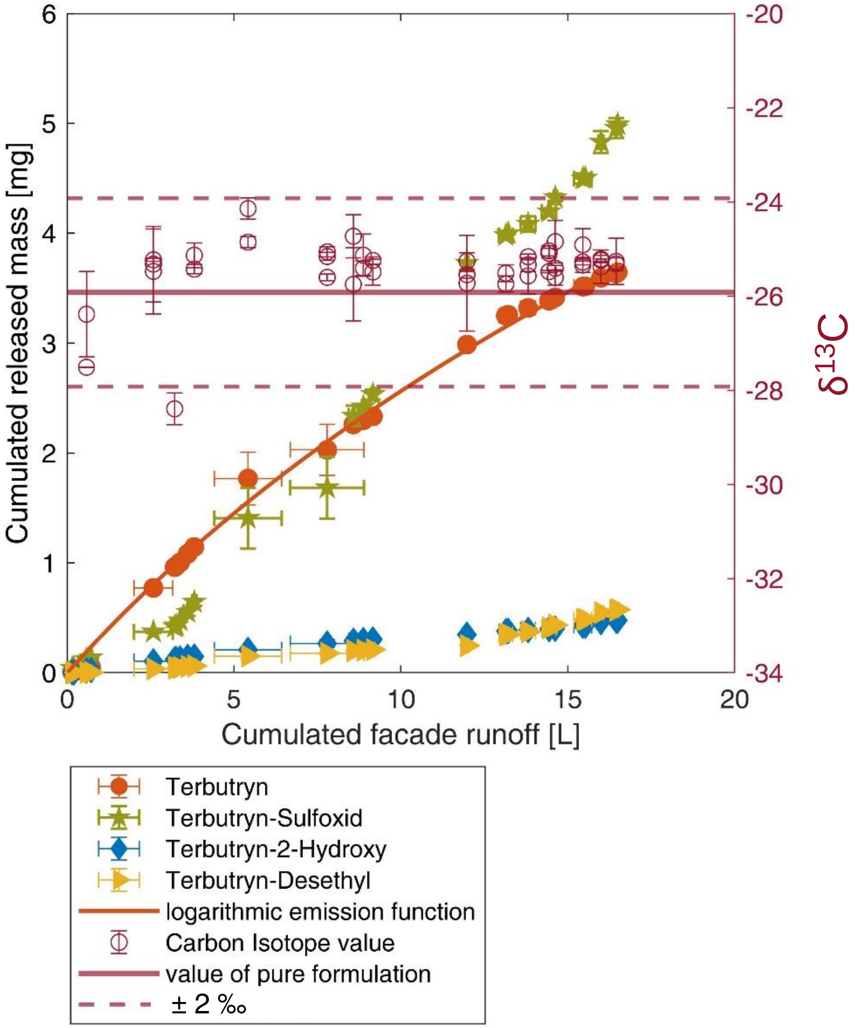


Reactive transport of urban biocides: Leaching from facades

- Release? Degradation? Applicability of CSIA to follow terbutryn degradation in the field?

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

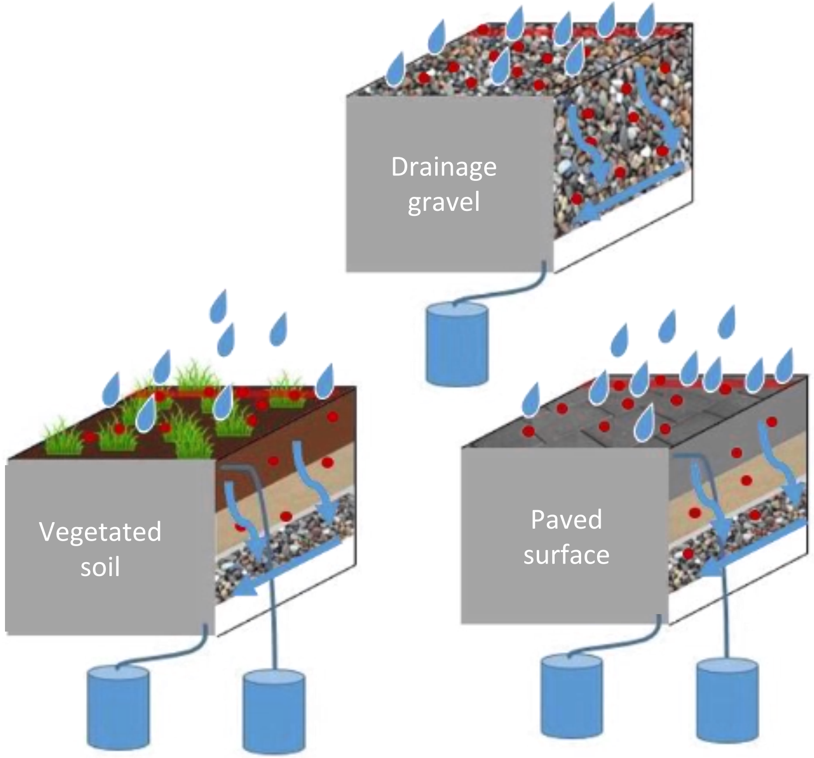
Reactive transport of urban biocides: Leaching from facades



- 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 "degraded fraction"

Reactive transport of urban biocides: lysimeter experiment



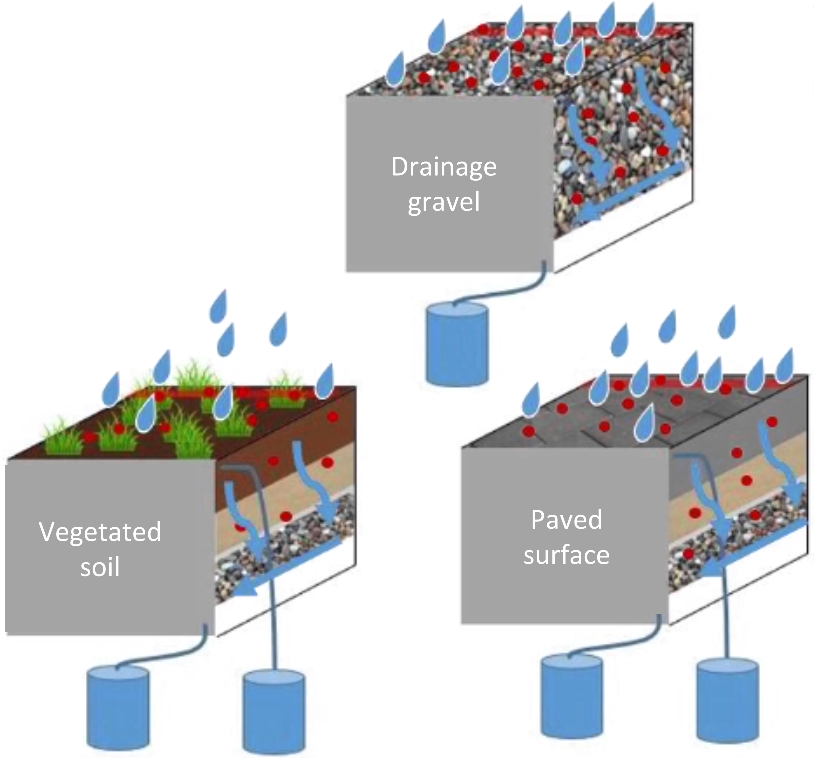
- Reactive transport and release towards groundwater?
  - Extent of degradation?
  - Formation of transformation products?
  - Applicability of CSIA ?

- Three types of materials

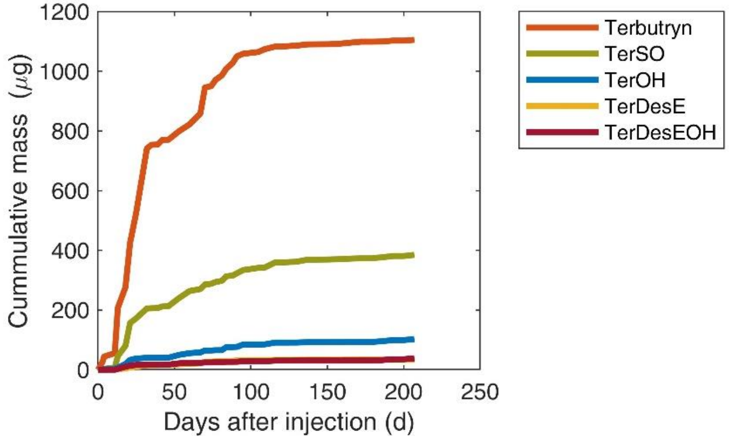
- Spiked with mixture of urban biocides

- Sampling at 40 cm depth, extraction (SPE) and analysis (LC-MS/MS)

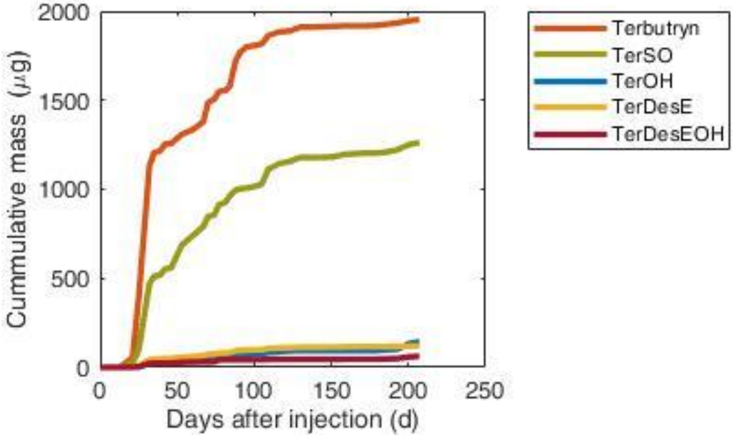
Reactive transport of urban biocides: lysimeter experiment



Drainage gravel



Paved surface



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

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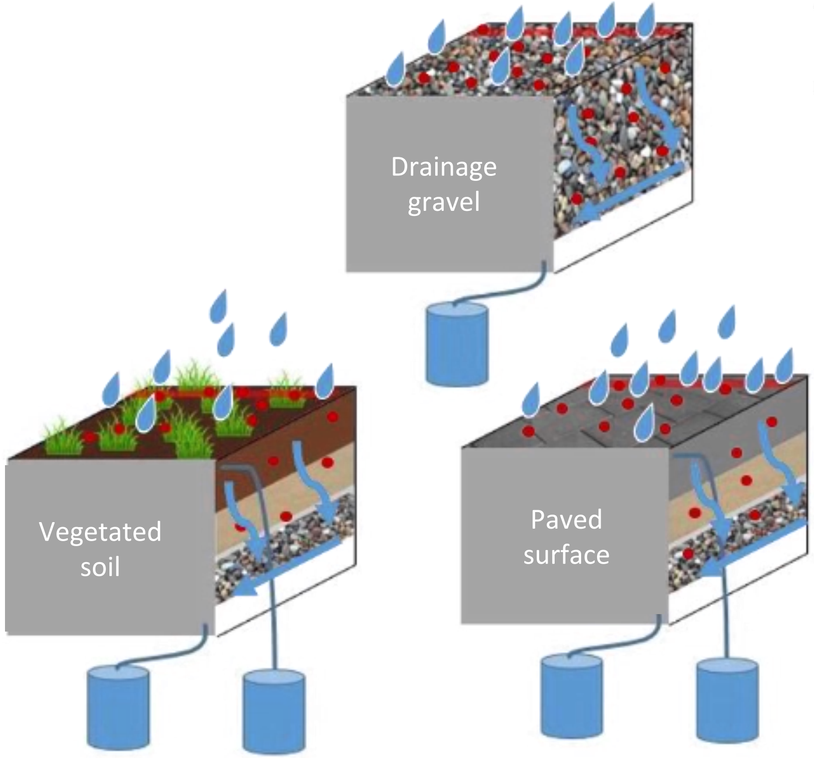

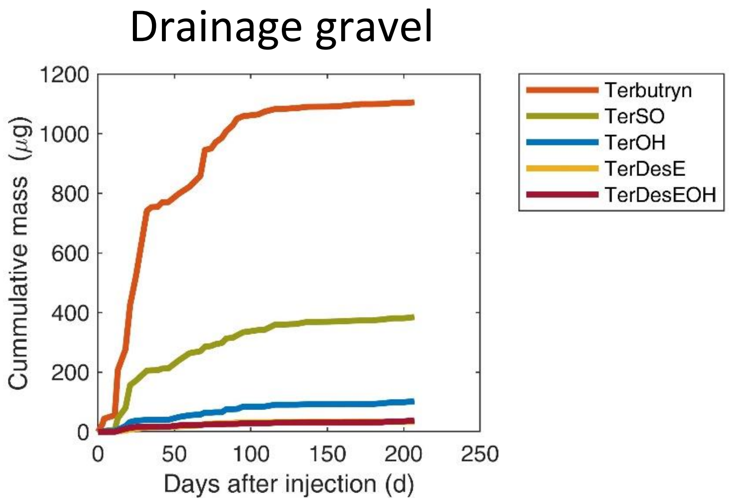

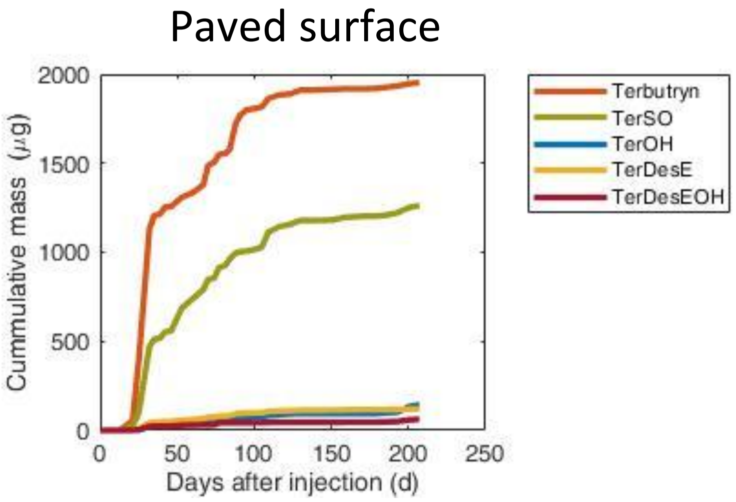

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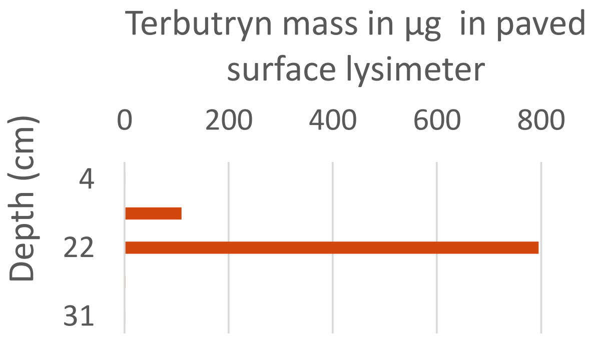
Where is the remaining fraction?

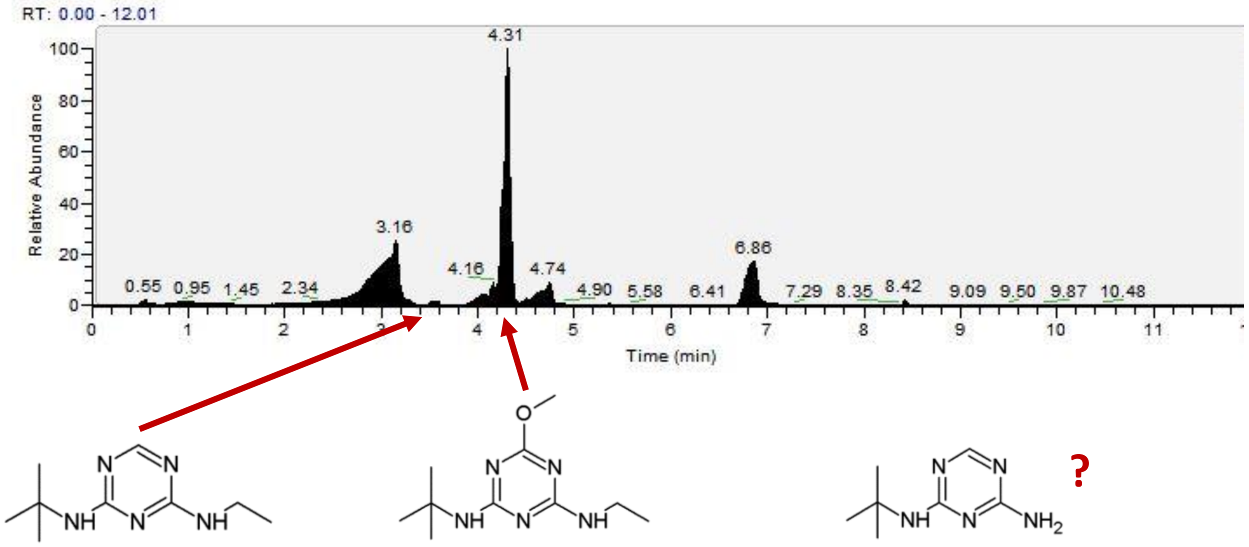
Reactive transport of urban biocides: lysimeter experiment

Where is the remaining fraction?

1. **Sorbed to the material →** extractions of materials reveal sorption of terbutryn → potential of desorption after long time periods



2. Leaching of transformation products that were not targeted in this study (semi-targeted approach)



TerDesS MEBT TerDesSDesE

Note: no isotope fractionation was observed (in agreement with laboratory experiments)

Take home messages

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

Institut Terre et Environnement de Strasbourg (ITES)

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Francois Wallon

Comments? Suggestions? Questions?
Contact me!

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