MICRO2022

Abstract number 427126

Publication available: 10.1016/j.envpol.2022.120298

THE HISTORY OF MICROPLASTICS' OCCURRENCE IN THE SEDIMENTS AFFECTED BY TREATED EFFLUENTS

AUTHORS

Mirka Viitala, Zacharias Steinmetz, Mika Sillanpää, Mika Mänttäri, Markus Sillanpää

BACKGROUND

When the environmental impacts of microplastics (MPs) are assessed, it is crucial to have monitoring data from different parts of the environment. In case of aquatic environments, MPs have been analyzed more often from water than sediment, which provide only limited information for the possible exposure of sediment dwelling organisms to MPs.

One well-known route for MPs into the aquatic environments are wastewater treatment plants (WWTPs). Wastewater treatment processes can remove even 98–99% of the incoming MPs load to the sludge fraction [1–2], but some MPs are still continuously discharged to the recipient lakes, rivers, and seas. Even though the MPs concentrations have been studied at many of the WWTPs in Finland, the abundance of MPs in the bottom sediments of recipient lakes or seas are rarely studied.

Moreover, the full potential of sediment samples in assessing the history of MPs pollution is seldom utilized. So far, only 20 studies have related MPs concentrations with the sedimentation year, only three out of which have focused on lakes [3].

In this study, the history of MPs pollution was assessed for sediment samples representing each decade from 1990 to 2018 in a Finnish lake that receives treated effluents from a local WWTP. The main objectives were to study the effect of WWTP effluents on the MPs abundance in the bottom sediment and to assess the history of MPs pollution.

METHODS

Sampling	• Samples were collected with a Limnos sediment corer in autumn 2018 in the recipient lake area of Kenkäveronniemi WWTP in Mikkeli, Finland (Figure 1) • Sediment cores were subsampled on-site as 1 (top 0–10 cm) and 2 cm slices (10+ cm)
Pretreatment	• Subsamples were dated according to their Cesium-137 activities • Sedimentation years 2018, 2010, 2000, and 1990 were studied together with the oldest subsamples from sites 1–3 • Organic material was degraded with 10% H_2O_2 and MPs were separated from denser material with Na_2WO_4 solution (density 1.4 g/cm^3)
Analysis	• Possible MPs (>100 µm) were manually separated from the filtered supernatants and analyzed with a Raman microscope • MPs were identified by a comparison with commercial libraries with KnowItAll Informatics System (Bio-Rad Laboratories, 2018) • The shape, size, polymeric composition, and color of detected MPs were reported

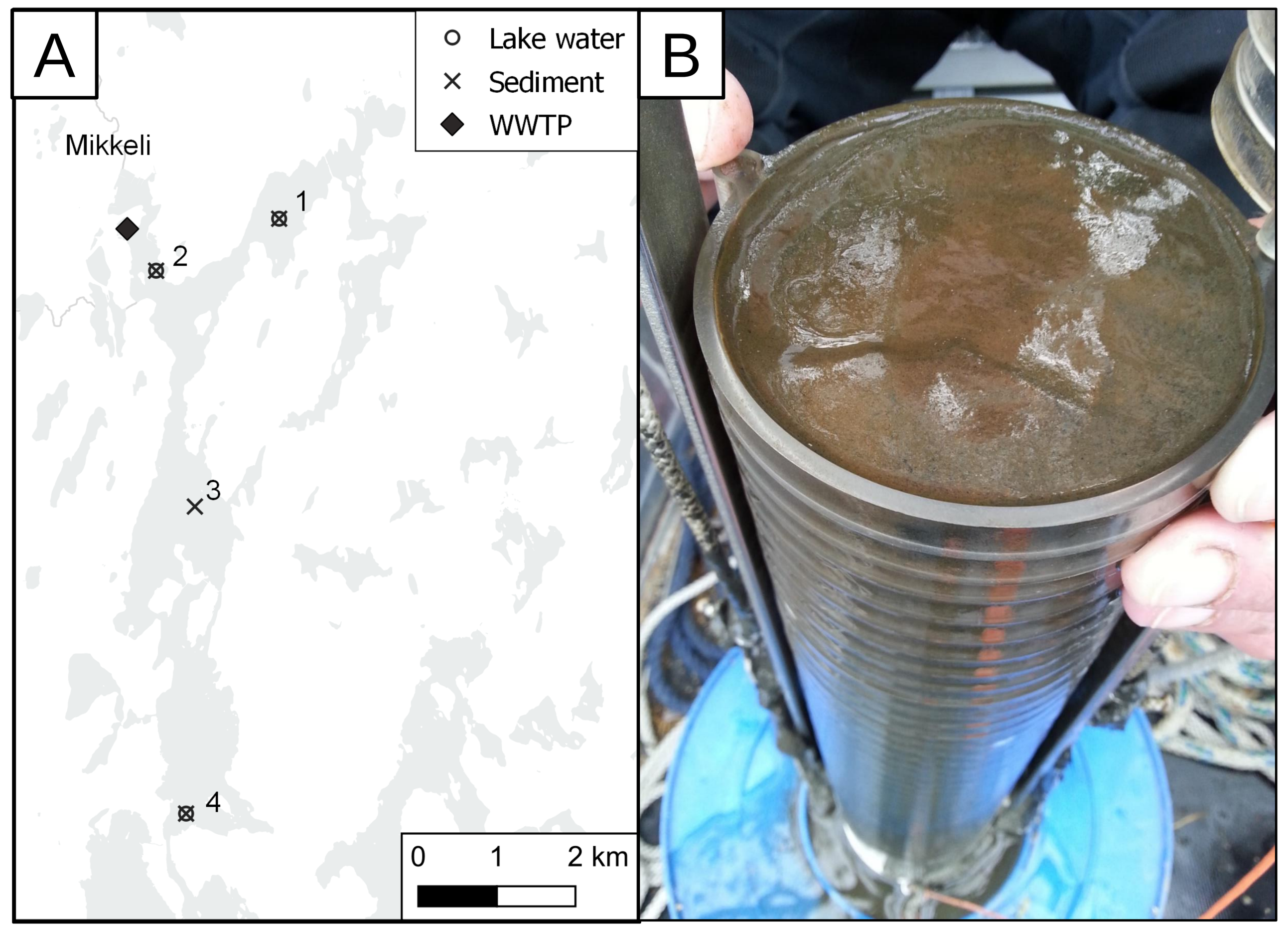

Figure 1. (A) The sampling sites of sediment (x) and (B) an example of a sediment sample in the Limnos.

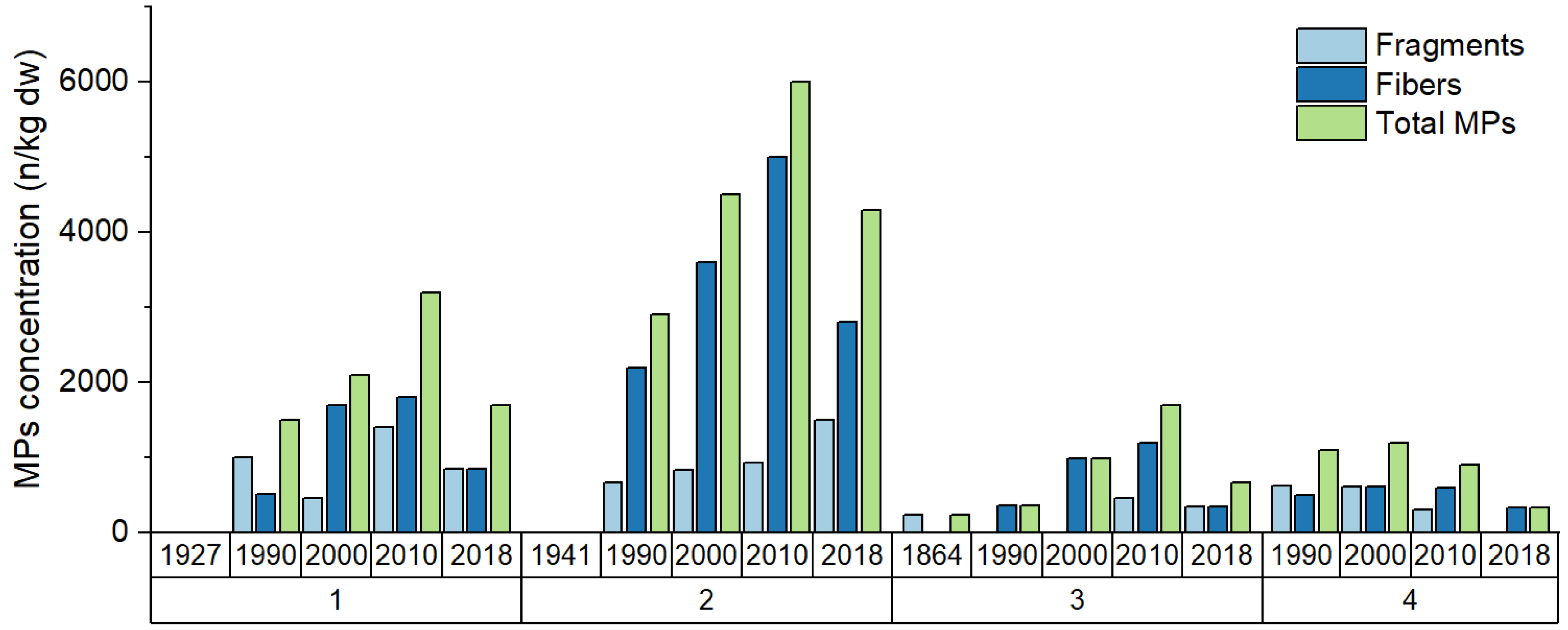

Figure 2. The concentrations of MPs (n/kg$_{dw}$) in the subsamples of the sediment cores collected from sites 1–4.

RESULTS AND CONCLUSIONS

The studied sediment samples dated from 1990 to 2018 contained 2100 MP/kg$_{dw}$ (>100 µm) on average, and the highest concentrations were detected at site 2 (4400 MP/kg$_{dw}$) (Figure 2). In general, the samples representing the year 2010 contained the highest concentrations of MPs, which slightly increased from 1990 to 2010 at sites 1–3. The lower concentrations in the subsamples representing the year 2018 in comparison with the year 2010 were likely caused by the sampling method.

Fibers covered 70% of the detected MPs (>100 µm) in sediment samples (Figure 3). They were most abundant at site 2 (77%), where 90% of the fibers consisted of polyester. The high number of fibers close to the discharge site and the slight increase of MPs concentrations in general was in line with global polyester fiber production that increased from 8 MT in 1990 to 55 MT in 2018 [4].

The results indicate that part of the MPs in WWTP effluents can be retained in the sediments close to the discharge site. As the consumption of plastics and likely also the MPs loads continue to increase in the future, the organisms living in the bottom sediments close to the discharge sites of WWTP may be exposed to high concentrations of MPs. According to this study, especially the impacts of polyester fibers should be concerned in the future studies.

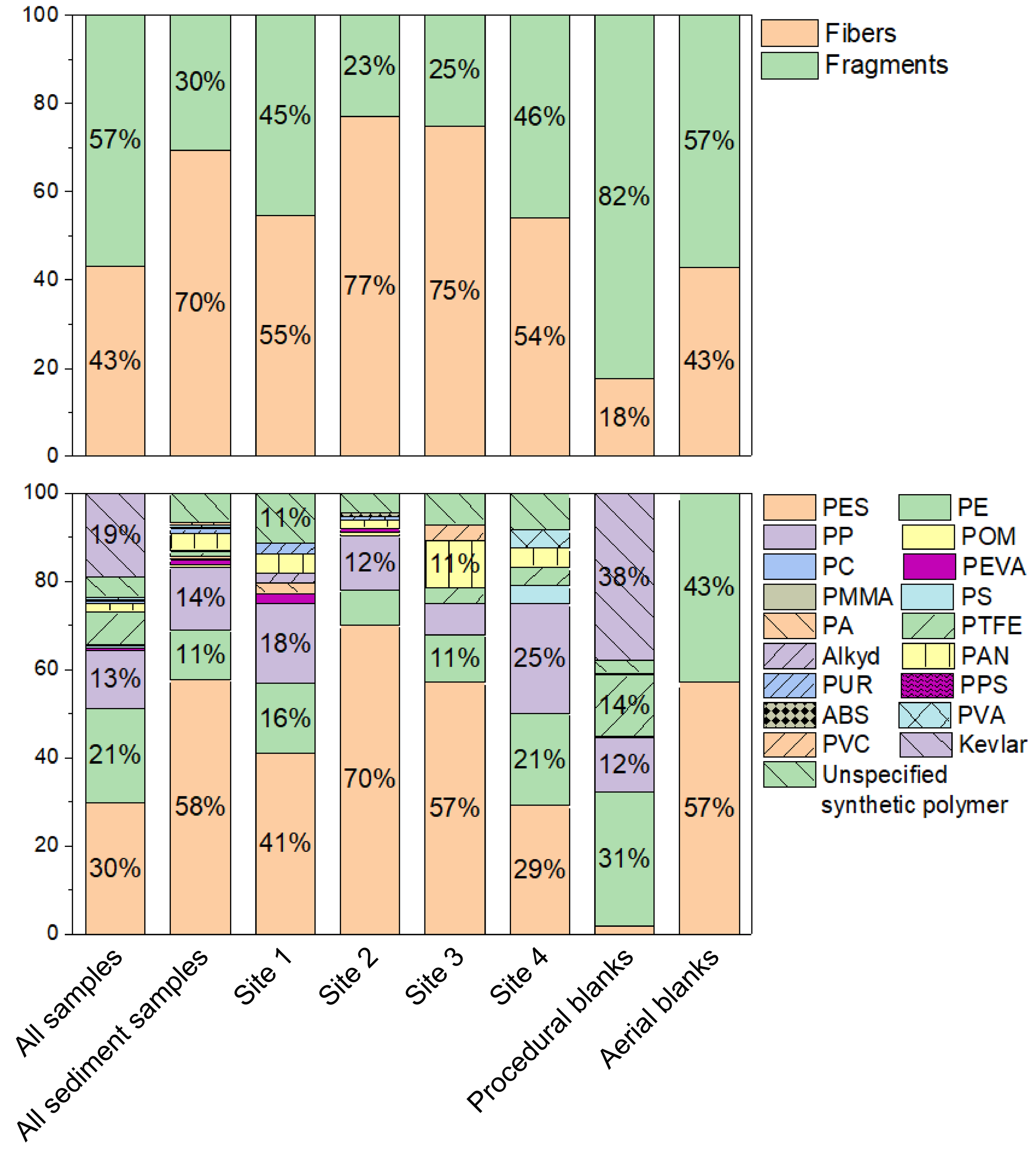

Figure 3. Detected shapes and polymer types of MPs in the sediment and blank samples.

REFERENCES

[1] Lares et al. (2018), 10.1016/j.watres.2018.01.049

[2] Talvitie et al. (2017), 10.1016/j.watres.2016.11.046

[3] Martin et al. (2022), 10.1016/j.scitotenv.2021.150818

[4] Opperskalski et al. 2019, Preferred Fiber & Materials: Market Report 2019

CONTACT INFORMATION

Mirka Viitala
Department of Separation Science, School of Engineering Science, LUT University
mirka.viitala@lut.fi

Zacharias Steinmetz
iES Landau, Institute for Environmental Sciences, University of Koblenz-Landau
steinmetz-z@uni-landau.de

Mika Sillanpää
Department of Chemical Engineering, School of Mining, Metallurgy and Chemical Engineering, University of Johannesburg
mikaetapiosillanpaa@duytan.edu.vn

Mika Mänttäri
Department of Separation Science, School of Engineering Science, LUT University
mika.manttari@lut.fi

Markus Sillanpää
Ecotoxicology and Risk Assessment, Laboratory Centre, Finnish Environment Institute
markus.sillanpaa@syke.fi