BONUS MICROPOLL

Multilevel assessment of MPs and associated pollutants in the Baltic Sea

Publishable summary report 2
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Project participants

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Second year meeting 2019, Klaipeda, Lithuania

BONUS MICROPOLL has received funding from BONUS (Art 185),
funded jointly by the EU and the national funding institutions: Federal Ministry of Education and Research (Germany), VINNOVA - Sweden's Innovation Agency (Sweden), National Centre for Research and Development (Poland), Estonian Research Council (Estonia), Research Council of Lithuania (Lithuania)

Project overview, goals, and expected results

The project focuses on the multilevel impacts of microplastics (MP), of associated pollutants and of attached biofilms on the ecosystem Baltic Sea. Besides detecting the status of MP in the Baltic Sea (abundance, composition, sources, sinks), the project explores the vector function of MP, as well as the impact of MP on Baltic biota. The gathered data will enable us to create spatio-temporal scenarios and simulations for MP transfer and circulation, which will help to understand the mitigation processes of MP and associated pollutants/biofilms in the Baltic Sea. We aim at developing indicators and suggesting monitoring strategies regarding MP and associated pollutants, this way contributing to the implementation of the Marine Strategy Framework Directive. Another part of the project is the evaluation of several MP avoidance measures and the testing of efficient wastewater treatment technologies. Overall, the project will serve as a solid framework for the implementation of source and impact prevention aimed measures for the reduction of plastics pollution in the marine environment.

Performance and progress since last reporting period

After two years project time the first results have already been published in 9 scientific peer review papers. All project partners met for the third time in May 2019 in Klaipeda, Lithuania. New collaborations investigating plastics in the Baltic Sea were established within the project but also with other projects. Close exchange with related projects, and the participation of several partners in stakeholder committees and participating at stakeholder workshops ensured the communication of project results, as well as regular updates on the projects' webpage. BONUS MICROPOLL appeared in interviews (18), multi-media products and outreach initiatives (31), and popular science papers (4), which granted excellent dissemination of the project results to stakeholders and the public.

Scientific progress was achieved in all research fields in the project:

Extensive sampling activities were engaged to obtain representative MP samples for further investigations. Water and sediment samples were collected with specialized equipment from rivers in Germany and Poland and beaches were sampled according to a dedicated rake-method at beaches in Sweden, Germany, Poland, Lithuania, Latvia, Estonia, and Finland. The workup of all sample types was strongly optimized for improving sample quality whilst reducing the required time. Particular progress was achieved in the workup of sediment samples by refined density separation. Further, the sample processing and analysis procedures were optimized to allow a clean, detailed and time-efficient analysis of large numbers of particles per sample. For maximizing the sample-throughput a (semi)-automated analysis and evaluation pipeline was developed. This includes an optical particle recognition by the software GEPARD (**G**epard-**E**nabled **PAR**ticle **D**etection), which was developed for the (semi)-automated analysis of up to 40,000 particles on a sample filter.

All particle results are collected in a comprehensive database that allows keeping track of each particle's individual history – from sampling to workup to final analysis. Having available the comprehensive set of data, including all details about the employed methods, is critical for asserting the reliability and validity of the gathered results. Hence, we are able to create a sound basis for any subsequent modelling steps that build upon the particle results.

To investigate the biofilm on plastic particles, and its vector behavior, two incubation experiments were carried out and samples were harvested. The first experiment investigates the very early (10h) biofilm that forms on plastic particles. Samples are currently under investigation. The second experiment included incubations in the German and Polish part of the Baltic Sea. Samples were taken at early, mid and late time points for DNA extraction and at a late time point for chemical absorption analysis. Chemical absorption analysis showed that most of analyzed pollutants can be found in plastic materials as compared to natural materials, which suggested that MP can absorb such compounds.

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Further, MP from aquatic environments across the world as well as the Baltic Sea, are being investigated in regard to their microbial biofilms. A meta-analysis of this 16S sequence data will be finalized by the end of the year. Biodegradation experiments showed that biological degradation rates of synthetic polymers appeared to be only on very low levels that have no influence on the time scales relevant for the models.

Regarding the impacts of MPs on biota, the key focus in the reporting period was on the development and application of experimental protocols and test systems required for the MP hazard assessment and models to come. Experimental work has also been conducted as well as analysis of MP body burden in various invertebrates and fish collected in the Baltic Sea. The scientific results and output are starting to accumulate and get published. They are also used to inform stakeholders and support undergraduate teaching.

The contamination potential of MP through waste water treatment plants (WWTP) was further investigated. A large collection of information has been gathered by the BONUS MICROPOLL-project from the countries around the Baltic Sea to understand how much MPs originates from wastewater treatment plants. It was found that the different wastewater treatment plants are not equally efficient in removing MPs from the wastewater due to differences in treatment technology. The total load of MP to the Baltic Sea from treated wastewater has been estimated to 90 ton/year. Moreover, it was identified that sanitary sewer overflow (SSO) events emit MP in the same magnitude as MP-emission from treated wastewater, while it is considered efficient to develop and implement techniques that can remove MPs also during these events. We have been testing different techniques and methods on how to increase the amount of MPs that is treated inside the wastewater treatment plant, but also during SSO-events. To analyze MPs in wastewater is challenging, and we are therefore developing new methods that will make this work easier and more reliable. Altogether, the aim of this work is to reduce the amount of MPs that is released to the Baltic Sea through wastewater in the most cost efficient way.

A quantification of MPs emissions into the Baltic Sea has been completed based on literature study and empirical results from within this project. A mechanistic separation into different sources of MPs, combined with a population density approach where the exact pathways are unknown, yielded an estimate for the total emissions. A large uncertainty of this present-day input, however, reflects the methodological uncertainty in the quantification of MPs load to the Baltic Sea. A model was developed to simulate the further transport of the MPs particles once they are inside the Baltic Sea. As waves play an important role for particle resuspension, especially in shallow areas but under extreme conditions also in intermediate depths, a focus was set to a good representation of these physical processes, which involved the use of a state-of-the-art wave model. Also, the use of a specific regional atmospheric model allows a better representation of storms. We prepared data for focusing on two scenarios in MPs transport: The influence of storm events and of heavy rainfall which leads to wastewater treatment plant overflows.

Our knowledge gathered when using various MP sampling methods in different compartments of the marine environment (sediment, biota, water column, etc.) served a great value in determining the coherent, consistent and comparable monitoring procedures. The experiments on the MP identification in Baltic biota allowed for further development of consistent methods (enzyme-based extraction and Nile red staining) for microplastic exposure assessment. A survey addressing cigarette butts pollution showed that the purposeful habit of littering and a lack of necessary infrastructure are the main reasons behind pollution with cigarette butts. An assessment of management action aimed to reduce marine litter pollution showed that a combination of prohibition and raising awareness serve as the most effective methods.

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