

(Bio)accumulation and biotransformation of organic contaminants in biofilm: how could these be affected by the presence of nanoparticles?

Lúcia H.M.L.M. Santos^{1,*}, Anna Freixa¹, Vicenç Acuña¹, Josep Sanchís², Sara Rodríguez-Mozaz¹, Marinella Farré², Sergi Sabater^{1,3}, Damià Barceló^{1,2}

¹Catalan Institute for Water Research (ICRA), Girona, Spain

²Department of Environmental Chemistry, IDAEA, CSIC, Barcelona, Spain

³Institute of Aquatic Ecology, University of Girona, Girona, Spain

**lhsantos@icra.cat*

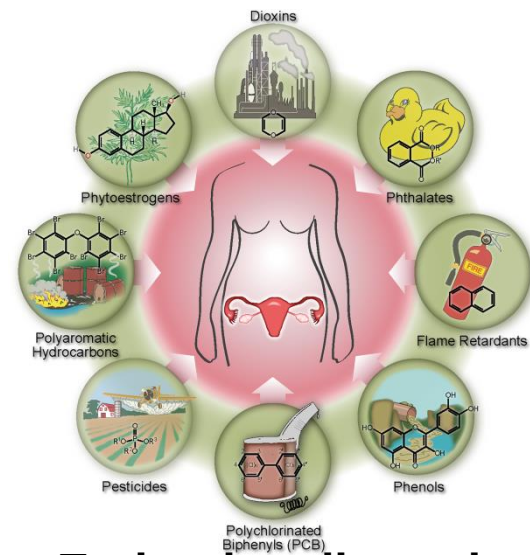
Organic micropollutants



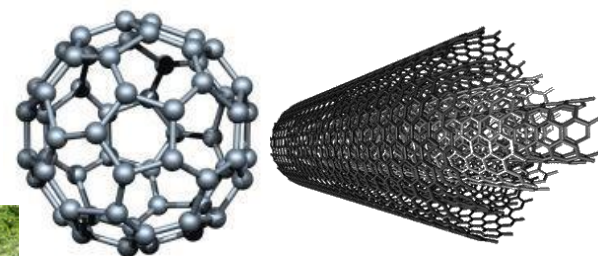
Pharmaceuticals



Personal care products



Endocrine disrupting compounds



Nanomaterials



Pesticides

Organic micropollutants

Commonly present in the environment (ng/L to few µg/L)



- Continuous exposure of aquatic organisms
- May negatively affect aquatic organisms

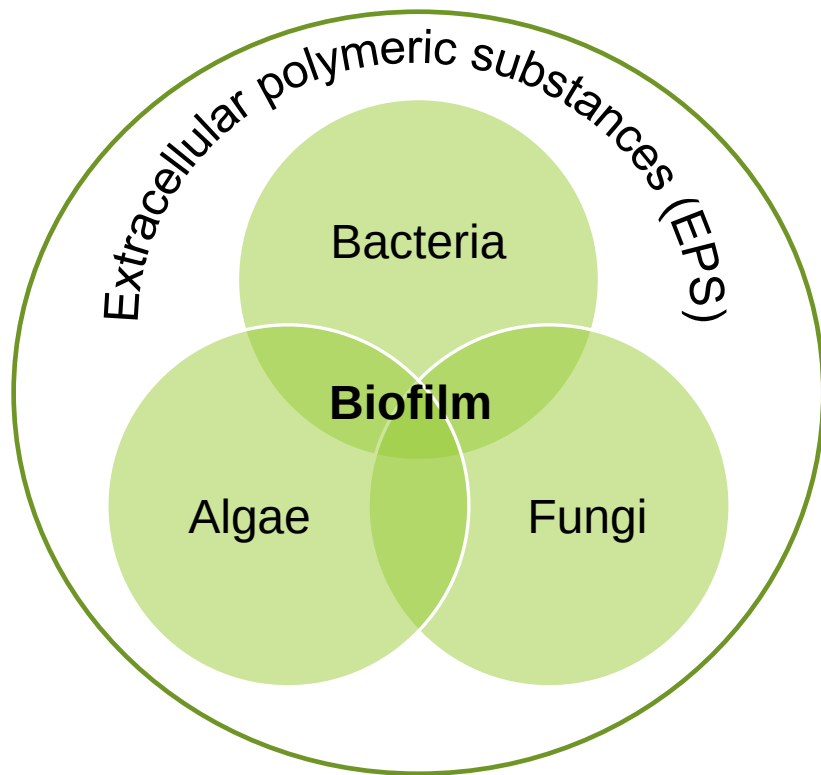
How interaction of different
organic contaminants
could affect...



- ✓ Toxicity
- ✓ Bioaccumulation
- ✓ Biotransformation



Biofilm as a indicator of water quality



Characteristics of biofilm:

- ✓ Protection from the surrounding environment (e.g. environmental changes)
- ✓ Facilitate nutrient availability
- ✓ Ability to communicate and exchange genetic material
- ✓ Capability to degrade and/or transform organic compounds



- Widespread
- Abundant biomass
- Retain organic contaminants

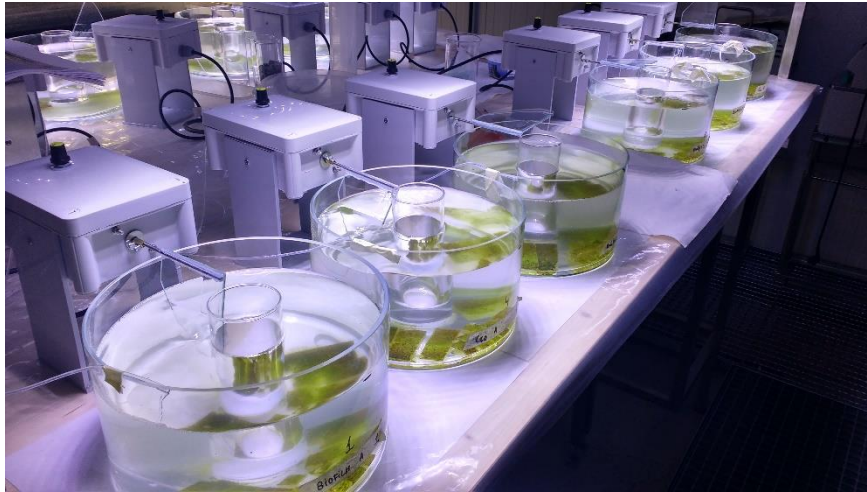
Source: Edwards and Kjellerup, *Appl. Microbiol. Biotechnol.* 97 (2013) 9909

Objectives

- Evaluation of the accumulation of three organic contaminants (**venlafaxine**, **diuron** and **triclosan**) in biofilm in mesocosm studies
- Assessment of the effect of fullerenes (C60) in the accumulation of the organic contaminants
- Study the biotransformation of the selected organic contaminants by the biofilm and how this process is affected by the presence of fullerenes (C60) following a target analysis

Experimental design

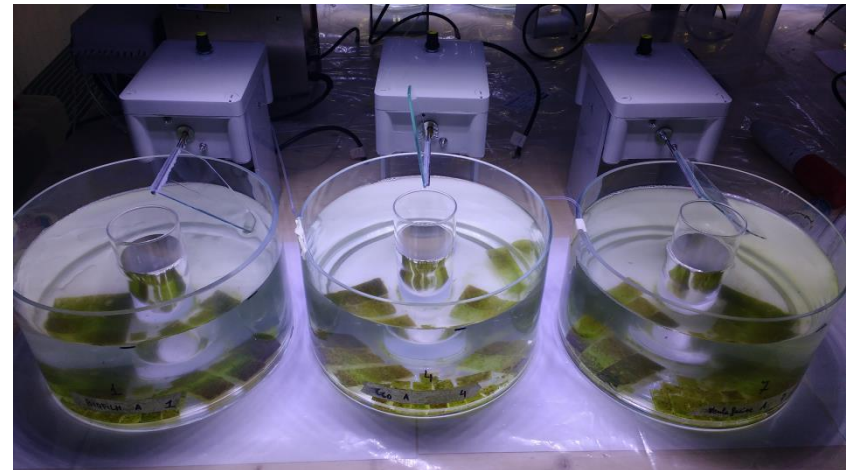
- 3 Individual batch experiments (**diuron**, **triclosan** and **venlafaxine**)



- Biofilm colonization period → 5 weeks
- Epilithic biofilm in glass tiles
- 12 mesocosms (3 replicates for treatment) fill with rainwater
- Exposure time: 72h

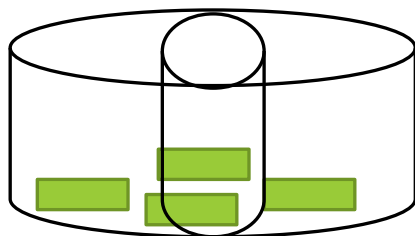
- Controlled temperature ($\pm 18^{\circ}\text{C}$)
- Constant day-night cycle (12h/12h)
- Constant agitation
- Sampling: **Water** → each 24h

Biofilm → 72h



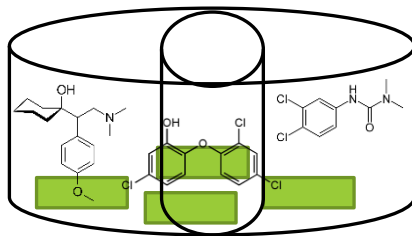
Experimental design

Control



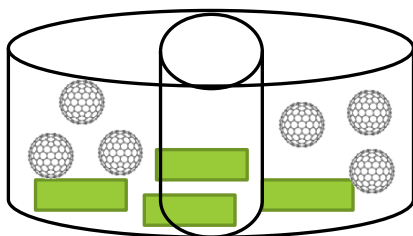
Biofilm

Contaminant



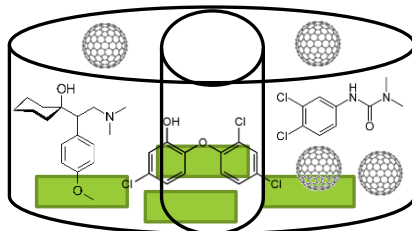
Biofilm +
Contaminant

Fullerenes (C60)

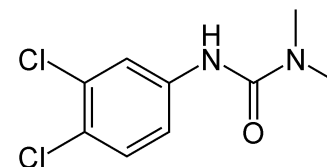


Biofilm +
1 $\mu\text{g/L}$ C60

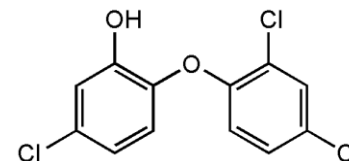
Contaminant + C60



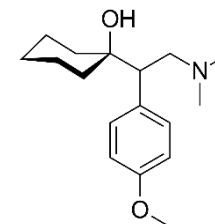
Biofilm +
Contaminant +
1 $\mu\text{g/L}$ C60



Diuron: 10 $\mu\text{g/L}$
EC₅₀ (24h) = 15 $\mu\text{g/L}$ (algae)



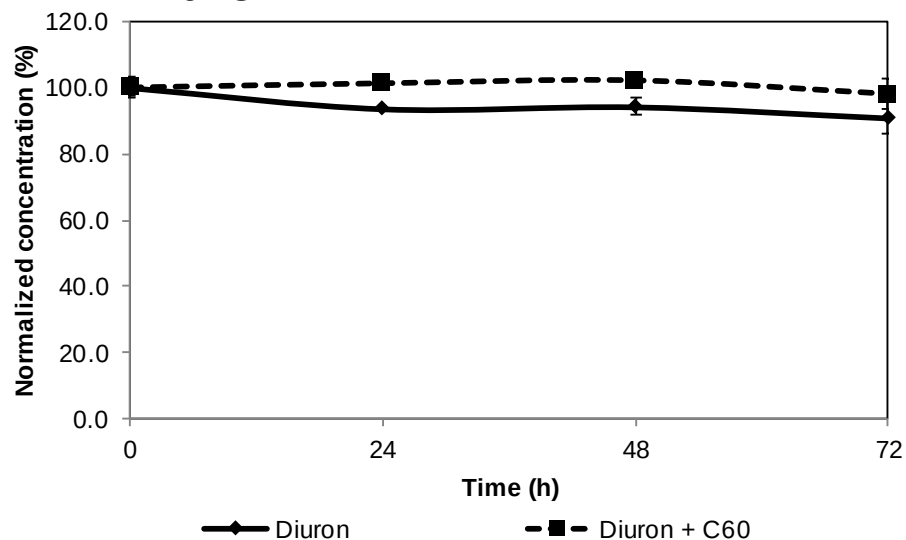
Triclosan: 10 $\mu\text{g/L}$
EC₅₀ (48h) = 43.9 $\mu\text{g/L}$ (bacteria)
EC₅₀ (48h) = 1.5-19 $\mu\text{g/L}$ (algae)



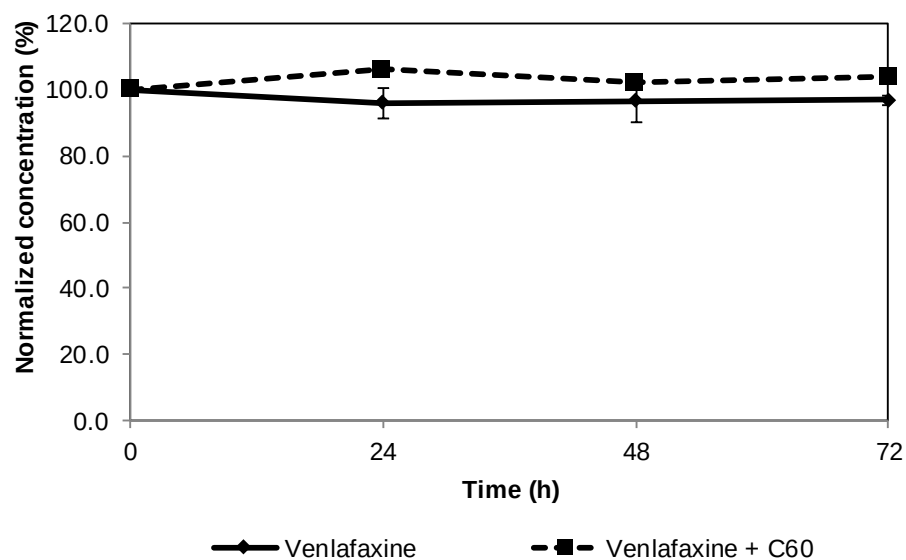
Venlafaxine: 50 $\mu\text{g/L}$
EC₅₀ (96h) = 12520 $\mu\text{g/L}$ (algae)

Results - Contaminants in mesocosms water (without biofilm)

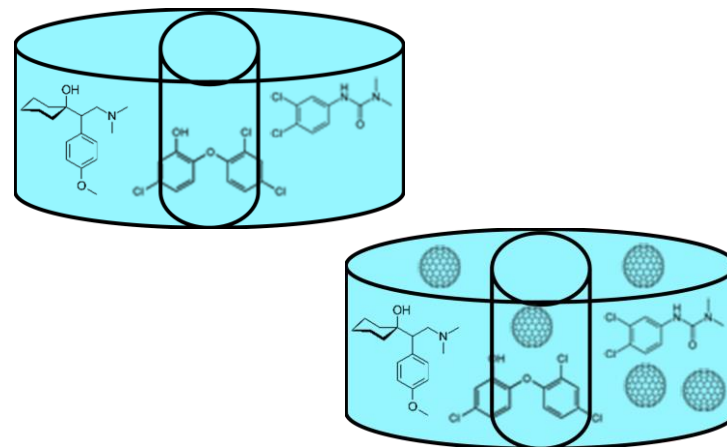
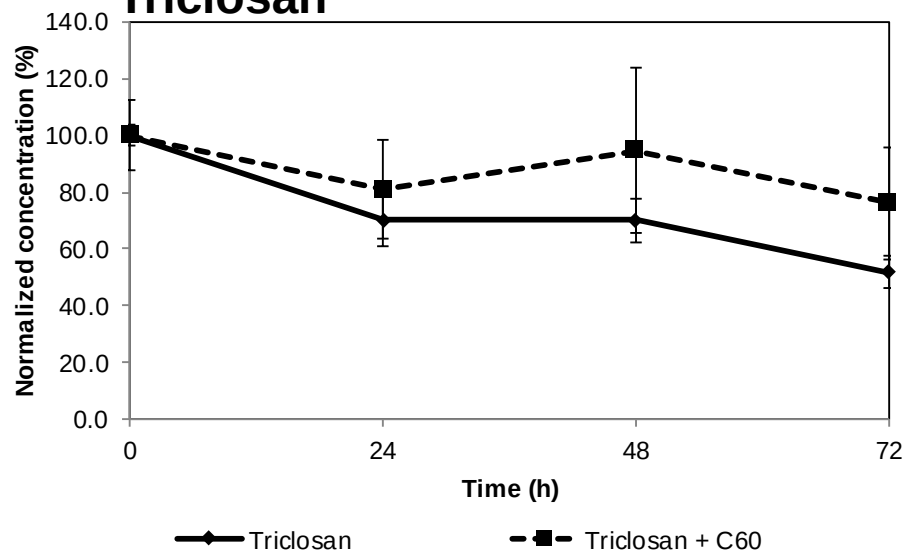
Diuron



Venlafaxine

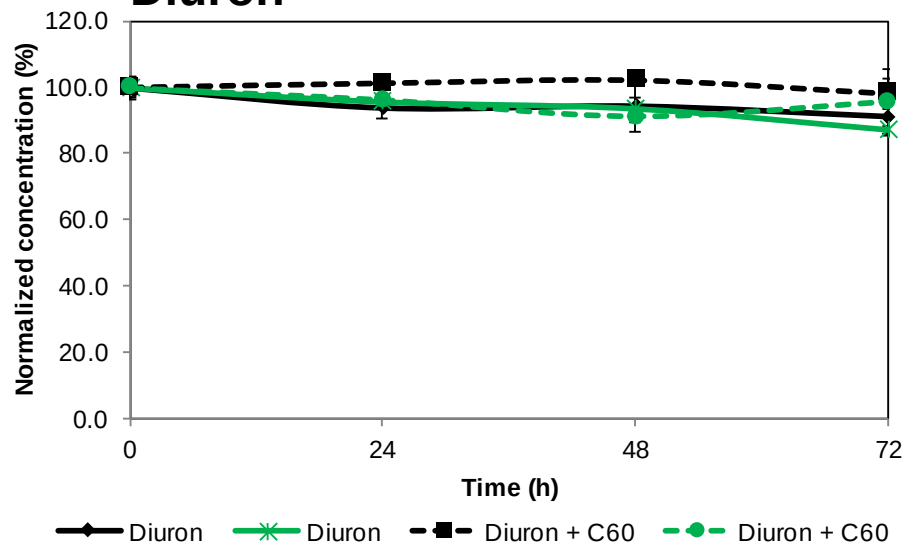


Triclosan

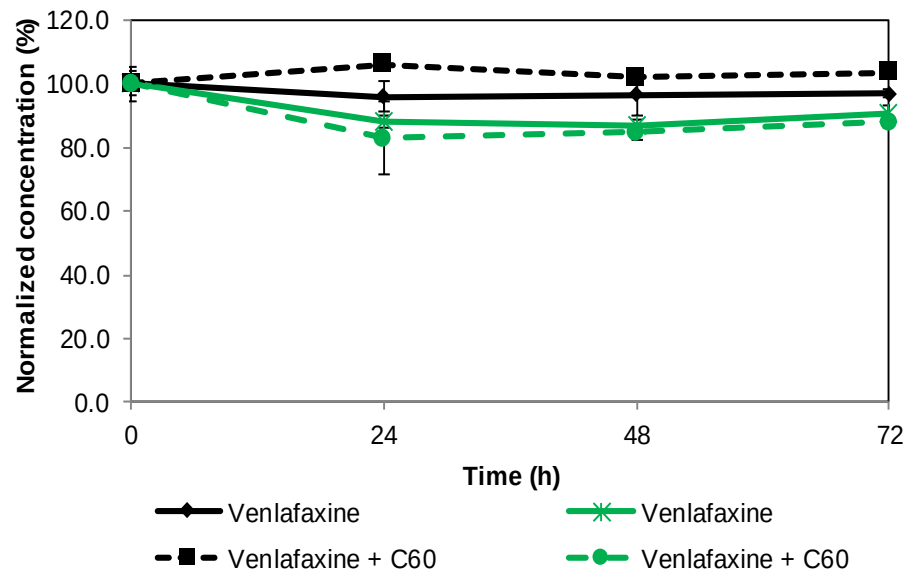


Results - Contaminants in mesocosms water (with biofilm)

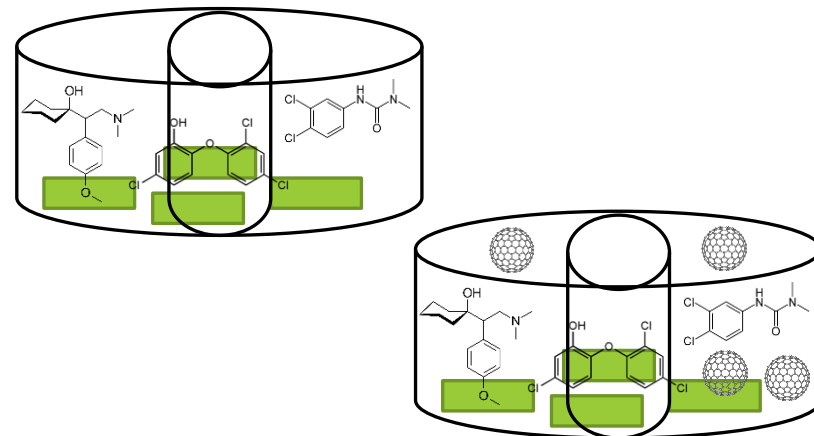
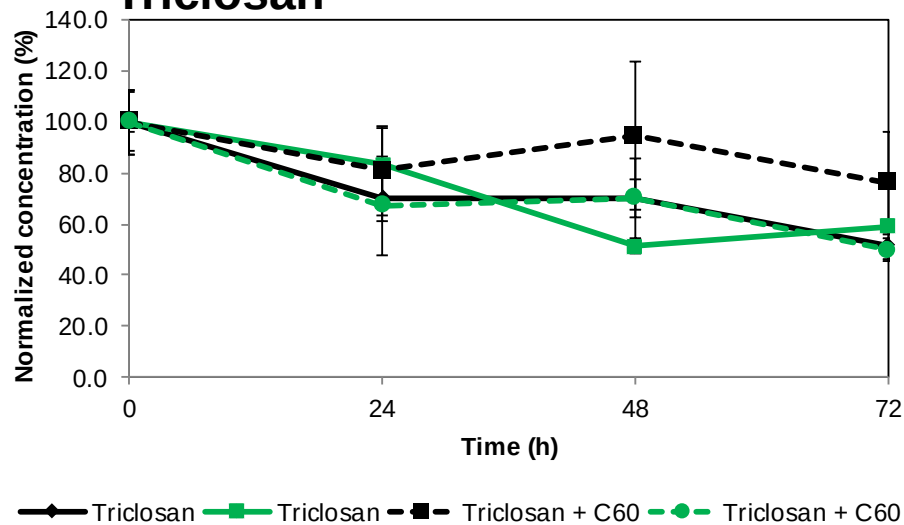
Diuron



Venlafaxine

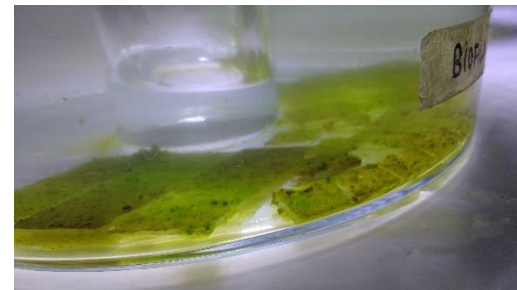
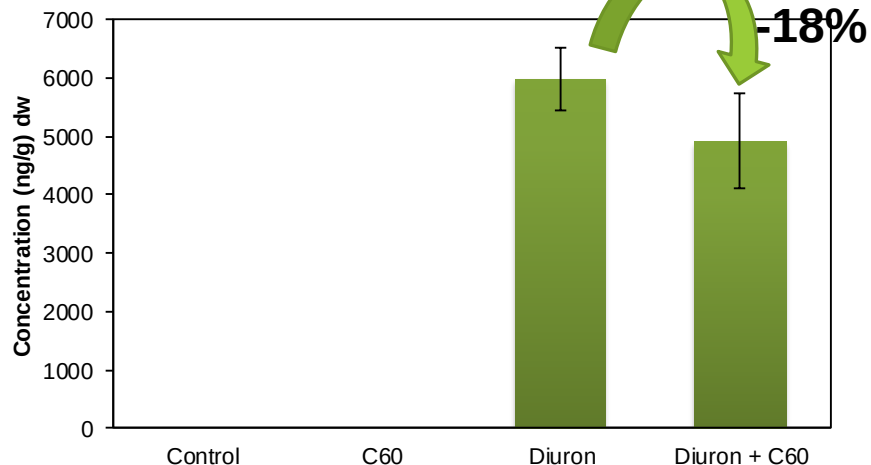


Triclosan

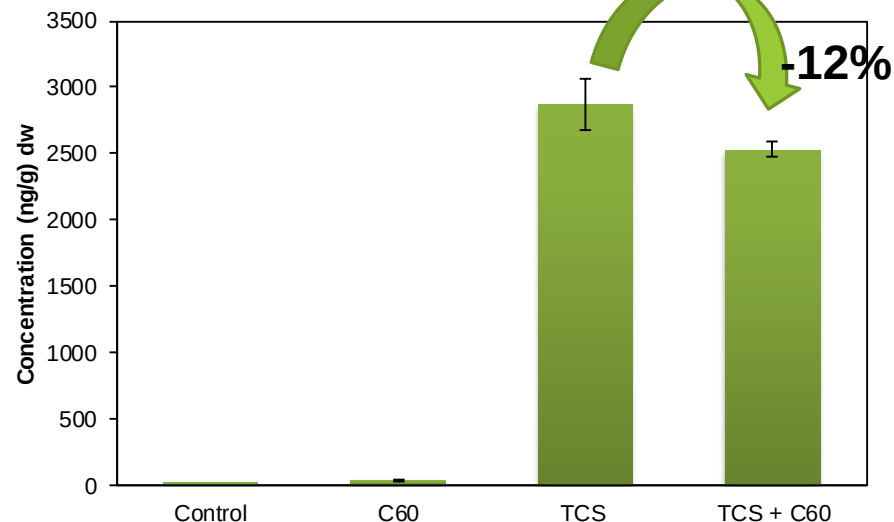


Results - Contaminants in biofilm

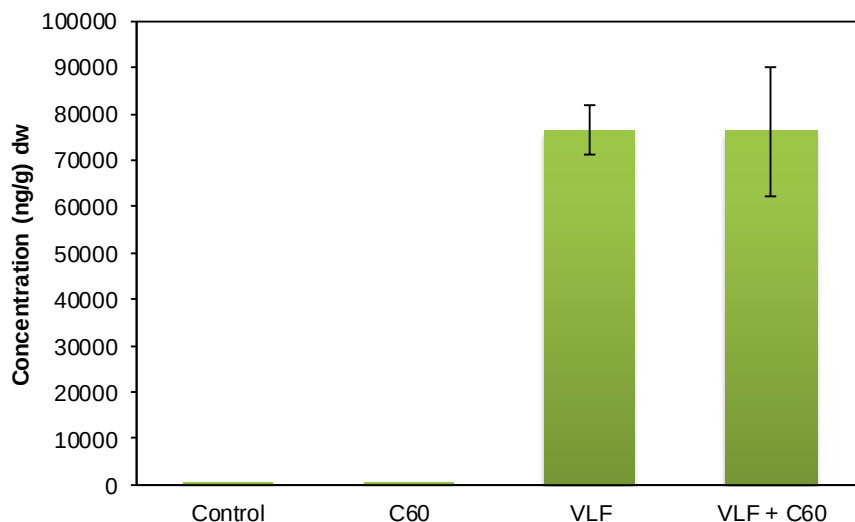
Diuron



Triclosan

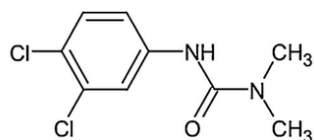
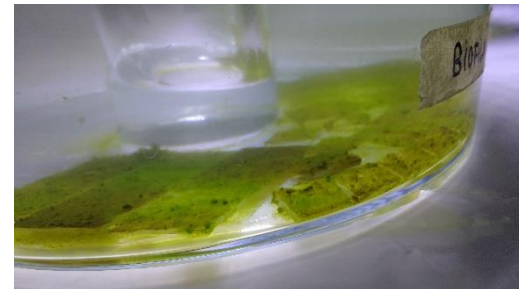


Venlafaxine

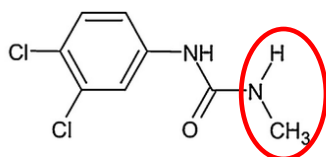


- The 3 contaminants accumulate in biofilm
- ↓ Accumulation of contaminants in the presence of C60 (12-18%)
- No effect of C60 in the accumulation of venlafaxine

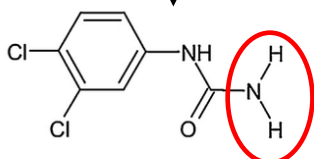
Results – Biotransformation



Diuron

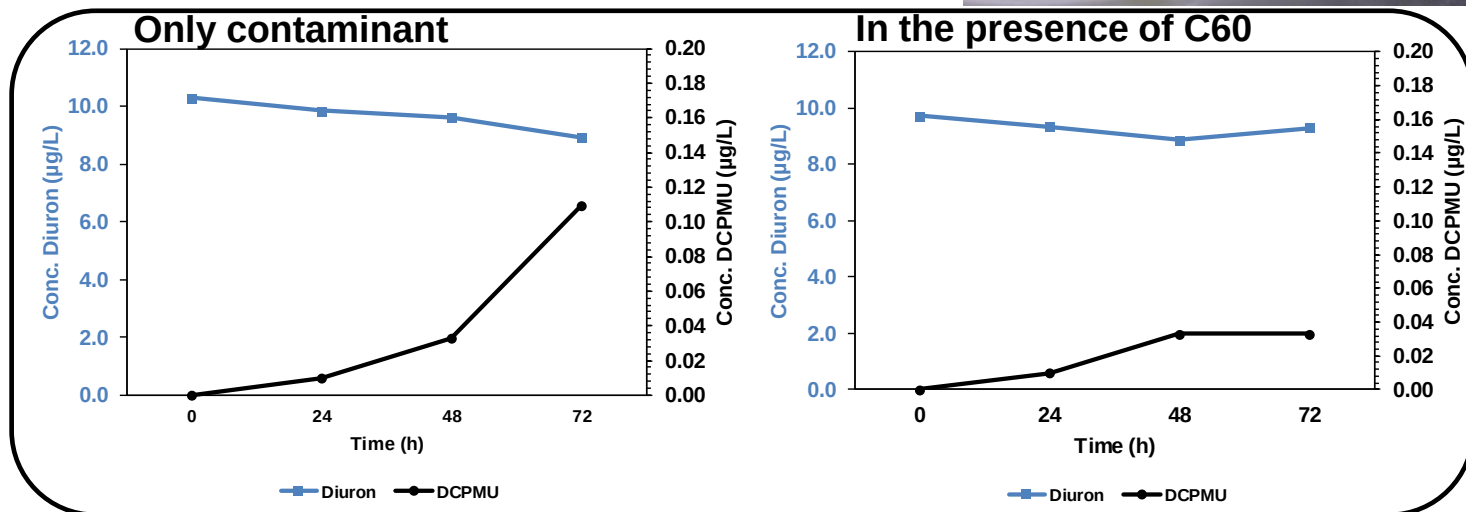


1-(3,4-dichlorophenyl)-
3-methylurea (DCPMU) ✓

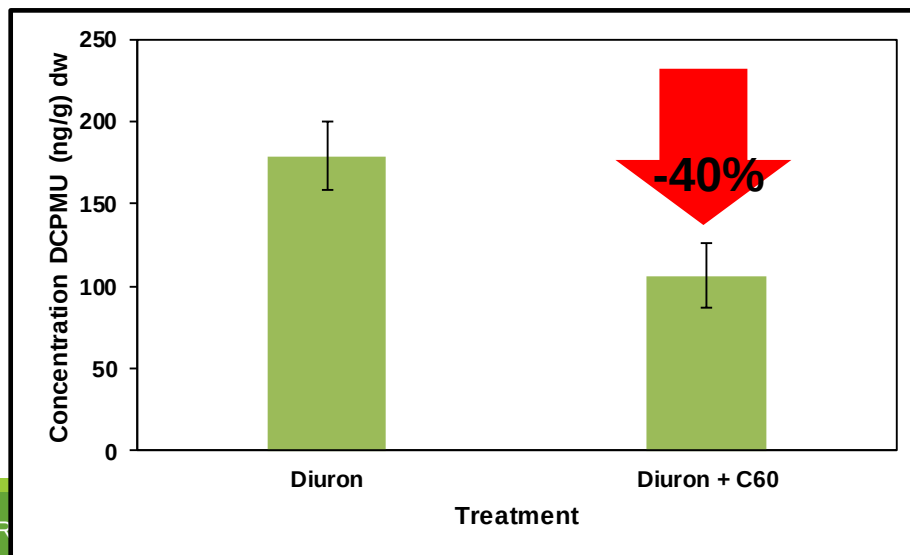


1-(3,4-dichlorophenyl)-3-
urea (DCPU) ✗

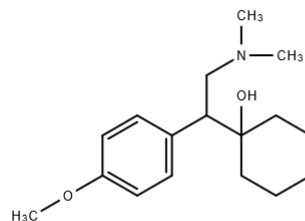
Water



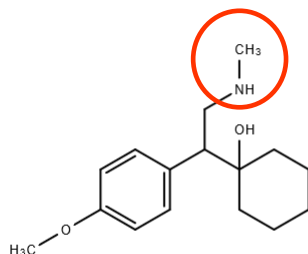
Biofilm



Results – Biotransformation

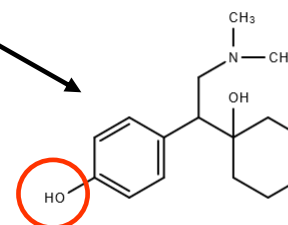


Venlafaxine (VLF)



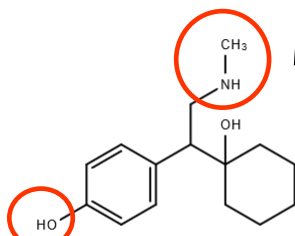
N-Desmethyl VLF

✗ Not detected in water
✓ Detected in biofilm

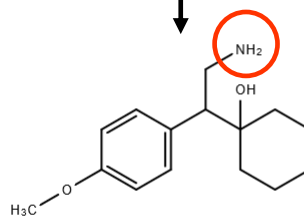


O-Desmethyl VLF

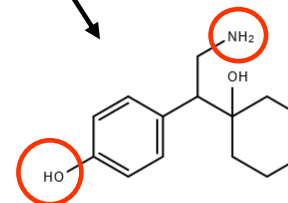
✓ Detected in water
✓ Detected in biofilm



N,O-Didesmethyl VLF



N,N-Didesmethyl VLF



N,N-didesmethyl-O-desmethylVLF

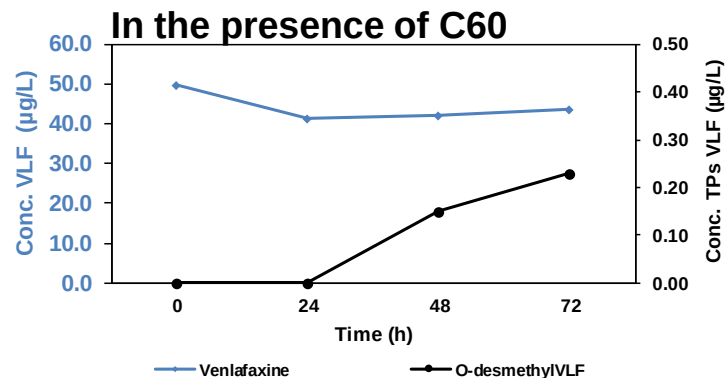
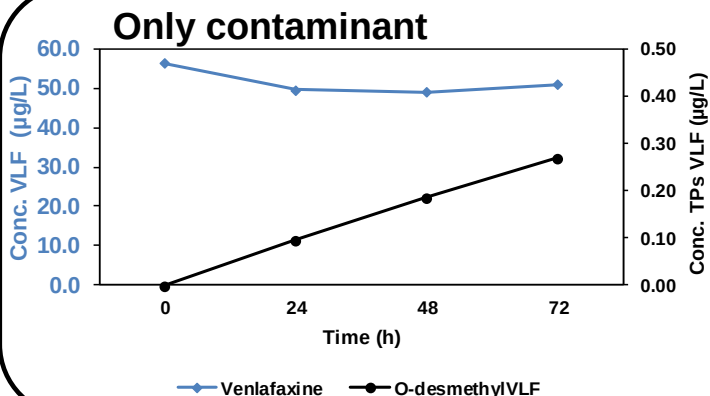


Results – Biotransformation

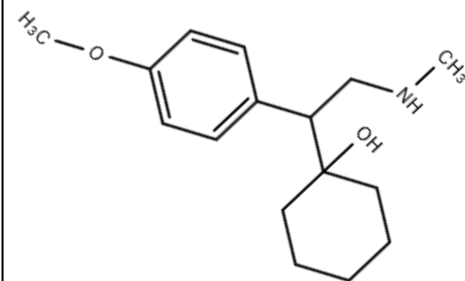
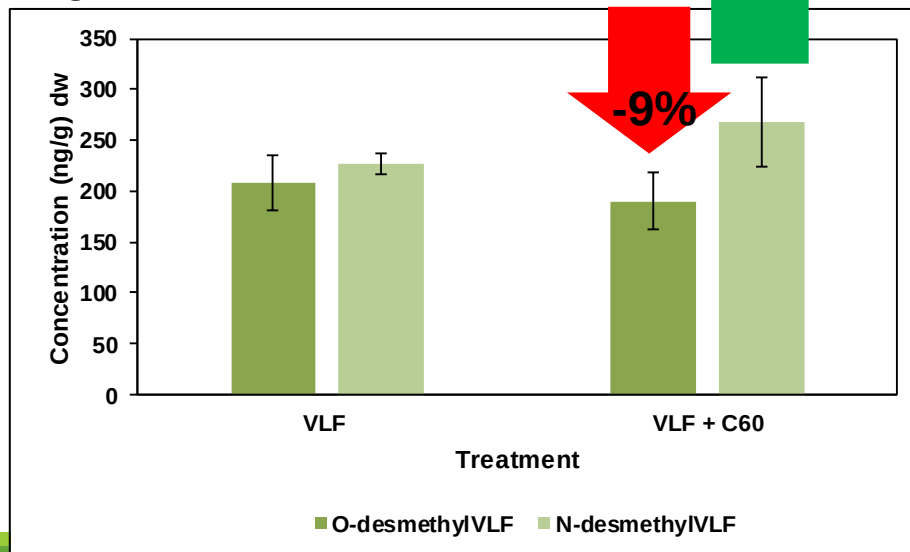
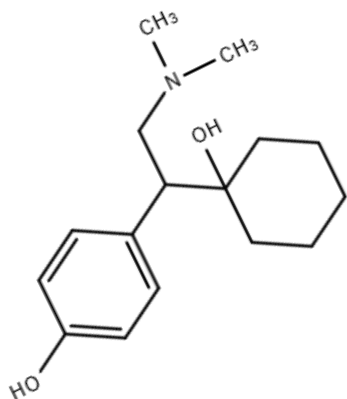
- Venlafaxine



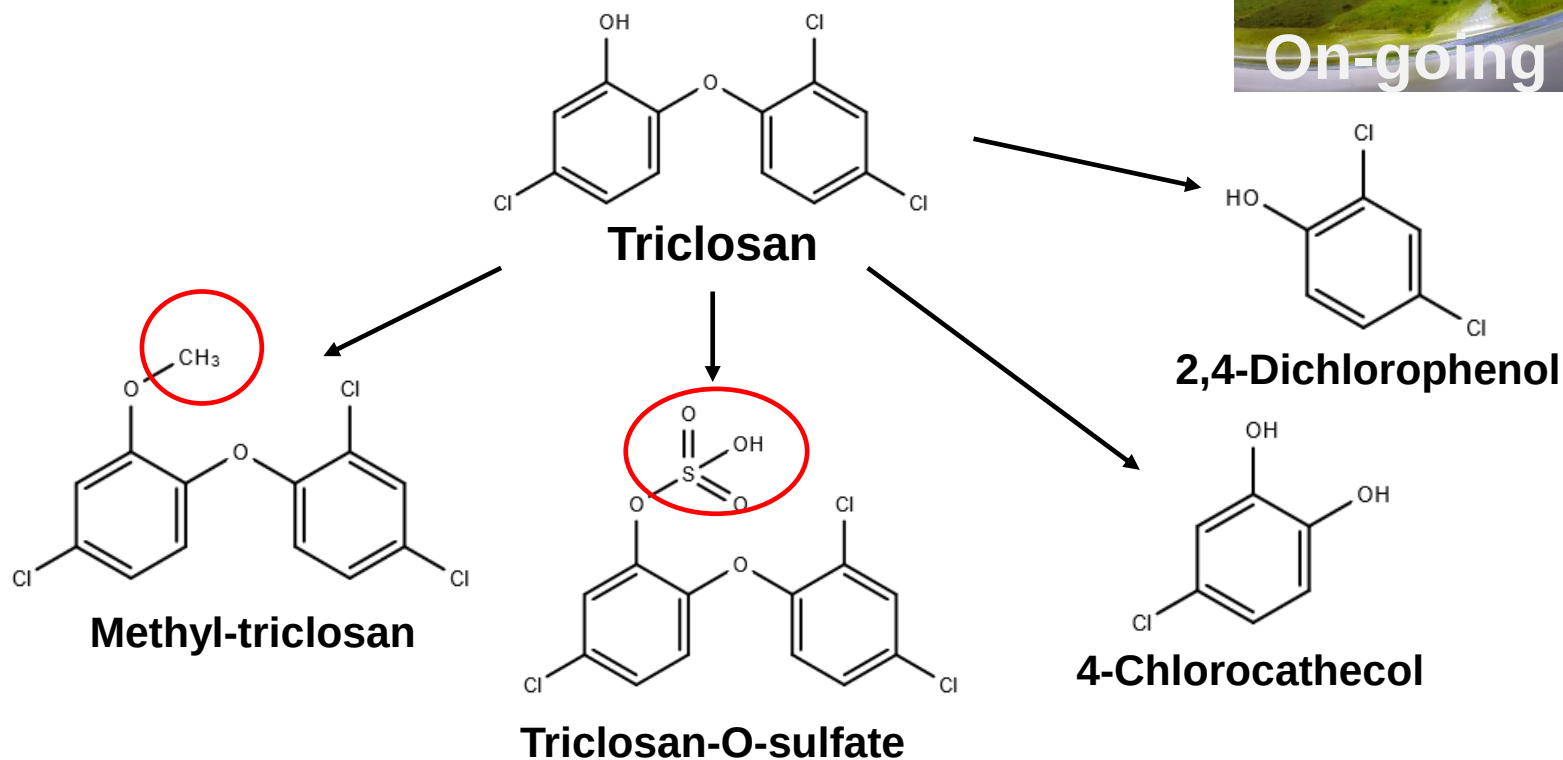
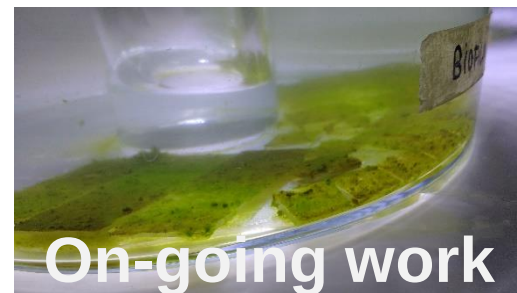
Water



Biofilm



Results – Biotransformation



- Optimization of a **GC-MS/MS** methodology for the analysis of triclosan TPs



Final considerations

Accumulation

- Accumulation in biofilm: Venlafaxine > Diuron > Triclosan
- The presence of fullerenes (C60) did not affect the accumulation of venlafaxine, but there was a slightly decrease for diuron and triclosan

Biotransformation

- The presence of fullerenes have an impact in the transformation products of the selected compounds
- Possible reasons:
 - Different impact of fullerenes (C60) in the biotransformation pathways
 - And/or adsorption of transformation products to fullerenes (C60)

The presence of fullerenes may affect the accumulation and biotransformation of organic contaminants.

NANO- Transfer



International Conference
& Winter School
19.- 20.10.2017
Aachen



For more information please visit:
www.nano-transfer.eu

Thank you for your attention!

INSTITUT
FÜR
Umwelt-
HUMANWISSENSCHAFTEN



RWTHAACHEN
UNIVERSITY



**TECHNISCHE
UNIVERSITÄT
DRESDEN**

