

Large Scale Modeling of Biocides to Groundwater

What happens to biocide emissions at the district level ?

- Biocides are used as film protection products in paints and renders in facades wash off and enter the environment where they can have adverse impacts on the ecosystem
- Stormwater infiltration systems such as swale-trench systems are an entry pathway for biocides to groundwater
- Other possible pathways of biocide entry to groundwater



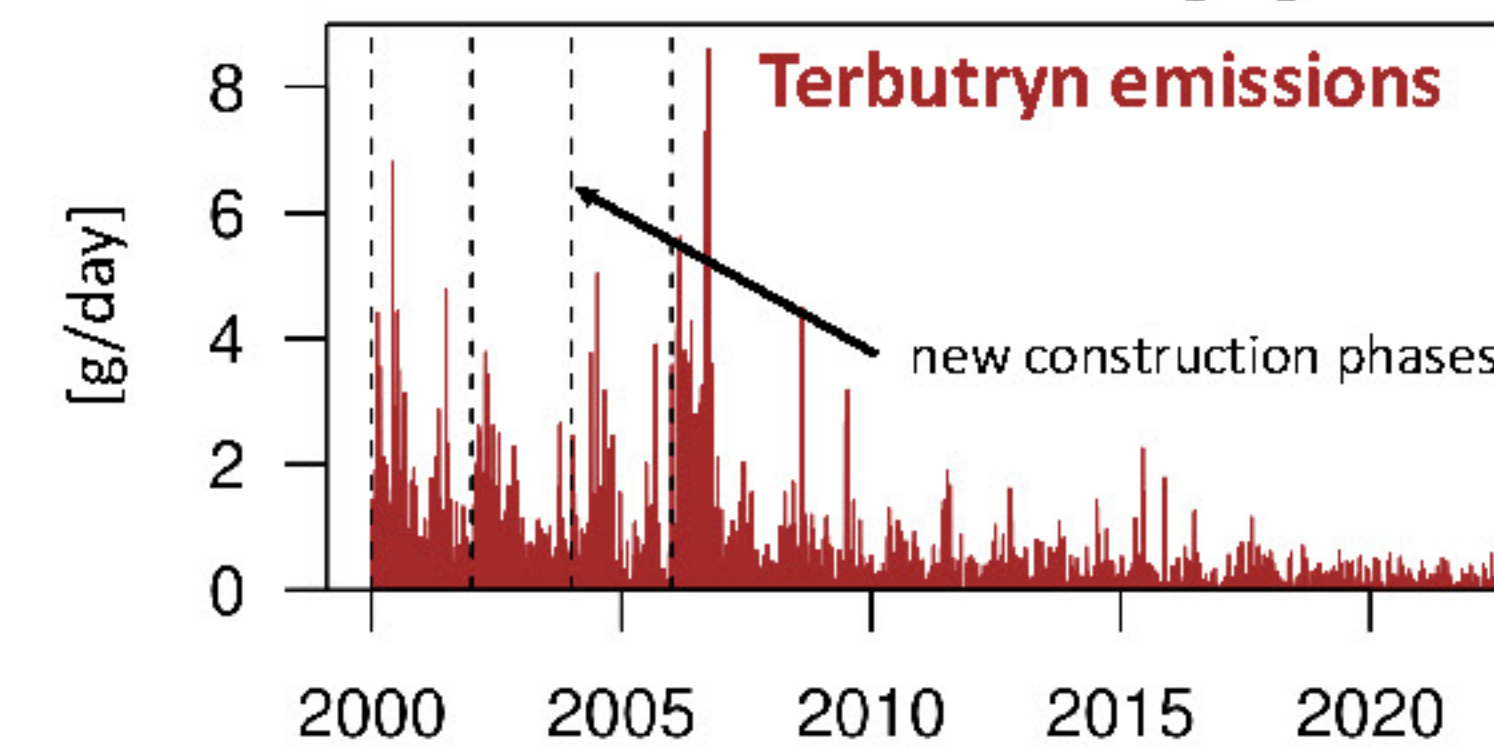
- Limited knowledge of biocide input to groundwater at larger scale

1. Where do biocides enter groundwater?
2. What amount of biocides is retained in the swale-trench systems?
3. How are biocides transported and degraded in the saturated zone?



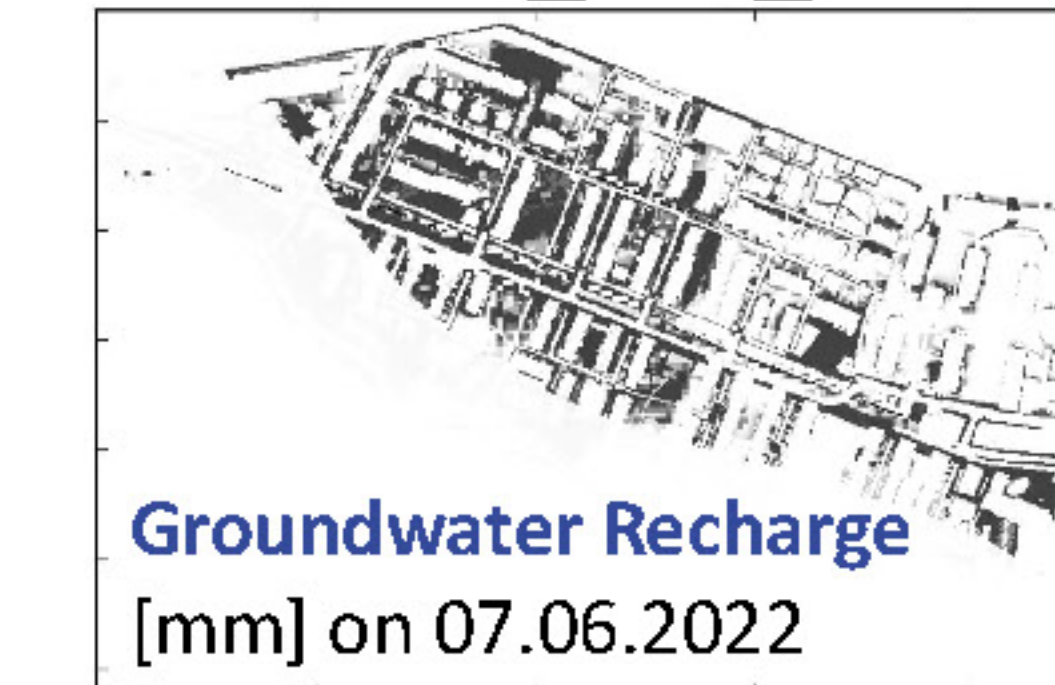
Methods: Model chain from facades to groundwater

Biocide emission model "COMLEAM" [1]



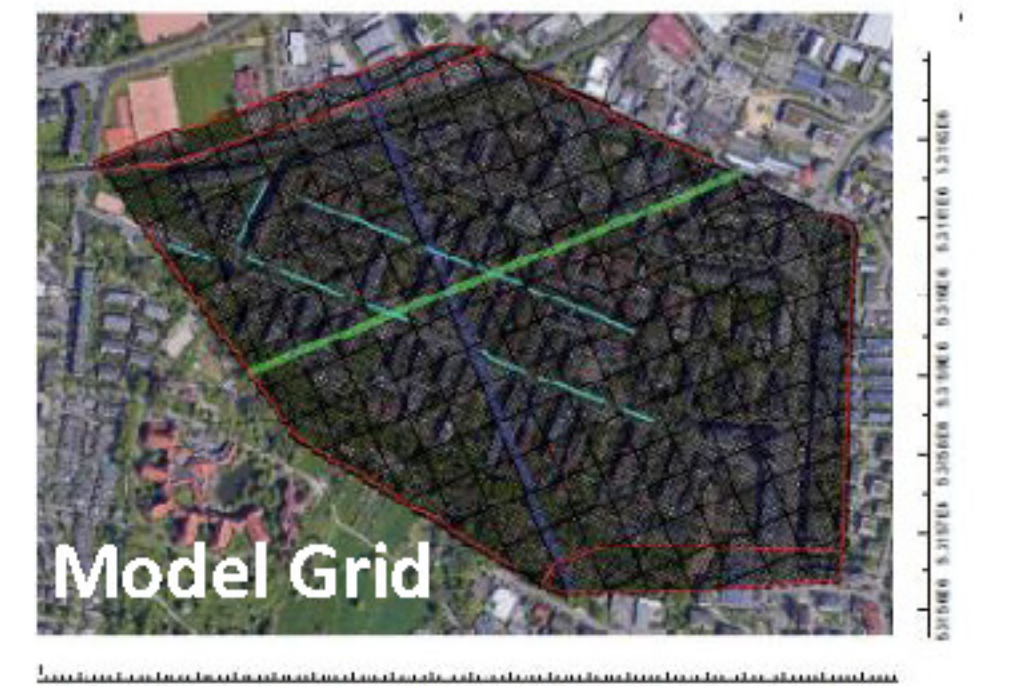
- Calculates biocide emissions from facades [g/day]
- Biocide terbutryn modeled based on previous measurements and common use
- Initial concentrations of terbutryn estimated

Rainfall-runoff model "RoGeR_WB_Urban" [2]



- Calculates urban water balance and groundwater recharge [mm]
- Buildings and surface areas mapped on the ground
- Same time period as biocide leaching model

Groundwater model "MODFLOW" [3]



- Calculates biocide infiltration and transport in groundwater [g]
- Calibrated with data from chlorinated hydrocarbons measurements

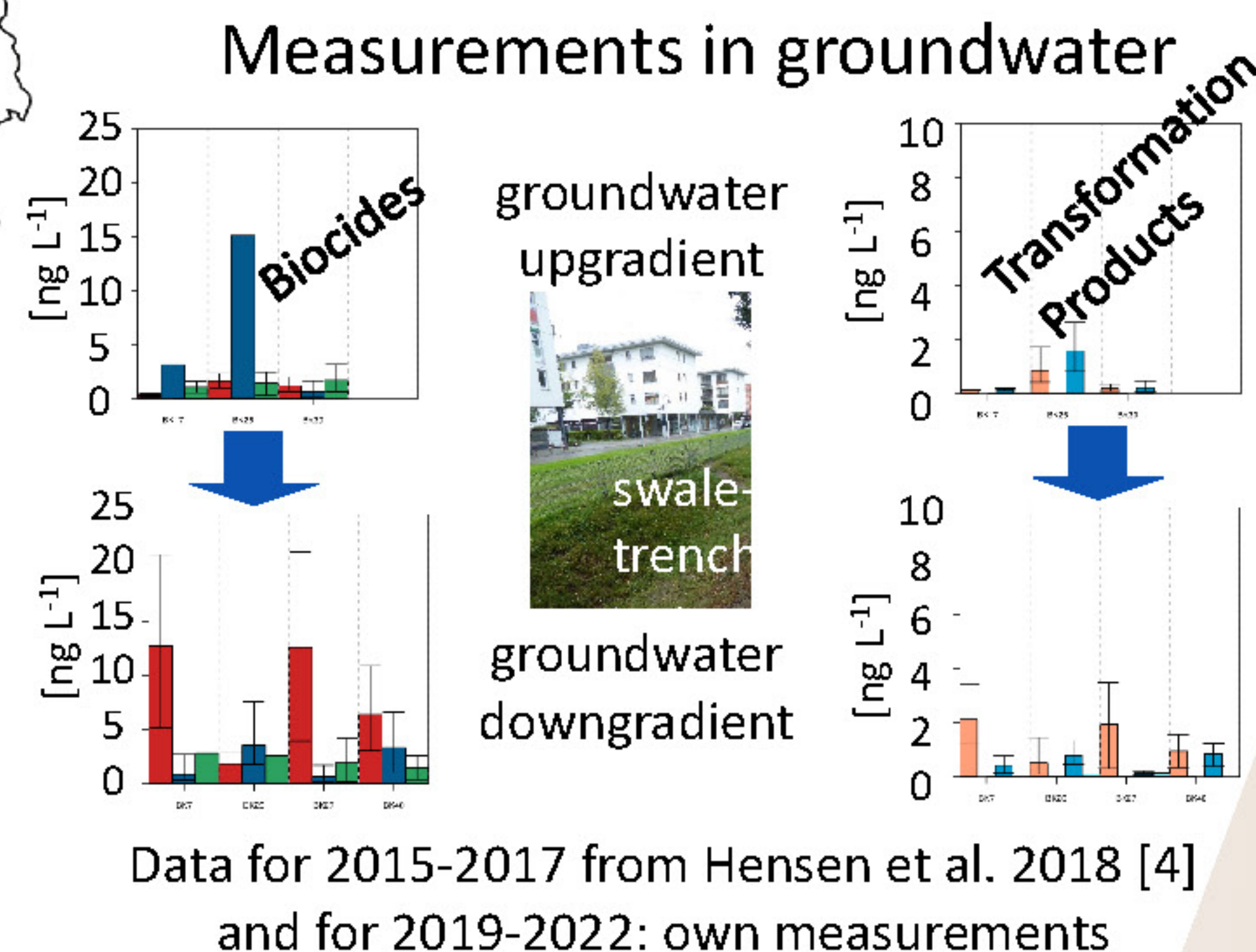
Study Area

City of Freiburg
District Vauban



Eco-district of 38ha built since 2000

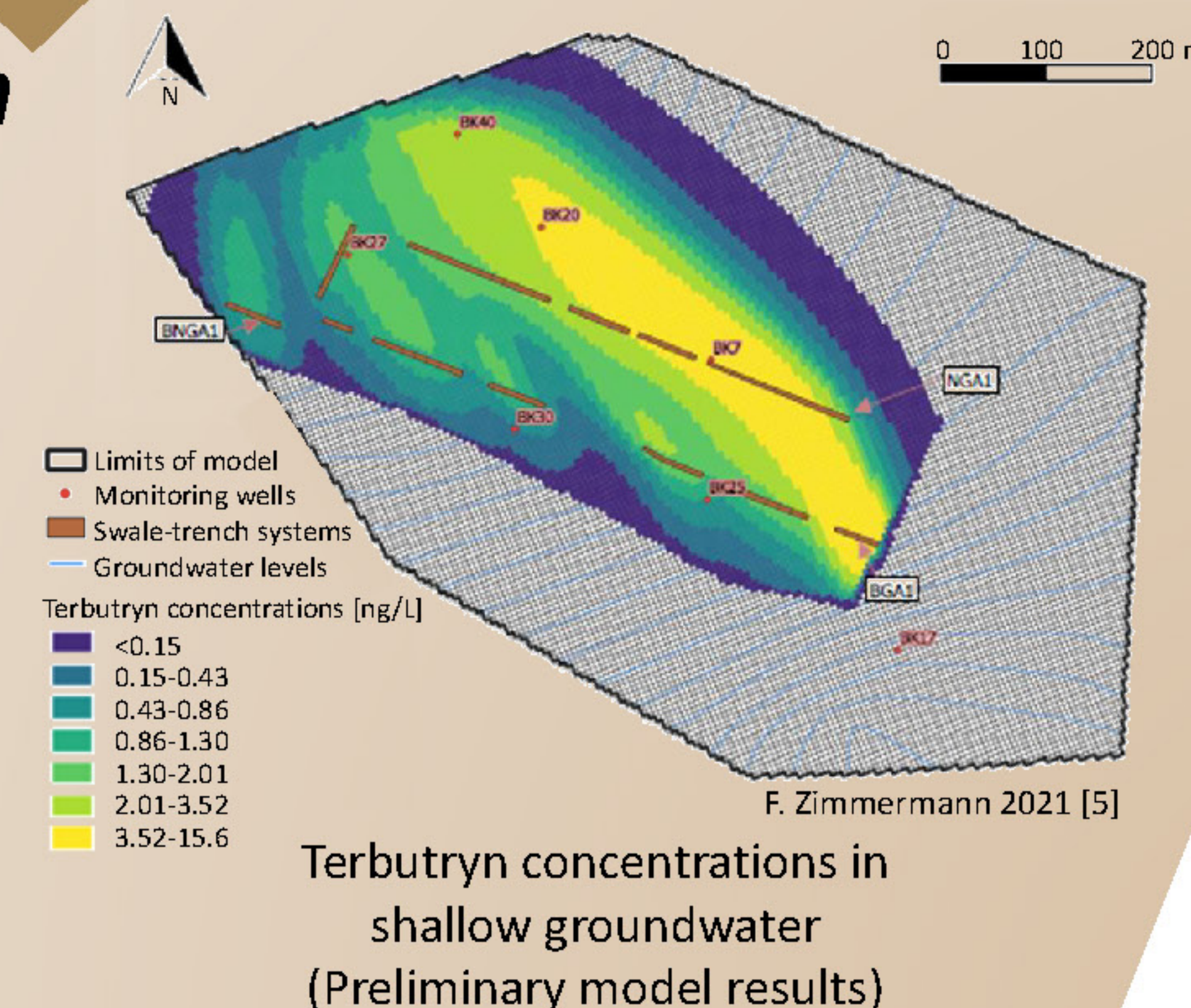
- Green district with mostly residential buildings, solar panels and green roofs
- District with sustainable stormwater management
- Numerous urban groundwater monitoring wells exist due to a contamination with chlorinated hydrocarbons (CHC)



Results: Output of model chain

Modelling results confirm groundwater monitoring data

1. Biocides enter the shallow groundwater via the swale-trench system. This is confirmed by higher terbutryn concentrations downgradient than upgradient of the swale-trench system. There are also other pathways for terbutryn to enter groundwater.
2. Retention capacity of biocides in swale-trench systems is limited due to shallow groundwater levels
3. Results suggest degradation and sorption of biocides in swale-trench systems although future studies are required.



Implications

- Model approach is a useful tool to investigate biocide emissions and transport to groundwater at a larger scale
- Measures to prevent groundwater contamination are most efficient at the source

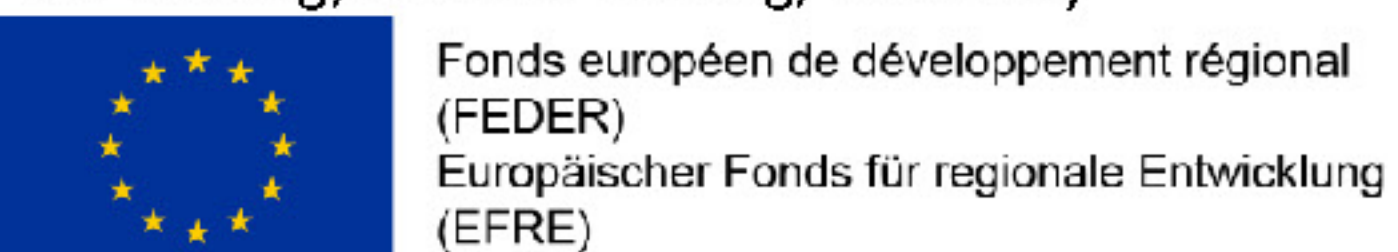
Next steps

- Calculate different scenarios with varying initial biocide use
- Vary amount of diffuse biocide losses within the district
- Include transformation products

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Literature

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- [2] Steinbrich, A., Leistert, H., and Weiler, M.: RoGeR – ein bodenhydrologisches Modell für die Beantwortung einer Vielzahl hydrologischer Fragen, Korrespondenz Wasserwirtschaft, 14, 94–101, 2021.
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Abstract

