Microplastic pollution in three rivers with varying anthropogenic impact in South Eastern Norway

Claudia Lorenz[1], Jane K. Dolven[2,3], Nina Værøy[2], Alessio Gomiero[4], Diana Stephansen[1], Stein B. Olsen[2], Jes Vollertsen[1]

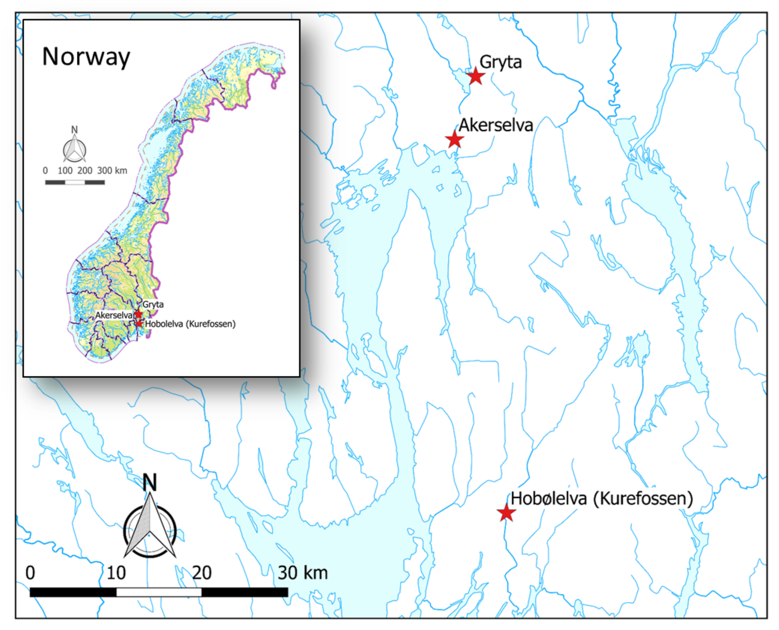
[1] Department of the Built Environment, Aalborg University, Denmark; [2] COWI AS, Oslo, Norway;
[3] University of South-eastern Norway, Porsgrunn, Norway; [4] NORCE – Norwegian Research Centre – Environment, Randaberg, Norway

MICRO2020 INTERNATIONAL CONFERENCE

Introduction

The ubiquitous pollution of various environments with microplastics (MP) is a global issue of growing concern. Freshwater environments, especially rivers, have gathered increasing attention as recent findings point out their role as relevant pathways of MP distribution. To see whether rivers with different characteristics carry different MP loads and polymer compositions, we investigated three rivers (city influenced, agricultural influenced and pristine) in South Eastern Norway regarding their MP concentration, loads, polymer composition and size class distribution.

Sampling



Sampling in three rivers of varying anthropogenic impact from low (green) to high (red) anthropogenic impact. Left to right: Gryta (pristine), Hobøl (agricultural influenced) and Akerselva (city influenced).

- Sampling of 1 m³ per river was conducted in May 2019
- A custom-built and well-established filtration device (UFO system)[1] enabled sampling of MP in the range of 10–5000 µm
- Field blanks for airborne contamination were collected at each site

Sampling for MP (10–5000 µm)

Custom-built filtration device (AAU UFO-system) with one 300 µm filter followed by two 10 µm filters installed

Sample preparation

Samples were processed through a multi-step enzymatic-oxidative sample treatment [2,3]:

1. SDS treatment (5% w.v.)
2. Two step enzymatic treatment (Protease; Cellulase & Viscozyme)
3. Fenton reaction (Fe (II) –catalysed)
4. Separation into two size fractions: 10–300 µm and >300 µm
5. Flotation with SPT (ρ = 1.7–1.8 g cm⁻³)
6. Sample evaporation in glass vial - 50% EtOH add. (5 mL)

ATR-FTIR & µFTIR-Imaging analysis & Pyr-GC/MS

Particles >300 µm:

Visual sorting of putative MP under stereo microscope

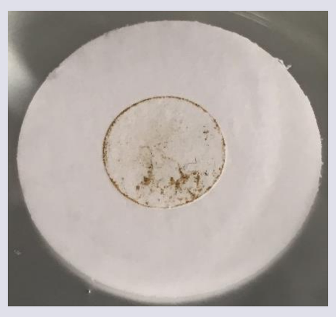
Analysis via Attenuated total reflectance Fourier-transform infrared spectroscopy (ATR-FTIR)

Particles 10–300 µm:

Deposition of a sub-sample on ZnSe window

Analysis via FPA-µFTIR-imaging and auto-detection via siMPle [4,5]

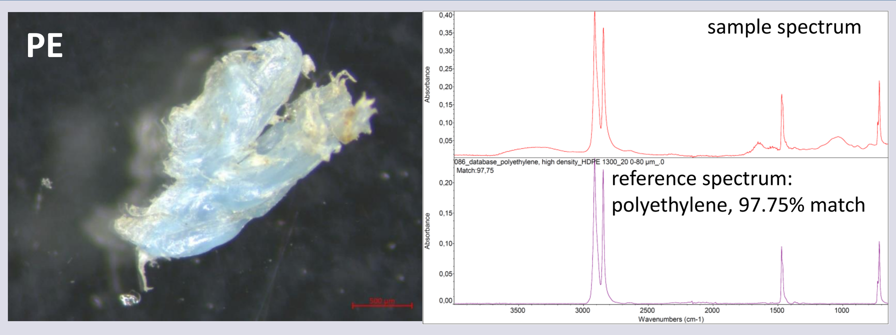
Filtration of sub-sample on GF/C filter



Analysis via pyrolysis gaschromatography/ massspectrometry (Pyr-GC/MS) [6]

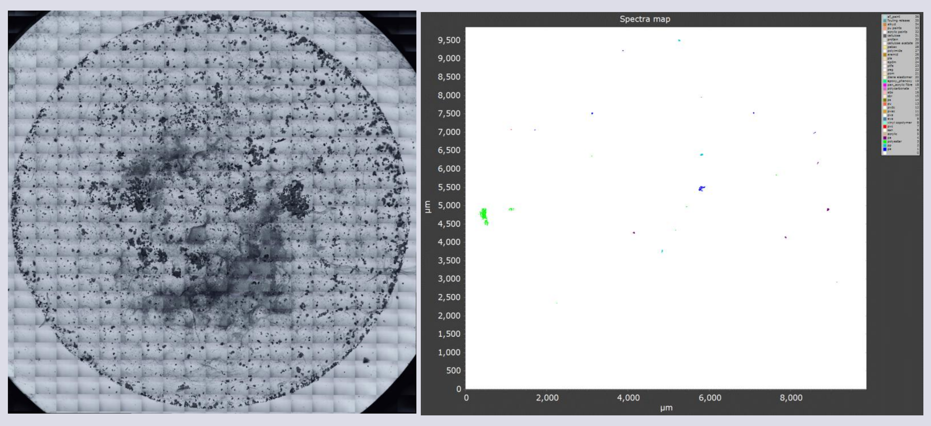
Results & Discussion

Particles >300 µm:

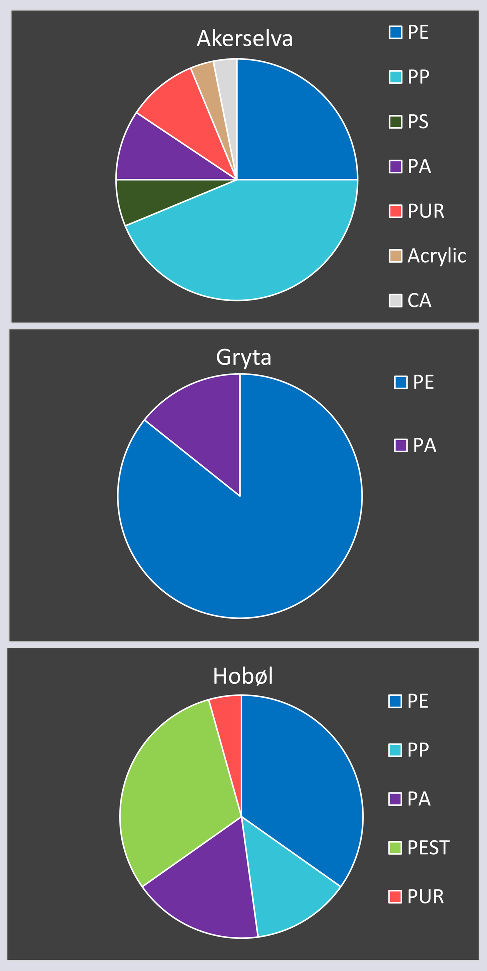


Particles >300 µm: at Akerselva and Hobøl each one polyethylene (PE) and one polyester (PEST) particle were detected

Particles 10–300 µm:

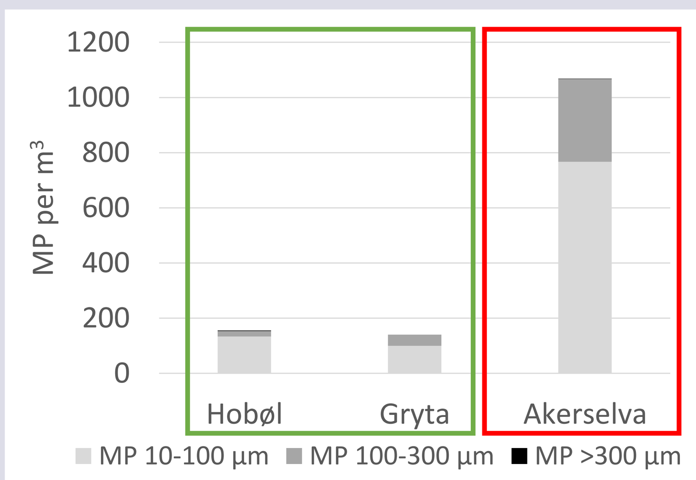


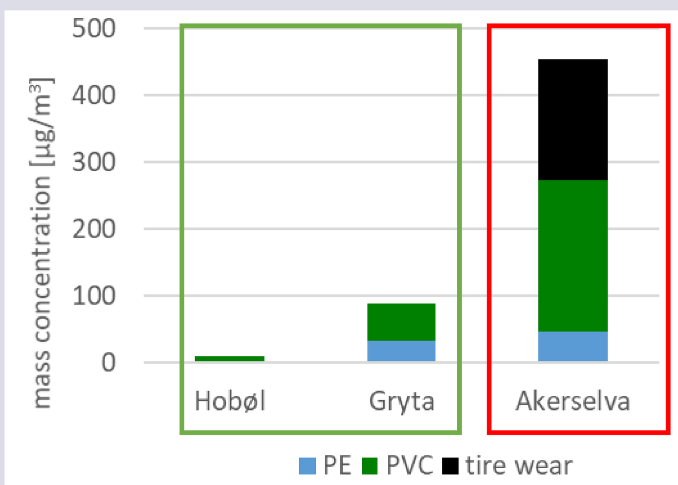
Example of the scanned window area and the results from the auto-detection via siMPle for the sample from Hobøl



Overall polymer distribution in the investigated rivers

The polymer type composition was different at the different sampling sites with the city influenced river Akerselva being the most divers (6), followed by the agricultural influenced river Hobøl (5) and the pristine river Gryta (2). At Akerselva polypropylene (PP) was the most abundant polymer type, followed by polyethylene (PE), polyamide (PA), polystyrene (PS), polyurethane (PUR) and some other less common polymer types (e.g. acrylics). In Hobøl PE and polyester/polyethylene terephthalate (PEST) were most common followed by PA, PP and PUR. In Gryta only two polymers were detected, namely PE and PA.





MP concentrations and loads in the small size fraction (10–300 µm) were highest in the city influenced river Akerselva (1067 MP/m³ and 2740 µg/m³) followed by the two rivers in the rural area, Hobøl (153 MP/m³ and 50 µg/m³), and Gryta (140 MP/m³ and 450 µg/m³). Furthermore, The thermoanalytical analysis with Pyr-GC/MS revealed the presence of tire wear particles in the city influenced river.

Conclusion

Our study showed that the number of microplastic particles were 7 times larger in the city influenced river (Akerselva) compared with the two rivers from the rural areas (Hobøl and Gryta). The city influenced river also had the most diverse polymer type composition and was the only river to contain tire wear particles.
More than 70% of the MP were between 10 to 100 µm in size, followed by 13–28% in the 100–300 µm fraction and hardly any MP were larger than 300 µm. MP concentrations of the large size fraction (300–5000 µm) were 150–530 times lower than in the small size fraction. This highlights the importance of analysing the small size fraction (MP 10–300 µm) when considering the impact of land-based discharge of MP to the oceans.

References

[1] Rist et al., 2020, https://doi.org/10.1016/j.envpol.2020.115248
[2] Löder et al. 2017, http://dx.doi.org/10.1021/acs.est.7b03055
[3] Liu et al. 2019, https://doi.org/10.1016/j.scitotenv.2019.03.416
[4] Primpke et al. 2020, https://doi.org/10.1177/0003702820917760
[5] https://simple-plastics.eu/index.html
[6] Gomiero et al. 2019, https://doi.org/10.1016/j.chemosphere.2019.04.096

CONTACT US

Claudia Lorenz — clo@build.aau.dk
Jes Vollertsen — jesvollertsen@build.aau.dk
Jane K. Dolven — jkdn@cowi.com

Aalborg University – Department of the Built Environment, Thomas Manns Vej 23, 9220 Aalborg Øst, Denmark

COWI AS, Karvesvingen 2, 0579 Oslo, Norway

We thank the Norwegian Environment Agency for financing this study!

Find the full report here: