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Environmental Fate and Behavior of Transformation Products of Pesticides used in Urban Areas

First Estimation of the Release and Transformation of the Biocidal Active Substance OIT

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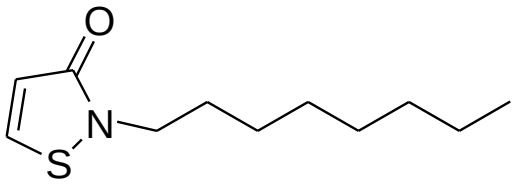
Biocidal Active Substances

Introduction

- Substances to **protect humans and products** against harmful organisms
- E.g. disinfectants, preservatives, coating agents, masonry preservatives

Studied Substance

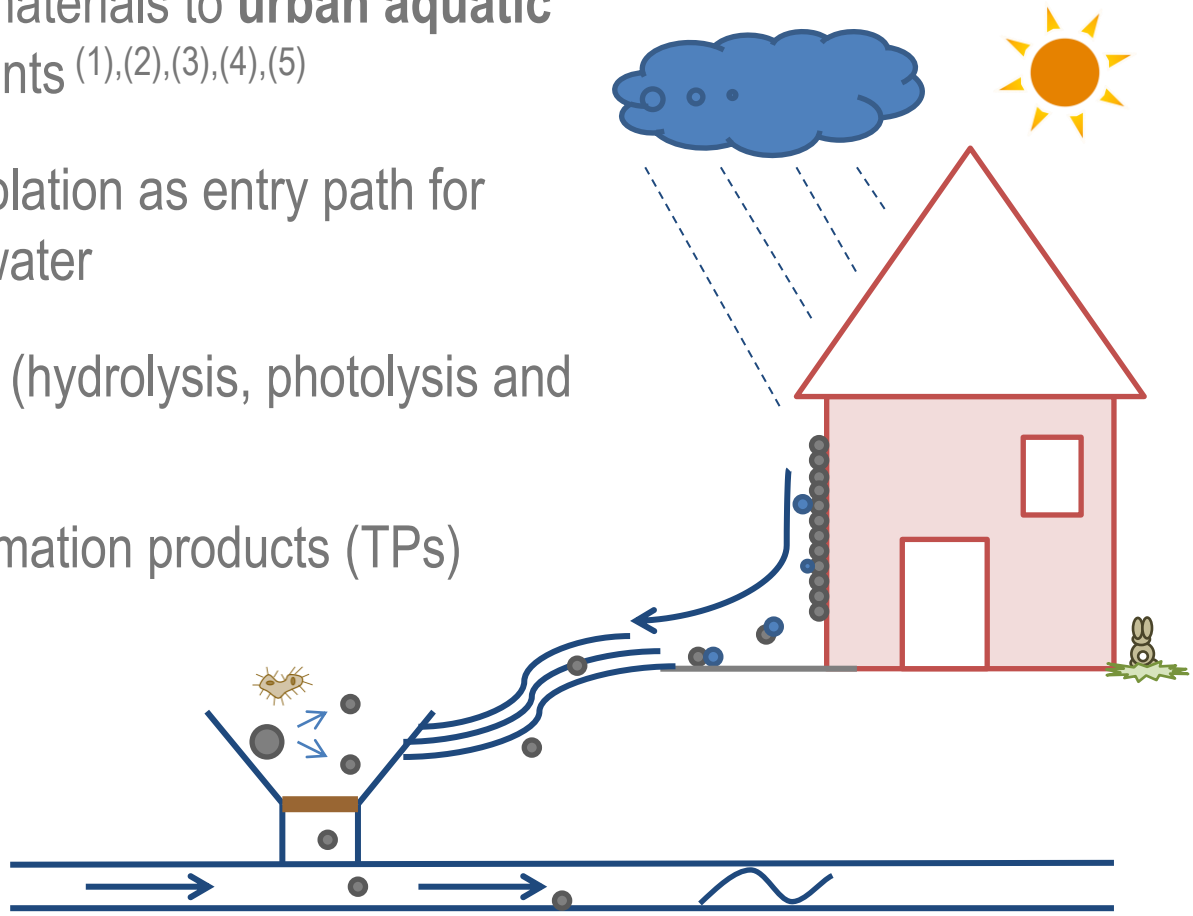
- **Octhilinone** (OIT) is a film preservative in water-based polymer resin paints
- **Fungicide** to prevent the growth of moulds and bacteria on facade paints



Release and Behavior of Biocides

Introduction

- **Leaching** from outdoor materials to **urban aquatic environment** by rain events [1],[2],[3],[4],[5]
- **Urban stormwater** percolation as entry path for biocides into the groundwater
- **Degradation processes** (hydrolysis, photolysis and biodegradation)
  - ➢ Formation of transformation products (TPs)



References: (1) Burkhardt et al. 2012; (2): Schoknecht et al. 2009; (3): Wangler et al. 2012; (4): Jungnickel et al. 2008; (5): Breuer et al. 2012).

Research Objective

Introduction

- Measured concentration in suburban areas in Denmark after heavy rain event: **5 - 50 ng/L** (6)
- Considered Predicted No Effect Concentration (PNEC) = **13 ng/L**(7)
- UV-irradiation of OIT lead to **7 TPs**(8)

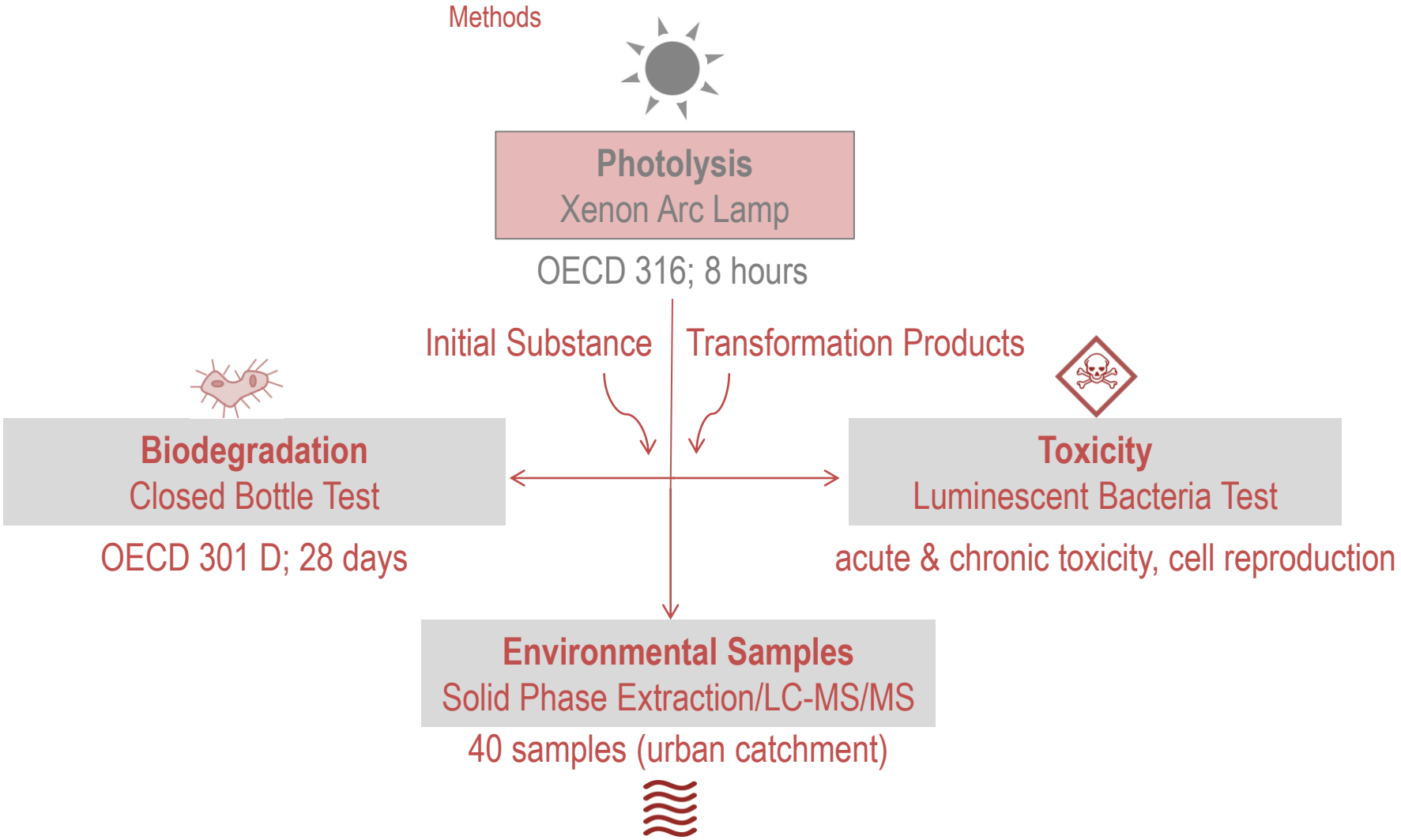
Identification of **transformation pathway** of OIT

Detection of TPs in urban rainwater discharge and groundwater

Contribution to an environmental **hazard assessment**

References: (6): Bollmann et al. 2014; (7): Burkhardt et al. 2009; (8): Bollmann et al. 2017

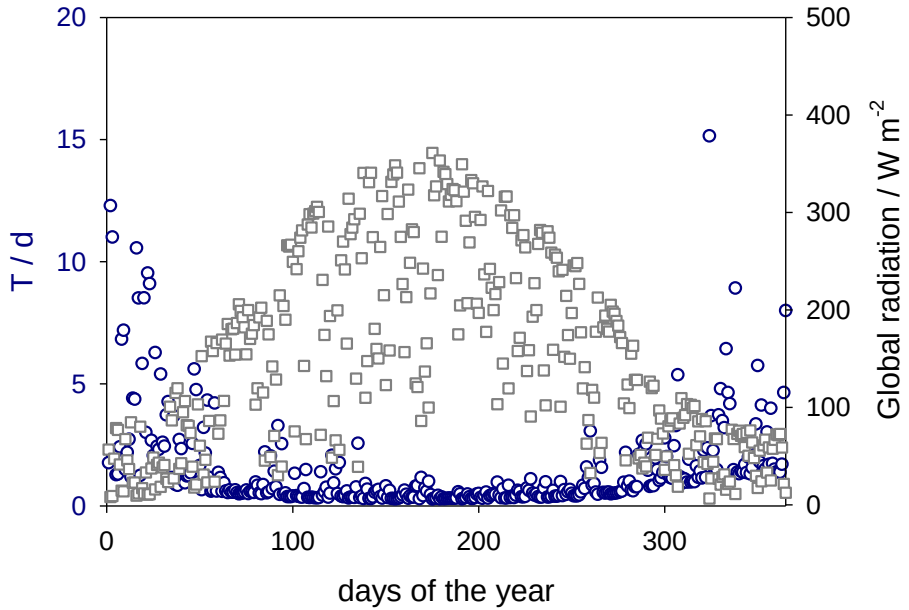
Experimental Approach



Kinetic of Photolytic Processes

Results

- **Photolytic efficiency:** quantum yield Φ = 0.01
- **Global radiation** (Germany, Freiburg: 48.0004 N, 7.5055 E)
- **Lifetimes (τ)** of 0.3 (summer) to 15 days (winter)



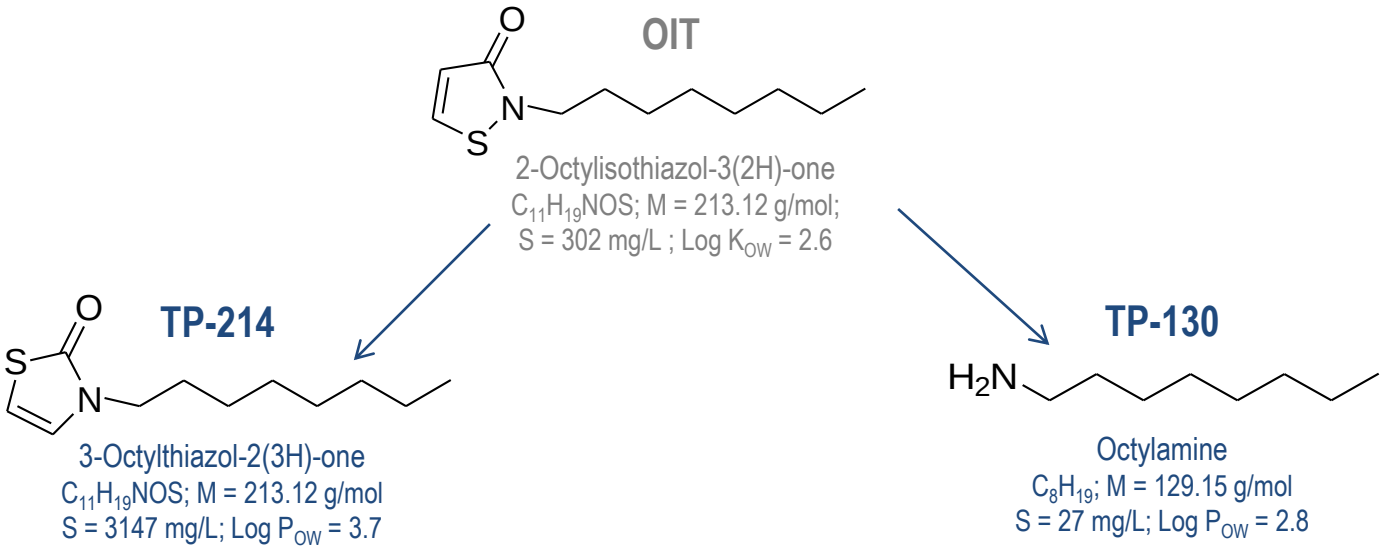
➢ OIT is photolytic degradable in the **environment** with low lifetimes

Development of TPs

Results

TPs during **photolysis** of OIT

- **Mobility**: **TP-130** > OIT > **TP-214**



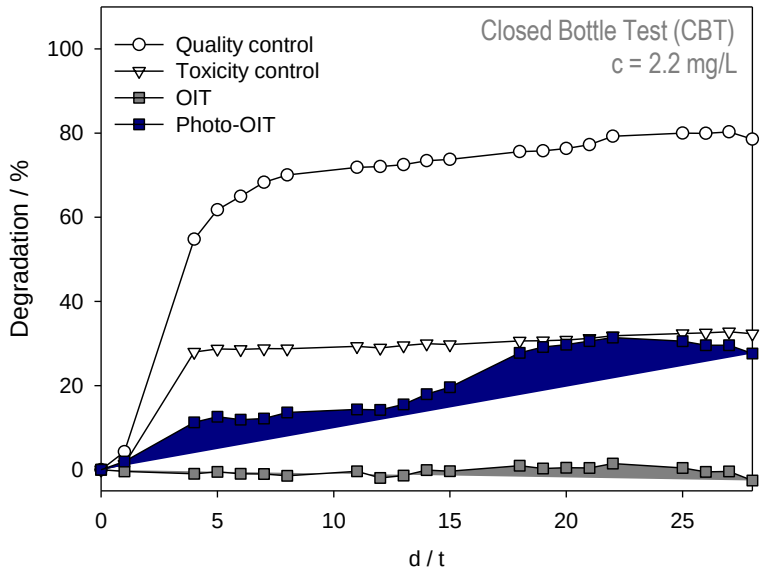
➢ Already known TPs [8] with **unknown properties** on environmental fate and behavior

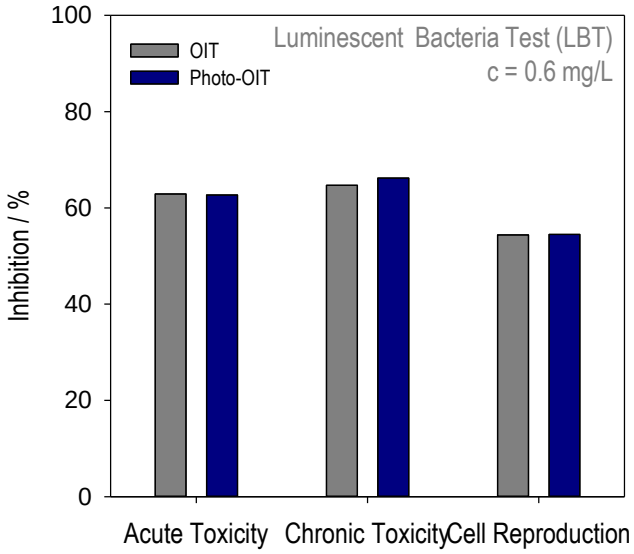
(8): Bollmann et al. 2017

Estimation of the Behavior of TPs

Results

- OIT is probably **not readily biodegradable**
- OIT shows **high toxic effects** (EC_{50} = 0.45 mg/L)





➢ **Higher biological activity** and **unchanged toxicity** of the photolytic mixture

Environmental Samples

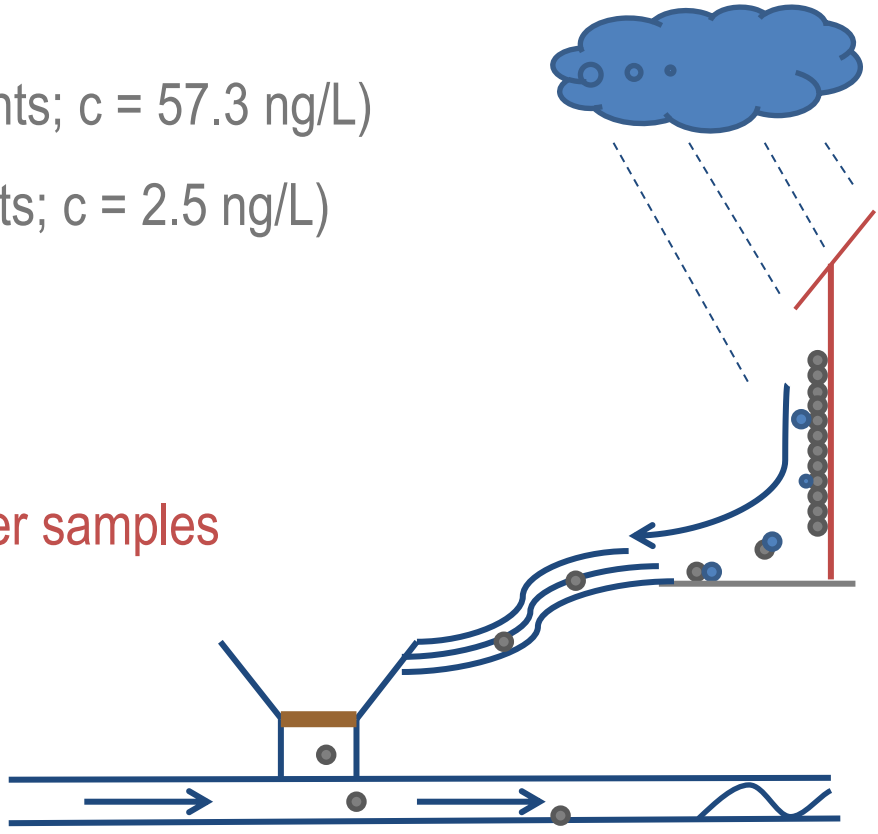
Results

Measurement of the **entry path** of OIT and its TPs in an urban catchment (Germany, Freiburg, 2016)

- Rainwater discharge (1/10 sampling points; c = 57.3 ng/L)
- Swale-trench-system (1/9 sampling points; c = 2.5 ng/L)
- Up- and downstream of groundwater (7/20 sampling points; c_{mean} = 0.7 ng/L)

➢ TP-214 **measureable** only in groundwater samples

➢ TP-130 **not detectable**

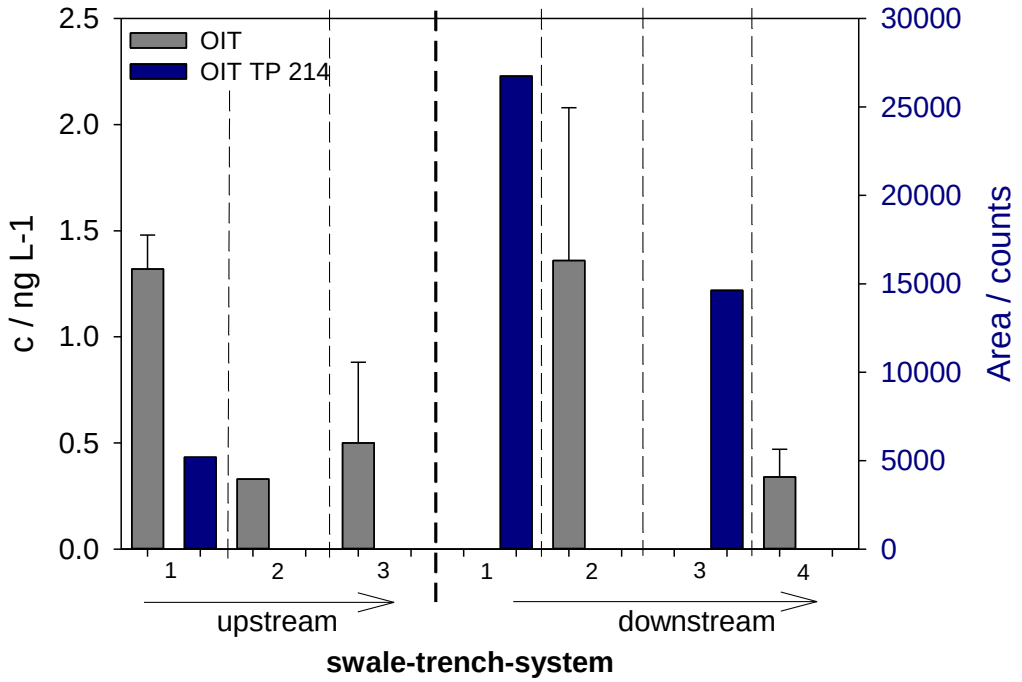


Environmental Samples

Results

Measurement of **groundwater samples** (Germany, Freiburg)

➢Up- and downstream of an infiltration system



Gained Knowledge & Further Issues

Conclusion

- **First detection** of OIT-TPs in groundwater
  - ➢ Rainwater infiltration as an possible **entry path** of OIT-TPs
- **Higher biological activity** and **unchanged toxicity** of TPs
- Potential **risk to human and environment** due to the entry to groundwater
- **Risk assessment** needs to be specified with regard to environmental relevant TPs

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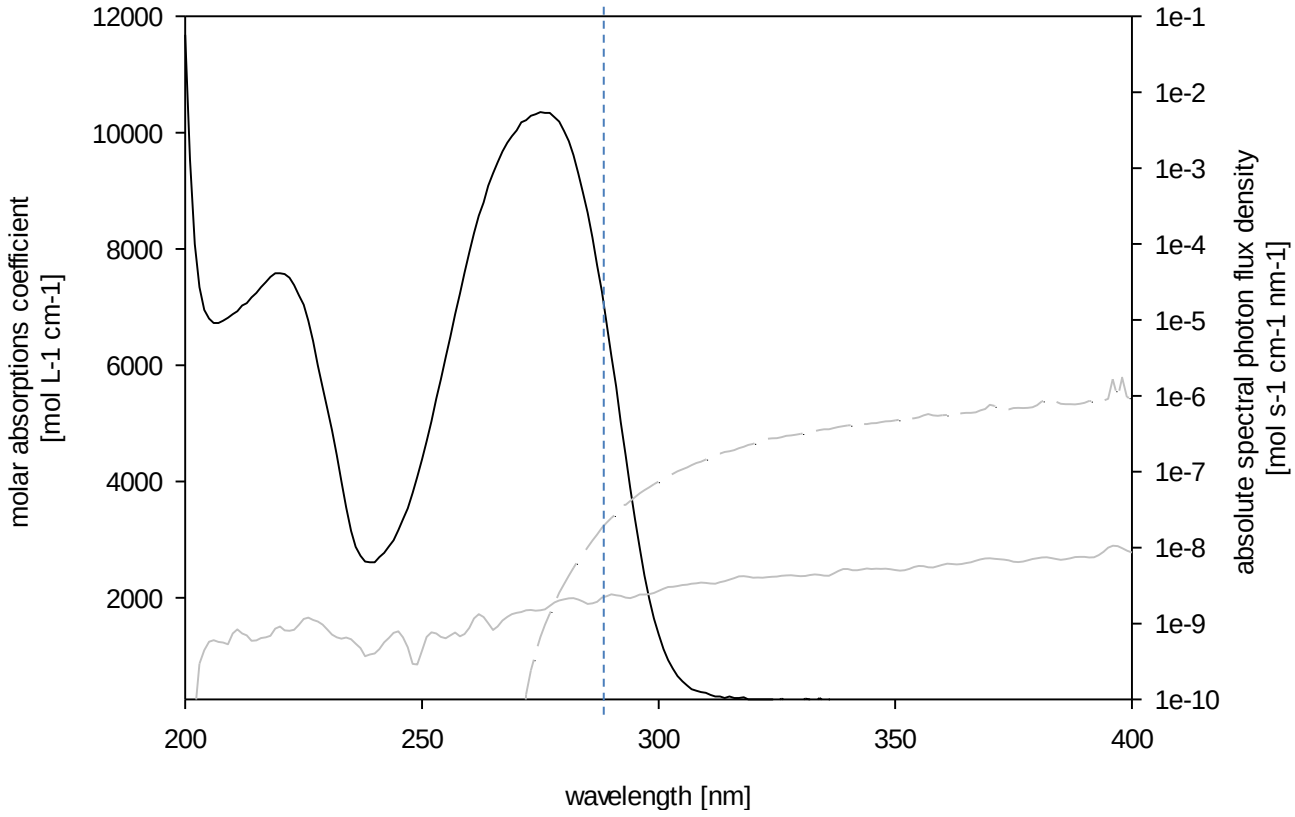
Annex I

Emission spectra of used lamps and absorption spectrum of OIT



Annex II

Quantum yields ϕ were calculated following equation (1) by means of the experimental received rate constant k (s^{-1}) and the molar absorption coefficient ε (L mol^{-1} cm^{-1}) of the substance as well as the absolute light intensity I_{abs} (mol s^{-1} L^{-1} nm^{-1}) of the xenon lamps.

$$\phi = (k) / (\sum(200nm - 400nm) \cdot (I_{(0,\lambda)} \cdot \varepsilon_{\lambda}) \cdot \ln(10)) \qquad (1)$$

The transfer of data acquired in laboratory to environmental rate constants was calculated as follows:

$$k_{env} = I_{solar} \cdot \ln(10) \cdot 1000 / 6.02 \cdot 10^{23} \cdot \phi \cdot \varepsilon \qquad (2)$$

Lifetimes are calculated by equation (3)

$$\tau = 1/k \qquad (3)$$