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Simultaneous biodegradation of water treatment additives: Transformation and byproduct formation, impact of biocide shock dosing and salinity

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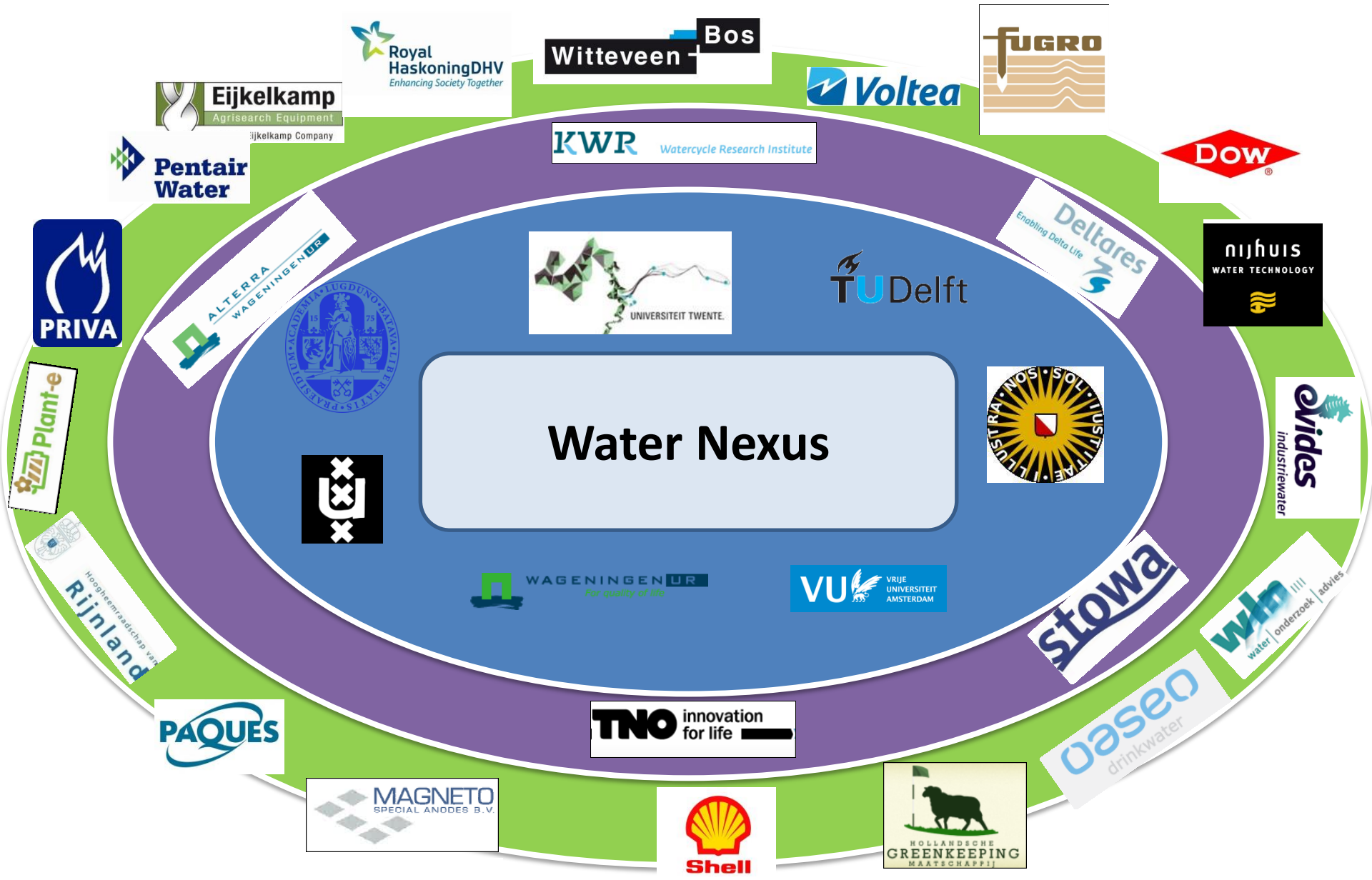
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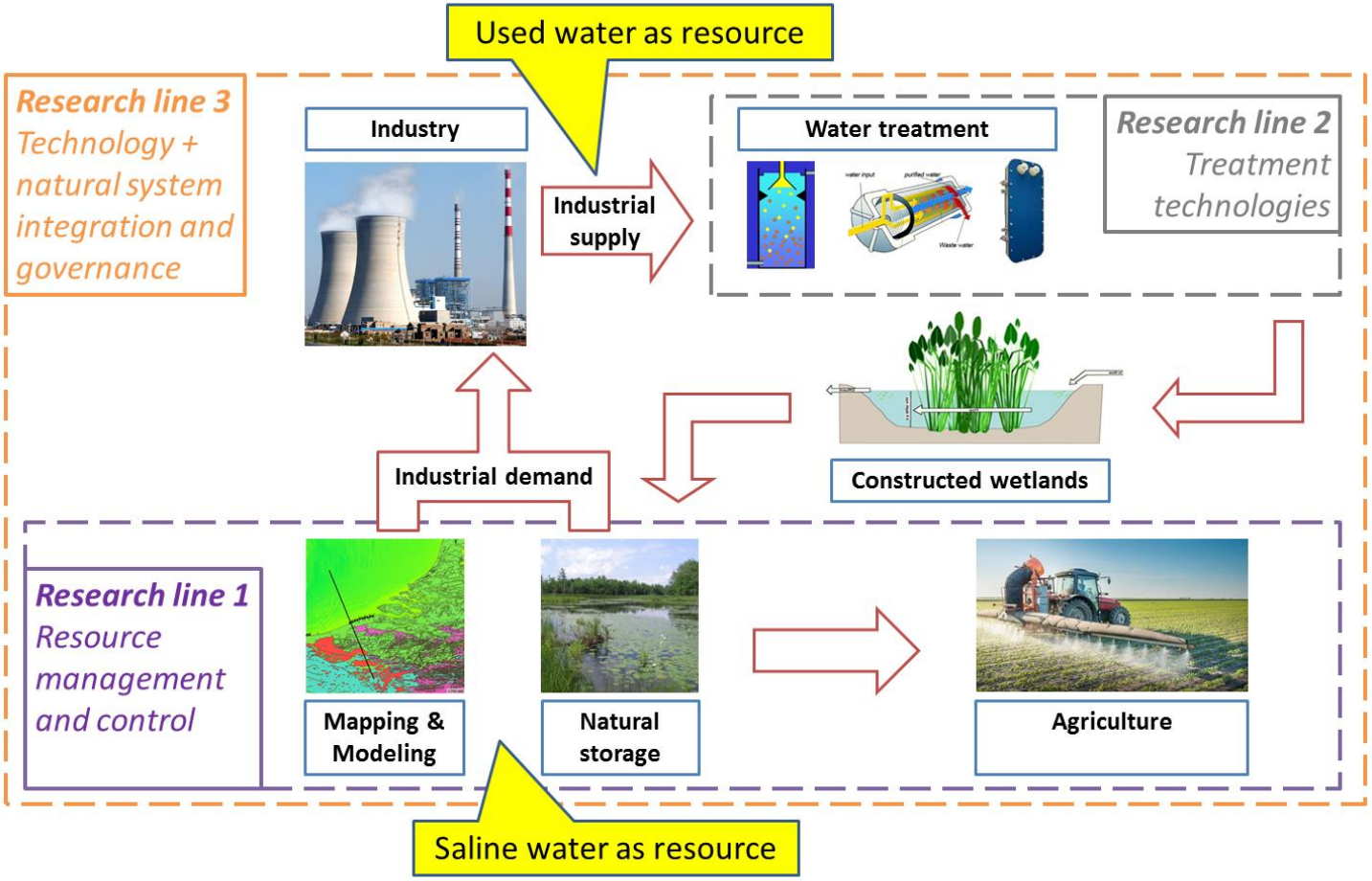
Make (agro) industrialised regions water self-sufficient using green infrastructure
Salt water when possible - fresh water when needed



Constructed wetlands

Jasper et al. (2013)

www.aaees.org

Removal processes

- Biodegradation
- Photodegradation
- Sorption to sediment and soil
- Uptake by plants

www.flickr.com

Constructed wetlands

Features that make constructed wetlands a suitable option for waste water treatment (WWT)

- Several simultaneous contaminant removal processes
- Effective removal of large variety of contaminants
- Combination with other WWT technologies
- Integration in the landscape
- Low maintenance effort & costs
- Low energy requirements
- Applicable for remote communities / industrial facilities

Research objectives

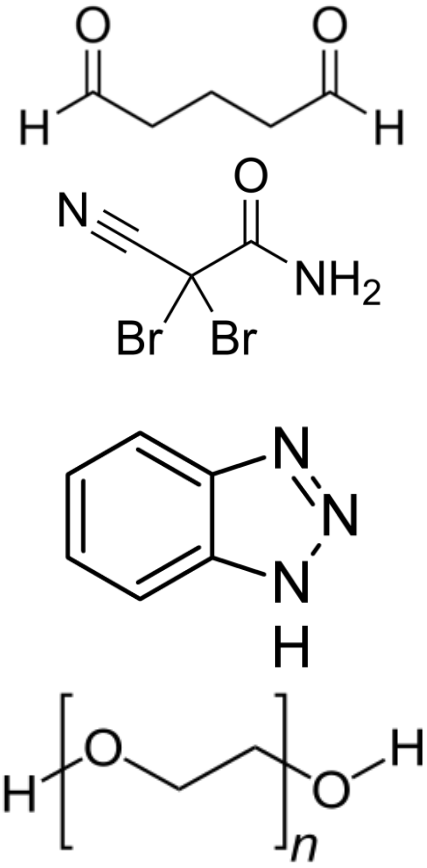
- Determine the optimal constructed wetlands (CWs) design for the removal of harmful substances from saline industrial water streams

- Two case studies:
  - Brackish cooling tower water
    - Mild salinity (5 g/L)
    - Industrial additives (biocides, corrosion inhibitors, antiscalants)
  - Produced water in hot dry climates
    - High salinity (10-120 g/L)
    - Hydrocarbons
    - Industrial additives

- Develop combination of CWs with other water treatment technologies (in cooperation with other Water Nexus PhDs)

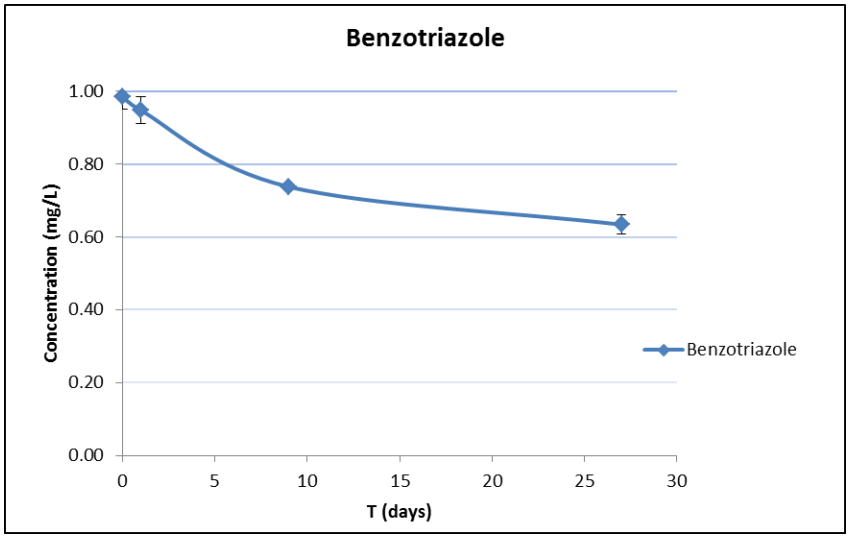
Model contaminants

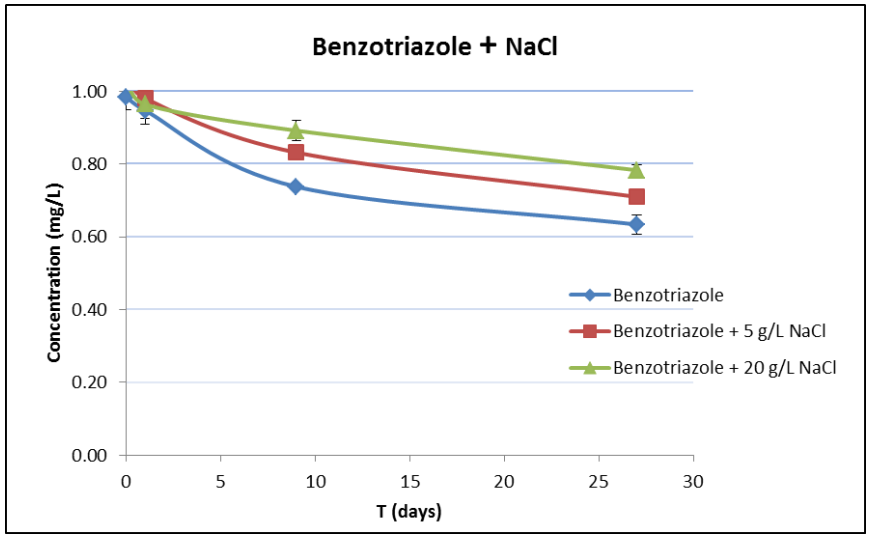
- Biocides
  - Glutaraldehyde
  - 2,2,-dibromo-3-nitrilopropionamide (DBNPA)
- Corrosion inhibitor
  - 1H-Benzotriazole
- Surfactant
  - Polyethylene glycol (PEG)
- Other additives?
  - Antiscalants?
  - Antifoaming agents?



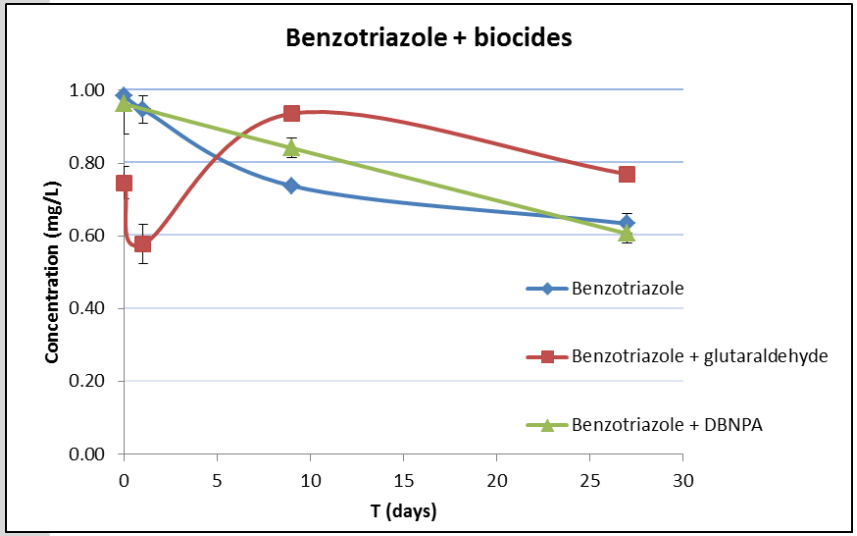
Biodegradation of 1H-Benzotriazole

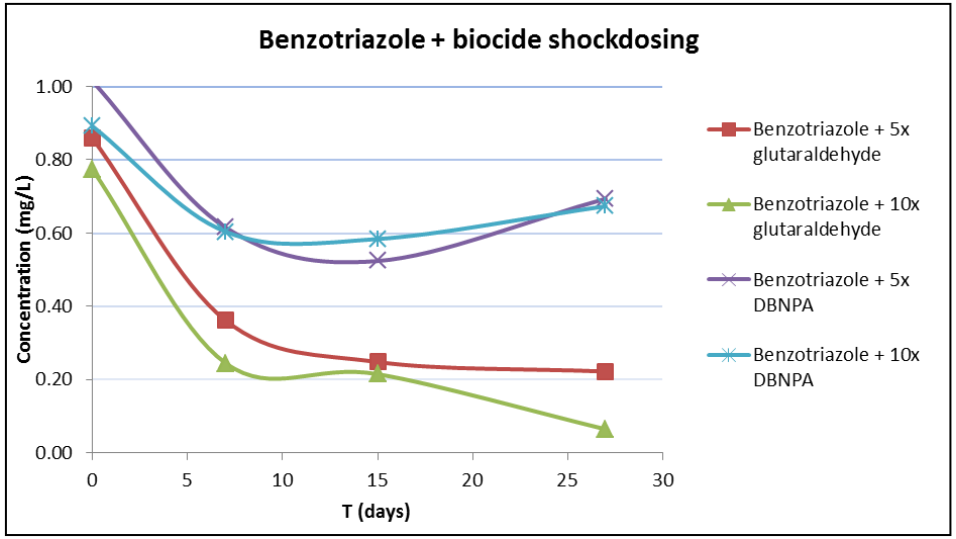
- In aerobic mineral medium
- Wetland sediment as inoculum
- Effect of salinity



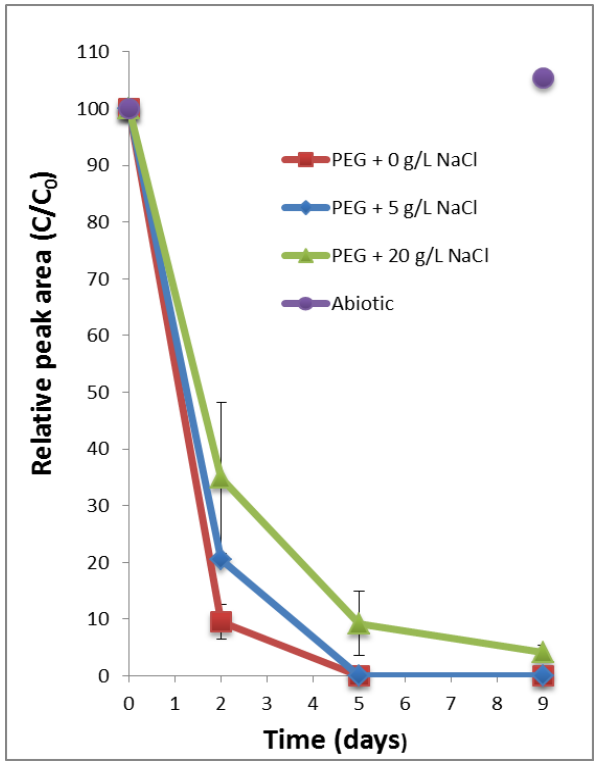


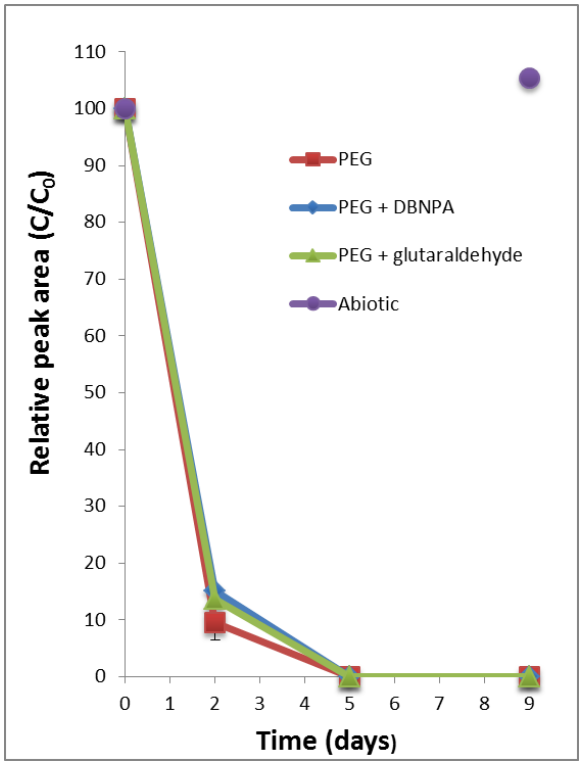
- Effect of biocides

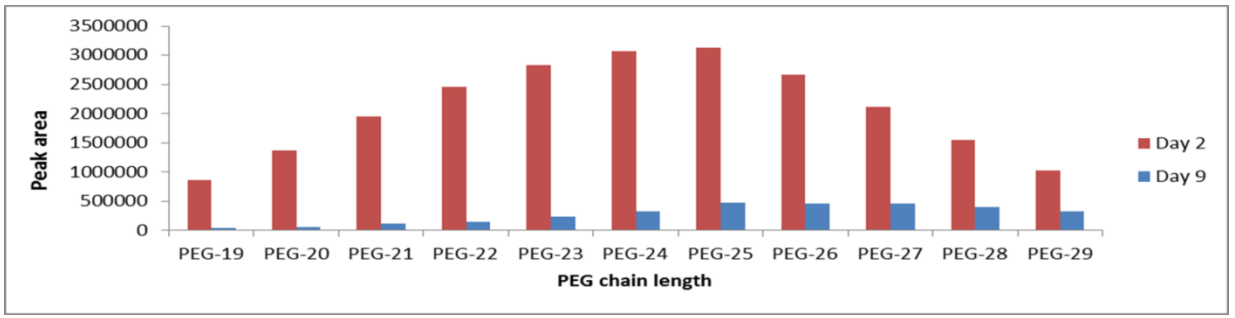




Biodegradation of PEG

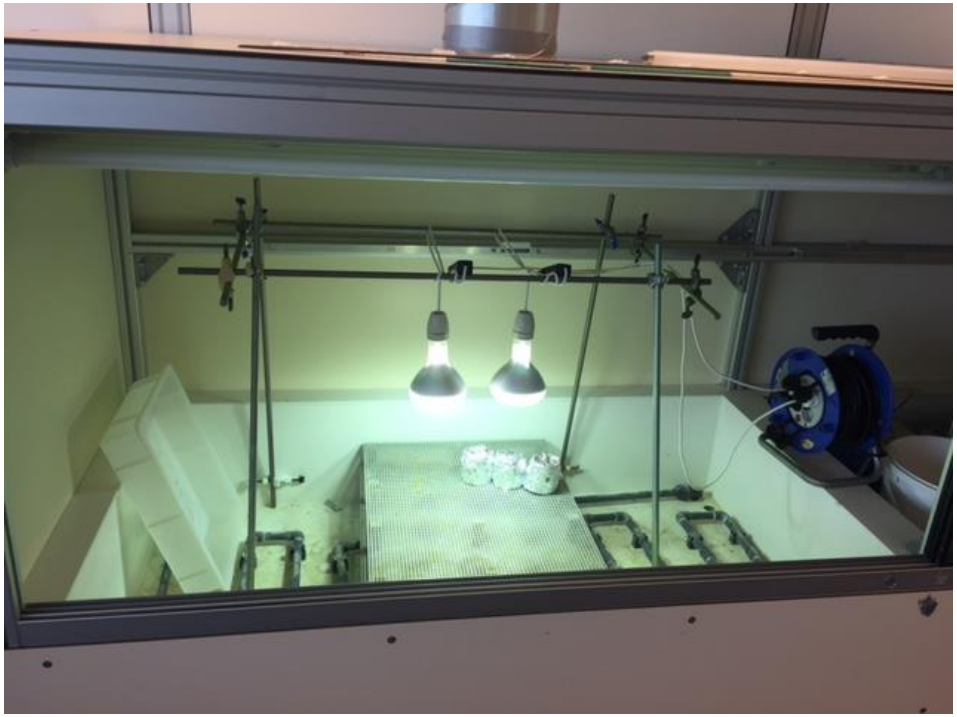






Photodegradation

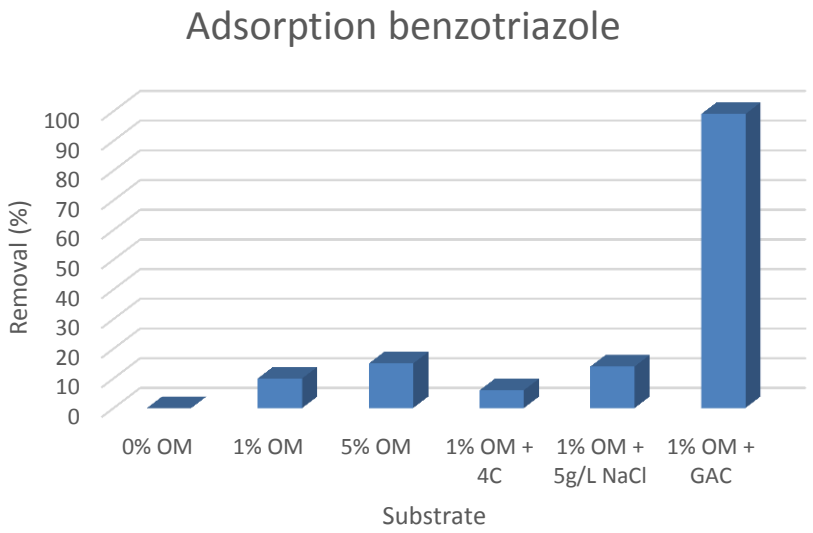
- Benzotriazole, DBNPA, PEG tested
- Direct photodegradation (solar spectrum)



- Influence of salinity
- Influence of DOM (indirect photodegradation)

Sorption

- Sorption of benzotriazole to:
  - Sand (0% OM): no removal observed
  - Sediment young wetland (1% OM): ± 10% removal
  - Sediment mature wetland (5% OM): ± 15% removal
  - GAC: 100% removal
  - Sediment amended with GAC: 100% removal



Conclusions

- Biodegradation may not be able to remove all additives
- Combinations of biodegradation with photodegradation and sorption may be required
  - Take into account in design of constructed wetlands
- Effects of salinity and toxicity of biocides may be significant factors

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- STW (NWO-TTW) and Ministry I&M

- More information: www.waternexus.nl

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