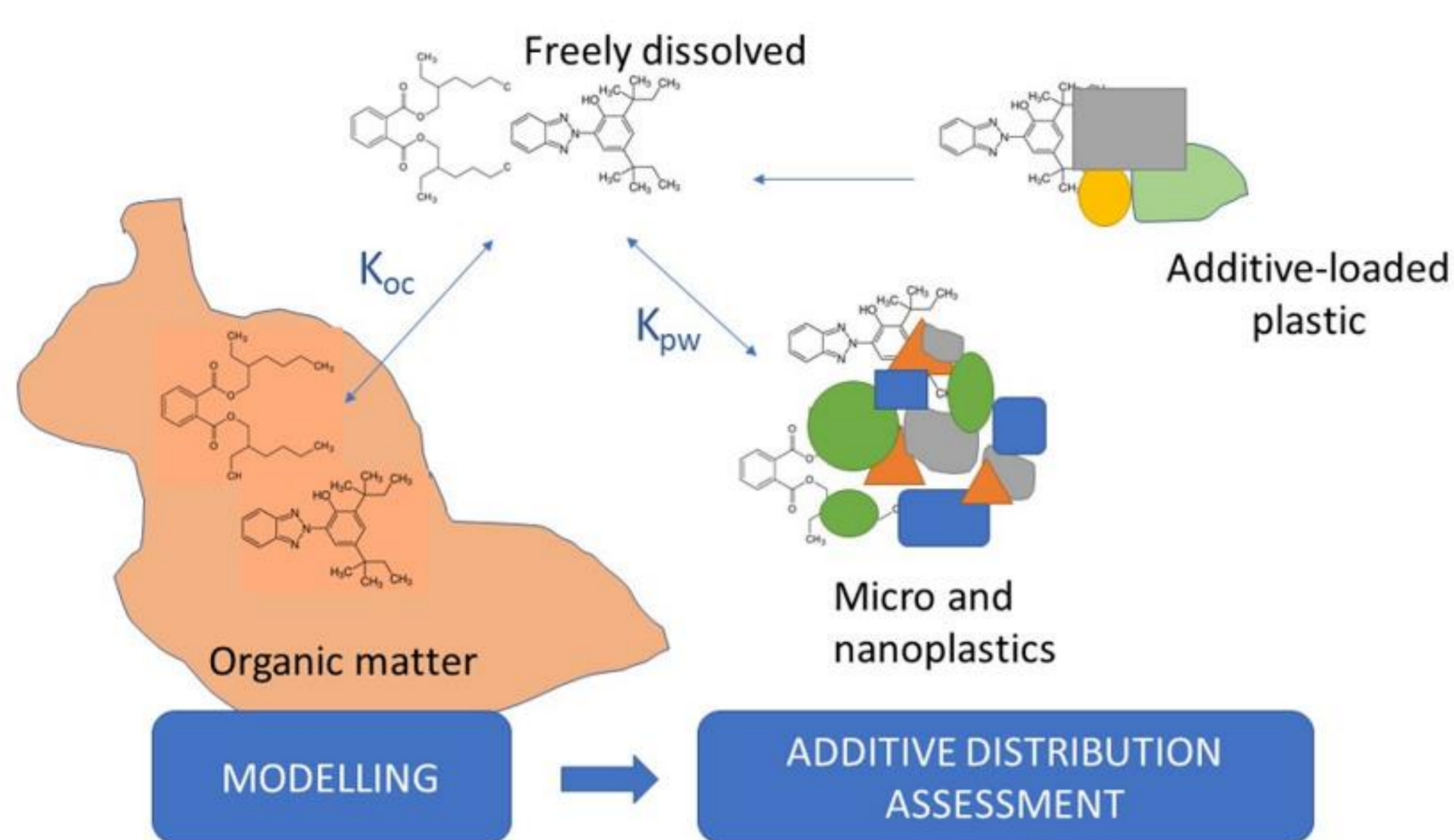


Plastic content and additive distribution in a wastewater treatment plant effluent in Norway

¹Norwegian Institute for Water Research (NIVA), Oslo, Norway

Introduction

- Wastewater treatment plant (WWTP) effluent as a relevant source of microplastic to water
- Additives loaded to plastic during production (plasticisers, flame retardants, UV filters, dyes...) with concentrations in the % range
- Distribution of plastic additives in WWTP effluents is unknown
- Modelling (Allan et al., 2022) and measurements to understand the distribution of additives in WWTP effluents



AIMS OF THIS STUDY

- Sample a large enough sample of suspended particulate matter (SPM) from the WWTP effluent at VEAS in Oslo
- Measure the plastic content of the effluent SPM by pyro-GC/MS
- Determine the distribution or speciation of selected additives in WWTP effluent

Methodology

- Sample effluent SPM to perform different extractions in the laboratory
 - Use of continuous-flow centrifugation (CFC)
 - Sampling done in December 2020; 3 consecutive weeks; collection of ~8 g dw of SPM each week



- PyroGC/MS analysis of the SPM
- Extraction of selected additives from the SPM sample:
 - Exhaustive extraction using Soxhlet extractor
 - Accessible concentration using silicone rubber (SR) extractions (C_{Access})
 - Passive sampling with SR in the effluent to determine freely dissolved concentrations (C_{free})

REFERENCES

Allan, I. J., Samanipour, S., Manoli, K., Gigault, J., & Fatta-Kassinos, D. (2022). Examining the Relevance of the Microplastic-Associated Additive Fraction in Environmental Compartments. *ACS ES&T Water*, 2(3), 405-413.

ACKNOWLEDGEMENTS

We would like to thank the Water Joint Programme Initiative (Water JPI) and IC4WATER for funding the "NANO-CARRIERS" project entitled Micro and Nanoplastics as CARRIERS for the spread of chemicals and antibiotic resistance in the aquatic environment (Norwegian research council grant no 297334).

Norwegian Institute for Water Research, Økernveien 94, 0579 OSLO, Norway. www.niva.no. Contact: ial@niva.no

Results

PLASTIC CONTENT OF SUSPENDED MATTER FROM THE EFFLUENT

- Presence of PVC, PE, PP mainly; 3-4 mg g⁻¹ SPM

	PVC	PE	PP	PS
December 2020*				
KOH treatment	1.74 (10)	1.7 (120)	0.13 (22)	0.031 (20)
H2O2 treatment	0.51 (92)	3.85 (120)	0.05 (170)	0.027 (83)

*Composite sample from 3 weeks CFC sampling
Note: in bracket %RSD of three measurements

SPECIATION OF TWO UV FILTERS (UV-328 and UV-329)

Effluent sampling with SR		Effluent suspended matter			
	UV329	UV328			
C_{free} (ng L ⁻¹)	0.10 (7)	0.013 (52)	C_{SPM} (ng g ⁻¹)	61 (5)	96 (3)
AlteSil™ SR 15 g; deployment 20 d; Sampling rate, R_s approximately 8 L d ⁻¹ In brackets, %RPD		C_{OC} (ng g ⁻¹)		164 (5)	259 (3)
		OC content = 37.1 (12) % dw $C_{\text{spm}} = 3\text{-}20 \text{ mg L}^{-1}$			
Partition or distribution coefficients					
	UV329	UV328			
$\log K_{\text{OC}}$ (L kg ⁻¹)	6.20	7.30			
$\log K_{\text{OW}}$ (L kg ⁻¹)*	7.3	7.4			
$\log K_{\text{SR-W}}$ (L kg ⁻¹)**	6.3	6.9			
*Pubchem; **Unpublished					

- With 3-4 mg plastic g⁻¹ SPM and assuming K_{OW} is an acceptable proxy for partitioning to plastic, at equilibrium, 9 ng of UV329 and 0.8 ng of UV328 would sorb to the plastic in 1 g of SPM

ACCESSIBLE CONCENTRATION

- Accessible fractions (24h and 8 g SR) of 67 and 8.4 % for UV329 and 328.

SR extraction to quantify C_{Access}	Fraction accessible (%)	
	UV329	UV328
C_{Access} (ng g ⁻¹)*	13 (6)	1.8 (16)
C_{Access} (ng g ⁻¹)**	41 (4)	8.1 (14)
*5h and 4 g SR; 24h and 8 g SR		

Comparison with another non-additive chemical: Hexachlorobenzene		% Accessible
Total concentration (ng g ⁻¹)	0.53	
C_{free} (ng L ⁻¹)	0.014	
$\log K_{\text{OC}}$ (L kg ⁻¹)	5.02	
C_{Access} (ng g ⁻¹); 5h, 4 g	0.32	61 %
C_{Access} (ng g ⁻¹); 24h, 8 g	0.37	70 %

Conclusions

- Realistic apparent $\log K_{\text{OC}}$ values
- Low UV filter amounts to be expected to sorb to the plastic content
- C_{Access} for UV329 ~ C_{Access} for hexachlorobenzene, not used as plastic additive
- Lower accessibility of UV328:
 - Presence as plastic additive?
 - Artefact of the extraction protocol?