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AKANoah Student Team experience: microplastics analysis technics on the Po River environment

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Abstract

AKANoah PoliTo is a student team from Politecnico di Torino which aims to design an environmental monitoring strategy for the urban river ecosystem and a plastic waste collection system.

Data gathering and analysis are key for monitoring, mitigating, and preventing pollution of such a pivotal resource as the river environment, as pointed out by the 2030 Agenda. The urban context is a critical hotspot of pollution because its high-density population leads to multiple types of contamination, such as stormwater discharges, accidental releases, littering and irresponsible use of the river infrastructure by locals. Furthermore, surface watercourses collect different pollutants along their path, becoming a very important matrix to be monitored.

The project focuses on developing and testing both the procedure and the proper instrumentation to carry out water quality assessment, microplastic sampling and macroplastic cleaning tasks, following the principles of efficiency, low environmental impact, and replicability. The monitoring and collection strategy proposed by AKANoah is a fast, efficient, and easily repeatable boat-based solution which combines macroplastic river cleaning and data acquisition on micro and macro pollutants.

This strategy is intended to bring a positive impact on both the local community and the ecosystem. It also has the potential to open new opportunities for city businesses and to bring educational values not only to students directly involved in the project but also to the citizens who benefit from a healthy, thriving urban river environment and its related ecosystem services (leisure activities, urban parks, storm flows regulation).

Keywords: Microplastics, River environment

Img 1: Logo of the AKANoah Student Team

1. Introduction

Plastics have become one of the most diffused pollutants in the world.

Microplastics are particularly critical because of their size which makes them difficult to trace but easy to be transported and assimilated by different organisms across the food chain through biomagnification processes (Assas et al., 2020; Devereux et al., 2021; Romeo et al., 2015).

Microplastics are characterized by their dimensions, typically ranging from 1 µm to 5 mm. Moreover, these microplastic particles act as carriers, due to their limited size and large specific surface area, binding with other toxic pollutants such as heavy metals, pesticides, hydrocarbons, POPs, antibiotics, and surfactants (Li et al., 2018; Li et al., 2019; Selvam et al., 2021; Zhou et al., 2019), thereby augmenting the toxic effects within tissues; this is a growing issue to which wastewater treatment plants must quickly adapt.

Microplastics can be classified into primary and secondary based on their origin; primary microplastics are directly produced with their characteristic size whereas secondary microplastics are the result of physical, chemical, or biological degradation of larger dimension plastics (Crawford & Quinn, 2016); the latter are the most diffuse in the aquatic environment.

Most of the research on microplastics are focused on the marine environment (Koutsikos et al., 2023) only in recent years some studies on the freshwater ecosystem have been published (Qin et al., 2023, Kunz et al., 2023, An et al., 2022, Su et al., 2022).

Rivers, however, are not only negatively impacted by microplastics but are also the main vectors from land to sea; therefore, it is necessary to improve the knowledge of their role to effectively address the problem of microplastics.

Starting from these considerations, AKANoah students' team from Politecnico di Torino (Img1), works on microplastic monitoring and macroplastic collecting in an urban river environment.

This study holds significant importance due to Torino being the first major metropolitan city along the course of the Po River. Furthermore, the city encompasses a water treatment facility that integrates treated river water into the distribution network, in conjunction with a downstream wastewater treatment plant serving the city.

Alongside these goals, the team aims to bring attention to this issue involving students in cross-sectoral challenges.

2. AKANoah Team: aim

Microplastics have become a pervasive pollutant in recent times, yet there is a lack of widespread understanding regarding the social and environmental consequences associated with this raising issue. In response to this, in 2020 AKANoah team was created with the aim of involving a larger number of individuals in this field. The primary objective of the AKANoah student team is to monitor and analyze microplastics while also collecting macroplastics from the Po River in Turin. Their aim is to raise awareness and spread knowledge within the community through social media, but also during samplings along the river.

To effectively carry out this work, the AKANoah team is structured into various groups, each consisting of members with diverse skill sets. The main subgroups include microplastics analysis and monitoring, macroplastics collection, and social communication; the team's objective is successfully implemented through the collaborative efforts of individuals from different backgrounds (Img2).

Each activity undertaken by the team is thoroughly documented and shared via their social media accounts, aiming to foster a sense of community engagement within the Politecnico di Torino and the city of Torino.

Img 2: AKANoah Team member during a Po river sampling

3. Activities

3.1. Microplastics sampling methods

Regarding the evaluation of the microplastic sampling method, two different methodologies were tested to assess which one could provide the best results: manta trawls mounted on a boat and water direct filtering. Both methods have shown advantages and drawbacks, also given the significant disparity in the volumes of water being analyzed.

The manta net allows for dynamic analysis; however, due to the large volumes of water sampled, filtering a smaller volume of water in situ allows for a lower percentage of organic material collected and reduces the number of filters needed, thus reducing analysis time. After following the procedure already presented, contrary to the previous sampling method, these samples were subjected to analysis using an optical microscope.

Despite the organic matter removal with 1:1 30% H_2O_2 solution, filters obtained from the manta sampling showed a significant residual percentage of organic mass, which, on one hand, could conceal possible microplastics (although their sizes would be too small for our analysis), but on the other hand, made it easier to identify those that exhibit fluorescence under UV light.

The filters produced from in-situ water filtration showed almost no organic material, making most particles collected visible. However, many particles, despite presenting a reaction to UV light, upon closer examination, were found to be natural fibers such as cotton, being industrial textile often mixed with additives fluorescent under UV light.

Although the activities started recently, some important considerations can be made: the manta net seems optimal for monitoring the central part of the watercourse, while the manual collection for riparian areas.

3.2. Macroplastics collecting system

Regarding the macroplastics collecting system, the goal is to design a system to be installed on the boat that allows the users to collect macroplastics during the monitoring campaign. After the collection, samples will be characterized by size, color and typology in the laboratory by means of spectroscopic analysis, thus allowing to hypothesize the origins. This system is still under development and testing.

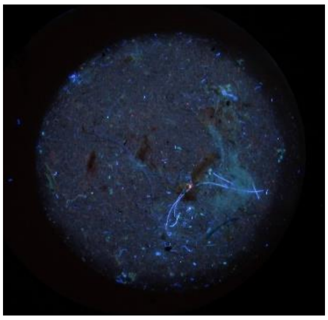
3.3 Laboratory analysis

All operators used nitrile gloves and cotton shirt in all steps, and all surfaces and tools used during laboratory analysis were cleaned with ethanol and MilliQ water to avoid MP contamination. Plastic equipment was replaced with glass and metal utensils. As previous studies have shown (e.g. Balestra & Bellopede, 2022). To separate the collected particles from the net, several washings with distilled water were done, collecting the liquid matrix in glass bechers. Prior to examining the microplastics in the collected samples, a preparation phase is necessary to remove the organic matter through the application of 1:1 30% hydrogen peroxide solution; after, samples were left to react for a week at room temperature... To avoid contaminations, bechers containing the samples were covered with aluminium foil. Next, samples are filtered through a 1.2-μm pore size glass filters, using a filtration system with a water-driven vacuum pump. Filters were then dried in an oven at 50 °C.

3.4 Microplastic characterization

Fluorescent whitening agents are often used in the production of plastic (Qiu et al., 2015), therefore, a great number of microplastic particles can be easily detected under UV light (Ehlers et al., 2020). Microplastics on filters were observed with and without an UV flashlight (Alonefire SV10 365 nm UV flashlight 5 W) under a Leitz ORTHOLUX II POL-MK microscope equipped with a DeltaPix Invenio 12EIII 12 Mpx Camera, with a 2.5×, 4×, 10× or higher magnification. The filters were illuminated with a UV light inclined at a 45-degree angle to enhance the visibility of microplastics in the images (Img 3).Visual identification was performed to identify and characterize microplastics in agreement with the selection criteria reported in Crawford & Quinn (2016). Particles smaller than 0.5 mm were cut off and particles that could not be clearly identified as microplastics were not take into consideration. Microplastics were characterized by shape, size and colour, following the guide lines of the standardised size and colour sorting system (SCS)(Crawford & Quinn, 2016).

Alongside, some filters were photographed and analyzed using MUPL automated software (Giardino et al., 2023) to obtain data on microplastics and textile fibre (natural, artificial and synthetics) pollution.



Img 3: Photograph of a filter under UV light

4. Future activity

Now that the methodology is set up, the next steps will be planning and designing the monitoring campaign of a stretch of the Po River in urban area.

The results of the analyses will be freely accessible and published on the team's social media accounts.

The activities carried out by the team will have value for the scientific community in increasing data and knowledge on microplastics in river environment. At the same time, the monitoring activity carried out on the river in urban context offers citizens the opportunity to get involved.

Furthermore, AKANoah's goal is to learn to work in team with multidisciplinary approach.

Dissemination activities and environmental education on different channels will be programmed to raise awareness of the problem of microplastic pollution.

References

An, L., Cui, T., Zhang, Y., & Liu, H. (2022). A case study on small-size microplastics in water and snails in an urban river. *Science of the Total Environment*, *847*. https://doi.org/10.1016/j.scitotenv.2022.157461

Assas M., Qiu X., Chen K., Ogawa H., Xu H., Shimasaki Y., et al. (2020), Bioaccumulation and reproductive effects of fluorescent microplastics in medaka fish, *Marine Pollution Bulletin*, **158**, 111446. https://doi.org/10.1016/j.marpolbul.2020.111446

Balestra V. and Bellopede R. (2022), Microplastic pollution in show cave sediments: First evidence and detection technique, *Environmental Pollution*, **292**, 118261. https://doi.org/10.1016/j.envpol.2021.118261

Cheremisinoff P.N. (1995), Handbook of Water and Wastewater Treatment Technology, Marcel Dekker Inc., New York.

Crawford C.B. and Quinn B. (2016), Microplastic pollutants, Amsterdam, Elsevier.

Devereux R., Hartl M.G., Bell M. and Capper A. (2021), The abundance of microplastics in cnidaria and ctenophora in the North Sea, *Marine Pollution Bulletin*, **173**, 112992. https://doi.org/10.1016/j.marpolbul.2021.112992

ECHA. Microplastics. Retrieved from https://echa.europa.eu/it/hot-topics/microplastics

Ehlers S.M., Maxein J. and Koop J.H. (2020), Low-cost microplastic visualization in feeding experiments using an ultraviolet light-emitting flashlight, *Ecological Research*, **35**, 265-273. https://doi.org/10.1111/1440-1703.12080

Giardino M., Balestra V., Janner D. and Bellopede R. (2023), Automated method for routine microplastic detection and quantification, *Science of The Total Environment*, **859**, 160036. https://doi.org/10.1016/j.scitotenv.2022.160036

Koutsikos, N., Koi, A. M., Zeri, C., Tsangaris, C., Dimitriou, E., & Kalantzi, O. I. (2023). Exploring microplastic pollution in a Mediterranean river: The role of introduced species as bioindicators. *Heliyon*, *9*(4). https://doi.org/10.1016/j.heliyon.2023.e15069

Kunz, A., Schneider, F., Anthony, N., & Lin, H. T. (2023). Microplastics in rivers along an urban-rural gradient in an urban agglomeration: Correlation with land use, potential sources and pathways. *Environmental Pollution*, *321*. https://doi.org/10.1016/j.envpol.2023.121096

Li J., Zhang K. and Zhang H. (2018), Adsorption of antibiotics on microplastics, *Environmental Pollution*, **237**, 460-467. https://doi.org/10.1016/j.envpol.2018.02.050

Li X., Mei Q., Chen L., Zhang H., Dong B., Dai X., et al. (2019), Enhancement in adsorption potential of microplastics in sewage sludge for metal pollutants after the wastewater treatment process, *Water Research*, **157**, 228-237. https://doi.org/10.1016/j.watres.2019.03.069

Parlamento europeo. (Novembre 2018), Microplastics: sources, effects and solutions. Retrieved from https://www.europarl.europa.eu/news/en/headlines/society/20181116STO19217/microplastics-sources-effects-and-solutions

Qin, X., Sun, N., Teng, W., Zhu, Y., Liu, Z., Li, W., Dong, H., Qiang, Z., Zeng, J., & Lian, J. (2023). Spatiotemporal distribution of microplastics in the Ganzhou Section of the Ganjiang River: An insight into the source area impact. *Journal of Environmental Chemical Engineering*, 109695. https://doi.org/10.1016/j.jece.2023.109695

Qiu Q., Peng J., Yu X., Chen F., Wang J. and Dong F. (2015), Occurrence of microplastics in the coastal marine environment: First observation on sediment of China, *Marine Pollution Bulletin*, **98**, 274-280. http://dx.doi.org/10.1016/j.marpolbul.2015.07.028

Romeo T., Pietro B., Pedà C., Consoli P., Andaloro F. and Fossi M.C. (2015), First evidence of presence of plastic debris in stomach of large pelagic fish in the Mediterranean Sea, *Marine pollution bulletin*, **95**, 358-361. https://doi.org/10.1016/j.marpolbul.2015.04.048

Selvam S., Jesuraja K., Venkatramanan S., Roy P.D. and Kumari V.J. (2021), Hazardous microplastic characteristics and its role as a vector of heavy metal in groundwater and surface water of coastal south India, *Journal of Hazardous Materials*, **402**, 123786. https://doi.org/10.1016/j.jhazmat.2020.123786

Sundaramanickam, A. & Ajith, N. (Ottobre 2021). Impact of Microplastic Contaminants on Marine Environment and its Life.

Su, L., Xiong, X., Zhang, Y., Wu, C., Xu, X., Sun, C., & Shi, H. (2022). Global transportation of plastics and microplastics: A critical review of pathways and influences. *Science of the Total Environment*, *831*. https://doi.org/10.1016/j.scitotenv.2022.154884

Zhou Y., Liu X. and Wang J. (2019), Characterization of microplastics and the association of heavy metals with microplastics in suburban soil of central China, *Science of the Total Environment*, **694**, 133798. https://doi.org/10.1016/j.scitotenv.2019.133798