TREND OBSERVATORY ON WATER

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TREND SHEET

Rivers drowning in plastics – an underestimated risk?

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Plastic pollution in rivers is a global issue but the extent of the problem may even have been underrated up to now, as too little is known about the real extent and the impacts microplastic may have on human and environmental health. This calls for a pre-cautionary approach and preventive measures at various levels, from local to global, as well as along the whole plastic value chain from production to discharge and recycling. Read this Trend Sheet for latest insights on (micro)plastic pollution and on-going initiatives and innovative approaches to address the challenge.

Content

Why this Trend Sheet?

What trend do we observe?

Water-related investments deliver substantial benefits for water security and sustainable development, by connecting multiple other sectors including agriculture, energy, urban development, public health and education. So far, this is not mirrored in levels of water-related investments that are far outweighed by funding flows benefitting other sectors.

Why is this trend important for water practitioners in development cooperation?

The world is not on track to meet SDG 6 on water and sanitation, largely due to insufficient levels of water-related investments. Scaling up investment in water is urgent, otherwise the water crisis will increasingly impede progress towards sustainable development, especially in low- and middle-income countries. One part of the challenge consists in making sure that existing policies and institutions actually enable water-related investments rather than impede them, and phase out perverse incentives to over-consume water. Another part is making the most effective use of existing funds. At the same time, exploring innovative financial approaches that have emerged recently is key in order to find out how they can best help granting sustainable access to capital markets to low-income countries and underserved communities.

What is new?

Financing water security is a crucial policy issue and has been discussed broadly since the UN2023 Water Conference. A new financing paradigm needs to be established to align financing flows with the development priorities set by the SDGs as neither public finance nor official development assistance (ODA) will be sufficient to fill the financing gap. This involves making best use of both public and private resources, as well as innovative approaches combining both. These approaches materialise via new opportunities arising from climate finance, blue bonds granting access to finance to underserved communities, or even alternative payment systems such as cryptocurrency to make funding of water projects more secure and less complex.

Introduction: a world of plastic - a world of waste

Global production of plastic has increased exponentially over the past decades. Annual world production has increased from 2 million tonnes (Mt) in 1950 to 234 Mt in 2000 and 460 Mt in 2019. In a business-as usual scenario, the OECD projects global plastic production to triple by 2060. Large shares of the plastic produced soon turn out as waste, especially short-lived products such as packaging and single-use plastics – like this 353 Mt of plastic waste were generated globally in 2019 (OECD 2022).

While the United States show by far the largest per capita plastic waste generation rate, major increases are expected for emerging economies in sub-Saharan Africa and Asia, where plastic waste generation is forecast to quadruple by 2060. This is alarming, as solid waste management in these countries is often inadequate and will not be able to keep up with waste generation, considering the various challenges in waste management in developing countries. Rapid urbanisation trends resulting in large informal settlements will further aggravate the situation.

Plastic waste far too often ends up in the environment, polluting land, rivers, and oceans. While some types of plastic are very stable, others very slowly fragment into tiny microplastic particles and eventually further into non-visible nanoplastics. As plastics can remain in the environment for many decades and production and use of plastic continues to increase, plastic pollution will be building-up exponentially over the next decades. This is ever more worrying since the resulting risks for human and environmental health are not yet fully understood.

What are microplastics and where do they come from

- **Microplastics** are defined as plastic particles smaller than 5mm in diameter in the international policy debate, e.g. in the OECD Global Plastic Outlook. **Nanoplastics** are considered a subset of microplastics, usually defined as being under 100 nm in size (UNEP 2022). However, various ongoing research on microplastic and nanoplastic uses different definitions, making it difficult to compare results.
- **Microplastics can be categorized by their source. Primary microplastics** are purposefully made to be that size (e.g. microbeads used in cosmetics and personal care products, virgin resin pellets used in plastic manufacturing processes). **Secondary microplastics** are the result of fragmentation of macroplastic into smaller particles, either during use or after disposal into the environment.
- Microplastics make up 12% of plastic pollution flows into the environment**.** Most microplastics found in the environment are secondary microplastics, with major sources including road transport (tire abrasions and brake wear), synthetic fibres, and wastewater sludge. Nevertheless, primary microplastics are also an important source of plastic pollution. Moreover, microplastics in the environment, especially in rivers and oceans, result from break-down of larger plastic items.
- **Microplastics are found everywhere** - once microplastics are released into the environment they are transported in various ways incl. through the air, rivers, and the food web, as they are ingested by animals. Like this microplastics are carried to even the most remote places, for example the arctic and high mountain glaciers. Microplastics also have been detected in human blood and lungs. The pervasiveness of microplastics across our planet raises serious concerns for human and environmental health.
- **The understanding of sources, pathways, and fate of microplastics in the environment is still limited.** More research is needed to better understand the full extent and impacts of microplastic pollution. However, considering the fact that once leaked into the environment, microplastics are difficult to contain, this should by no means delay the implementation of preventive policies to reduce microplastic pollution.

Rivers and lakes act as plastic pollution reservoirs

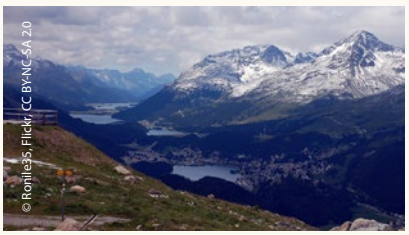
Around 32% of all plastic pollution ends up in aquatic environments, i.e. in rivers, lakes and oceans. Direct dumping of waste contributes a significant portion of plastic in rivers. But mismanaged waste from land can also be flushed into water bodies, e.g. by heavy rains, which feed into larger tributaries and rivers, which in turn empty into oceans. In this way, plastic from far inland can travel many miles through local streams into larger tributaries and main river down to the coastline.

Rivers have for long mainly been considered a mere courier for plastic into the oceans, but more recent research found that a major part of the plastic remains within the river systems for many years, like water bottles from the 1970s at the riverbank of the Seine have shown. In 2019 alone, 5.8 Mt of plastic waste are estimated to have ended up in rivers and lakes, of which only 1.7 Mt flowed into the ocean.

Huge amounts of plastics have already accumulated in rivers and lakes and the problem is piling up: estimates are that more than 109 million tons of plastic are floating around or settling at the bottom of rivers and lakes -much more than the 30 million tons accumulated in the world's oceans – and these numbers are expected to triple until 2060 (OECD 2022). This figure by the OECD shows current and expected plastic pollution flows in aquatic environments.

Highest plastic pollution is found in rivers running through densely populated urban areas in Asia where waste management is often lacking. Researchers expect Africa to establish on the list of riverine plastic pollution hotspots in the next decades. Similar observations were made for microplastic pollution of freshwater bodies, where highest concentrations were found in China and lowest in Switzerland (Chen et al. 2022). Nevertheless, microplastics have also been found in remote Swiss mountain lakes.

Microplastics in the Upper Engadine – Swiss Junior Water Prize



The presence of microplastics in alpine regions, especially in Switzerland, is barely researched. This inspired Swiss high-school student Anna Sidonia Marugg to do some research on her own in the waters of the Upper Engadine, which won her the Swiss Junior Water Prize 2020. In cooperation with the University of Basel and the Lyceum Alpinum Zuoz, she provided the first evidence for microplastics in these waters, while also researching the types of synthetics and the differences in their concentration in different locations.

To collect water samples at 8 different sites, Anna used a self-made light and portable construction, the so-called LADI (low tech aquatic debris instrument), with a 0.3mm-mesh trawl.

Analysing the examples in a laboratory, she found 22 different types of polymers, with ethylene-vinylalcohol-copolymer being the most prevalent. Surprisingly, even the headwaters at a height of 2485m above sea level were contaminated with microplastics. The highest concentration was found in the Lake St. Moritz, reinforcing the assumption that the concentration rises in the vicinity of agglomerations, although more research needs to be done to specify this correlation. Watch this video for a presentation of the project.

Main source of microplastics in rivers and lakes include road transport, synthetic textiles, and fragmentation of plastic waste. Small particles from tyre abrasion, brake wear and eroded road markings get washed into water bodies, especially during heavy rains and floods. While wastewater treatment plants can remove microplastics from wastewater, where wastewater is discharged untreated it can carry significant microplastic loads (e.g. from washing synthetic clothes) into rivers and lakes. The main origin of microplastic pollution varies with the level of development. In the Global South, where waste management is often inadequate, break-down of macroplastic contributes a higher share of microplastics in freshwater environments.

Impacts on environmental and human health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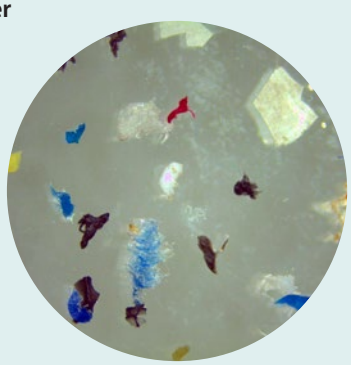
The most visible environmental impacts of plastic pollution in aquatic environments are the entanglement of wildlife in floating plastic debris, such as birds entangled in plastic nets. Moreover, pieces of plastic have been found in the digestive system of many aquatic species - a study on wild-caught fish found microplastics in the intestines of 65 per cent of the 496 species examined (UNEP 2022). While major knowledge gaps remain, recent research indicates that ingestion of microplastics can affect the growth rate and hatchability of aquatic species, and increased mortality, of e.g. mussels, fish and sea birds following the ingestion of macro and microplastics has been observed.

Microplastics have also been found in the digestive tract of mussels and fish destined for human consumption. Therefore, eating of seafood contaminated with microplastics is a potentially significant exposure pathway for humans. This is of particular concern as major inland fisheries are located in the very plastic polluted rivers of the Global South. This illustration by GRID Arendal shows various pathways of human exposure to microplastics and nanoplastic particles. While the human health impacts of microplastics are not yet sufficiently understood, researchers see causes of concern.

Chemicals and trace-metals, which are added to plastic, e.g. as plasticisers and flame retardants, may leach out into the aquatic environment and organisms as well as into human bodies. Just as with microplastic particles, the impacts that plastics-associated chemicals may have on ecosystems and human health is yet under-researched. However, common chemicals found in plastics, such as bisphenol A, phthalates, and polychlorinated biphenyls (PCBs), have been linked to endocrine disruption, developmental disorders, reproductive abnormalities and cancer.

Microplastic in drinking water

Research has demonstrated the presence of microplastics in tap and bottled water at various locations around the world. However, there are huge differences in reported microplastic concentrations, and the data is still insufficient to draw general conclusions. The results vary significantly depending e.g. on the particle sizes looked at and on the applied detection method. With analytical techniques developing rapidly, ever more and ever smaller particles (nanoplastics) can be detected. This will likely also change insights on nanoplastic concentrations in tap and bottled water.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Most studies found higher microplastic concentrations in bottled water compared with tap water (Gambino et al 2022). While there are insufficient comparable studies to fully substantiate this observation, assumed reasons for higher concentrations in bottled water are that drinking water treatment can remove microplastic particles and bottles release plastic particles into the water.

However, drinking water is likely not the main source of microplastic uptake for humans. Other pathways, such as inhalation of microplastic fibres and dermal contact with nanoplastics are expected to play more important roles as sources of exposure (Kirstein et al 2021). Moreover, the World Health Organisation (WHO) concludes that limited access to water and sanitation are more important issues to be tackled than microplastics in order to address water-related health risks. Nevertheless, the organisations calls for more and better research on microplastics in water as well as for a pre-cautionary approach to reduce plastic pollution, in general, and to "optimize water treatment processes for particle removal and microbial safety, which will incidentally improve the removal of microplastic particles", more specifically.

Ways to reduce plastic and microplastic pollution in freshwater (and marine) environments

There are several approaches to tackling plastic pollution in rivers and lakes. Major entry points are:

- **Reducing the production and use of plastics,** e.g. by promoting the use of reusable bottles or banning single-use plastics.
- **Preventing that plastic waste from entering into rivers and lakes,** e.g. through improved waste management or better management and treatment of wastewater and urban run-off to prevent microplastic discharge into freshwater bodies.
- **Removing plastic from freshwater environments,** e.g. though community river clean-ups – however this is virtually impossible for microplastics.
- **Improving data and knowledge** about plastic pathways into aquatic environments and funding research to better understand human and environmental health risks.

Experts stress the need to take a preventive approach to addressing plastic pollution in rivers and lakes. First and foremost, the problem should be addressed at its source, i.e. plastic production. Secondly, considering the large amounts of plastic waste that have already been generated, measures need to be taken to contain plastic waste and microplastic on land, where it originates, as plastic is much more difficult to remove once they entered water bodies.

Plastic pollution is a global issue that requires international cooperation to be addressed. Plastic in rivers will slowly be transported downstream and across national borders in transboundary basins. The environmental consequences further threaten global commons, such as the oceans. Moreover, plastic as well as plastic waste is shipped across the world. While most plastic waste is traded within the world regions, the Global North exports around 1.6 million tonnes of plastic waste to low-to-middle-income countries annually. As waste management systems in these countries are often inadequate, parts of these waste flows will end-up in the environment, including rivers and oceans.

In order to strengthen international cooperation in addressing plastic pollution, in March 2022 the UN member states agreed to develop an international legally binding treaty on plastic pollution by the end of 2024. Since then, an Intergovernmental Negotiating Committee has worked towards drafting and negotiating a treaty. The zero draft of the treaty text was presented at the third round of negotiations in Nairobi, in November 2023.

Listen to our Trend Observatory Podcast with Senior Policy Advisor Per-Olof Busch to learn more about progress in the negotiations for a UN treaty, in general and opportunities to address plastic pollution in rivers and lakes, in particular.

Project examples:

Join the Pipe: reducing plastic waste by promoting drinking of tap water

Join the Pipe is committed to tackling the dual challenge of plastic pollution and safe access to drinking water for all. The company aims to reduce the use of plastic by promoting drinking tap water, offering refill stations for companies, hotels, resorts and events, and selling reusable bottles made from sugar cane. With the proceeds of their products as well as donations to their foundation, Join the Pipe provides clean drinking water and refillable bottles in areas where people currently have no or difficult access to safe drinking water.

In their projects, Join the Pipe donate refillable bottles and install community taps in cities, water filling stations and water kiosks in schools, or low-maintenance hand-pumps in rural areas. The Join the Pipe foundation further carries out clean-up projects and educational programmes with school children in urban areas of the Global South.

Wasser 3.0 – tackling microplastic pollution with low-tech wastewater treatment technologies

Wasser 3.0 is a German non-profit company developing technologies to reduce the contamination of ecosystems with microplastic and micropollutants. Their approaches aim to provide cost- and energy efficient solutions by using low-tech processes with high-tech materials. The non-profit has developed the first filter-free process solution for the fast, efficient, and cost-effective removal of microplastics and other pollutant classes from different types of water.

The Wasser 3.0 PE-X® technology, uses a so-called "Clump & Skim" method. In this process, non-ecotoxic chemicals, mainly silica gel, are added to the water to bind the existing microplastic in aggregations. These "clumps" then float on the water surface and can thus be removed relatively easily. After this purification process not only can the water be reused, most of the bound plastic can also be recycled. In their activities, Wasser 3.0 complement research and innovation with education-initiatives on the topics of microplastics and wastewater.

Sungai Watch: Community river clean-ups using plastic barriers in Bali

The registered charity and environmental organization Sungai Watch was founded in Bali, Indonesia, in 2020, and today consists of about 90 "river warriors", working to stop the leakage of plastic pollution into the ocean. They approach this problem by designing and installing simple trash-barriers in rivers and setting-up a collection and up-cycling system. With the help of many volunteers, the obstructed plastic is collected and sorted, documented and further prepared for recycling.

Most of the collected plastics are packaging materials. If possible, the barcodes are scanned and data such as brand and type are stored for further analysis.

By blocking the waste with their barriers, Sungai Watch not only stops plastic from reaching the ocean, where the retrieval would be much more complicated and costlier, they also improve the understanding of the flaws in waste management.

An essential part of Sungai Watch's work further consists in community outreach. In addition to emergency cleanups at illegal dump sites and along riverbanks they also organize education and socialization campaigns with the local community to prevent throw-away behavior. The visible barriers creating huge accumulations of trash serve as a conversation starter and help raising public awareness of the waste problem, that is particularly problematic in Indonesia. Sungai Watch already have collected about 1.3 million kg of plastics and almost 0.5 million kg of organics through more than 600 community cleanups and installation of 180 waste barriers. Their mission is to install 1000 barriers and clean every river in Indonesia.

The GPML Risk and Warning System for Macroplastic Litter

The Risk and Warning System for Macroplastic Litter provides real time monitoring of litter load in rivers worldwide. It was developed by the Global Partnership on Marine Litter (GPML) in cooperation with the UNEP-DHI Centre on Water and Environment in order to prevent and reduce marine plastic pollution.

Understanding, monitoring and forecasting plastic flows in rivers can help identify where the problem originates and how best to intervene in order to address the problem of land-based sources of plastic pollution in freshwater and marine environments.

The system builds upon DHI's global hydrological forecasting model and can be accessed through the GPML datahub. The plastic load can be visualized on a map, either in tons per day or relative to the average load at a location. It can provide a 9 months-forecast of the plastic load in certain areas and allows to analyse and compare the plastic load with any other data layer on the data hub platform.

Further reading:

OECD (2022): Global plastics outlook: economic drivers, environmental impacts and policy options www.oecd-ilibrary.org/environment/global-plastics-outlook_de747aef-en

OECD (2022): Global Plastics Outlook: Policy Scenarios to 2060 https://www.oecd-ilibrary.org/sites/aa1edf33-en/index.html?itemId=/content/publication/aa1edf33-en

Laura Parker for National Geographic (2021): Plastic gets to the oceans through over 1,000 rivers https://www.nationalgeographic.com/environment/article/plastic-gets-to-oceans-through-over-1000-rivers

Laura Parker for National Geographic (2023): Microplastics are in our bodies. How much do they harm us? https://www.nationalgeographic.com/environment/article/microplastics-are-in-our-bodies-how-much-do-they-harm-us

Chen et al (2020): A Regional Difference Analysis of Microplastic Pollution in Global Freshwater Bodies Based on a Regression Model https://www.mdpi.com/2073-4441/12/7/1889

UNEP (2022): End plastic pollution: towards an international legally binding instrument https://wedocs.unep.org/bitstream/handle/20.500.11822/41263/Plastic_Science_E.pdf

UNEP (2021): From Pollution to Solution: A global assessment of marine litter and plastic pollution https://www.unep.org/resources/pollution-solution-global-assessment-marine-litter-and-plastic-pollution

UNEP (2021): Drowning in plastics: marine litter and plastic waste vital graphics https://wedocs.unep.org/xmlui/bitstream/handle/20.500.11822/36964/VITGRAPH.pdf

Hannah Ritchie, Veronika Samborska and Max Roser (2023): "Plastic Pollution" Published online at OurWorldInData.org. https://ourworldindata.org/plastic-pollution

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The "**Trend Observatory on Water**" of the Swiss Agency for Development and Cooperation (SDC) aims at informing the RésEAU, SDC's Water Network, and interested parties about relevant emerging trends and innovative approaches for development cooperation in the water sector. Initiated by SDC's Water Section and run by adelphi, it analyses how major global trends can affect water resources and management practices in the future. Through various communication formats and its website https://hazu.swiss/deza/trend-observatory-on-water it aims to raise awareness of opportunities that arise for more sustainable solutions, but also of the risks and challenges that might come along with them.

Contact:

SDC - Swiss Agency for Development and Cooperation
Section Water
Eichenweg 5, CH-3052 Zollikofen, Switzerland
Phone: +41 (0)58 465 04 06
Focal Point Water E-Mail: daniel.maselli@eda.admin.ch

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