NO MICROPLASTICS, JUST WAVES.

Fact sheet on microplastics in waters

Within the framework of the "Blue Lakes" project

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www.lifebluelakes.eu / info@lifebluelakes.eu

Blue Lakes
No microplastics, just waves.

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Plastic is omnipresent

From car tyres to toothpaste - plastics surround modern civilisation like no other material. But the light, hygienic and unbreakable material, which can be moulded into any shape and has found its way into all areas of life, also shows its dark side. If plastics end up in our environment because they have not been properly disposed of or recycled, they remain there for centuries.

Microplastics: The problem becomes visible under the microscope. Microplastics can be created by decomposing plastic waste into smaller particles, but they are also already produced as such. Road and tyre abrasion, fibre fragments from synthetic textiles and plastic particles from cosmetics and cleaning products play a central role in the formation of microplastics. Fortunately, the issue of microplastics has been receiving greater attention for some years now. The amount of microplastic is increasing dramatically due to the continued growth in global plastic production: current forecasts predict that the annual amount of pollution will increase tenfold by 2025 (Fath 2019). Plastic is carried into the oceans via rivers as macro- or microplastics. Huge rubbish carpets are now floating in the oceans. Even in uninhabited places like Antarctica or the Pacific islands, microplastics have been detected in increasing quantities. Scientists have already found microplastics in water, soil, air and even in our food. But we still know very little about the health impacts of the tiny particles on humans and nature.

The Life Blue Lakes Project

While there is already a lot of research on the pollution of the oceans by microplastics, the microplastic pollution of inland waters has only been studied in a few scientific papers so far. There is a need for additional research on the status of inland waters as well as on possible solutions and recommendations for action.

Therefore, the Lake Constance Foundation and the Global Nature Fund, in cooperation with the Italian nature conservation organisation Legambiente and four other partners, have launched the EU Life project "Blue Lakes" on the topic of microplastics in water bodies. In five lake regions in Italy and Germany (Garda, Trasimeno, Bracciano, Lake Constance and Lake Chiemsee), measures on this issue are being implemented with the aim of improving decision-making processes and regulatory framework conditions with regard to microplastics. The issue of microplastics is addressed through an integrated approach of governance, training, technology and monitoring,

Project partners

Italy

- Legambiente Onlus
- Authority of the Central Apennine River Basin District (ABDAC)
- Environmental Protection Agency of Umbria (ARPA UMBRIA)
- Italian National Agency for New Technologies, Energy and Sustainable Economic Development (ENEA)
- Polytechnic University Marche

Germany

- Global Nature Fund
- Lake Constance Foundation

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information and awareness-raising activities for institutions, stakeholders and citizens.

Further information on the project is available at: https://lifebluelakes.eu/en/.

What is microplastic?

Types of microplastics

Microplastics are solid, insoluble synthetic plastic particles consisting of mixtures of polymers and additives. Additives are added to polymers to improve their functional material properties. These can be plasticisers and stabilisers, such as flame retardants, or antioxidants, such as bisphenol-A. Bisphenol-A is suspected of having both ecological and human toxicological endocrine effects, in simple words of being harmful to health (Umweltbundesamt 2016, Waldschläger 2019).

There is no uniform definition of microplastics yet, but most sources define microplastics as particles ranging in size from 0.0001 to 5 mm. Regardless of the type of polymer, microplastics can have different forms (microspheres, pellets, fragments, fibres, films, foams) (Waldschläger 2019). For fibre fragments, the length is also taken into account. Fibres with a length between 300 nm and 15 mm are considered microfibres (ECHA 2020). Some of the researchers assume that portions of the particles of natural rubber are biodegradable. However, whether and under what conditions such degradation processes take place is still controversial and the subject of current research (Baltruschat 2020).

A distinction is made between different types of microplastics. **Primary microplastics** are plastic granulates that are deliberately manufactured and added to a product, e.g. as abrasives in peelings or cleansing products. **Secondary microplastics** are plastic particles that are created by fragmentation of larger plastic parts. On the one hand, this can be plastic waste that becomes brittle through weathering and UV radiation and breaks down into smaller and smaller pieces. Secondary microplastics are also produced by the abrasion of tyres on the road or by washing and wearing synthetic clothing.

Why is microplastic dangerous?

Reports of countless marine animals and seabirds getting caught in old fishing nets and drowning or starving to death with full stomachs because they have swallowed plastic parts are increasing. But not much is currently known about the effects of microplastics in the environment. There are, however, some risks that are increasingly the focus of research. For example, microplastics are long-lasting and persistent and cannot be decomposed by microorganisms and thus have the potential to accumulate in the environment (Fath 2019).

Microplastics start at the bottom of the food chain due to the small size of the particles. It can already be detected in plankton and is ingested by sediment-eating or water-filtering organisms such as mussels, among others. The small, sometimes sharp-edged plastic particles can injure the stomach and intestinal tract or the gills of the organisms, preventing them from feeding. Ultimately, they accumulate in living organisms and in the food chain (bioaccumulation). Furthermore, scientists have found that microplastics can have "behavioural, morphological and reproductive effects on aquatic organisms" (Chen et al. 2020, p.2). Another problem is that animals can mistake macro- and microplastic particles for food. For example, 52 % of the world's sea turtles are thought to carry plastic (Wilcox et al. 2018).

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Another aspect makes microplastics extremely problematic in the environment. Microorganisms can attach themselves to the rough surface of the particles. These can form biofilms in the aquatic ecosystem. These biofilms affect the nitrogen (N) and phosphorus (P) cycles. One study showed that this can accelerate ammonia and nitrite oxidation as well as denitrification, which can lead to oxygen deficiency (Chen et al. 2020). Similarly, gas exchange in oceans can be interrupted by the microplastic and can thus lead to hypoxia (oxygen shortage) (Jepsen u. Bruyn 2019). However, additional research is needed to determine the exact effects (Chen et al. 2020).

In addition, pollutants can attach themselves to the surface of the particles. These can be pathogens or environmental toxins such as pesticides, which first bind to the particles via the input pathways or in water bodies. This cocktail of different chemicals has an incalculable ecotoxic potential. In addition, microplastics are only one of many trace substances detected in the environment that threaten organisms and ecosystems. Microplastics, including all enriched environmental toxins, are passed on through the food chain and eventually end up in fish and thus also on people's plates (Roch 2015).

Researchers at the Australian University of Newcastle have calculated that people consume an average of up to five grams of microplastic per day. That is equivalent to the weight of a credit card.

What health effects microplastics ultimately have on humans has not yet been sufficiently researched. However, there are already studies on the effects of some polymers: During the decomposition processes of the original material in the environment, harmful additives can be released. These can be heavy metals such as zinc or cadmium originally introduced together with the microplastic, but also plasticisers, bisphenol-A (BPA) or other toxic substances. Two polymers frequently used in plastics have a particularly high hazard potential: polyvinyl chloride (PVC) and polycarbonates (PC). PVC consists to a large extent of plasticisers, which make the polymer elastic. However, these can interfere with the hormonal balance of organisms and thus have a negative effect on reproductive ability. PVC is absorbed through breathing, direct contact with the skin, food, cosmetics and pharmaceutical products (BUND 2018). Polycarbonates are produced with the help of bisphenol-A, one of the most widely produced industrial chemicals. Bisphenol-A is a hormone-damaging chemical that can cause prematurity, reduced sperm count, diabetes or immune deficiency. Polycarbonates have already been detected in the air, in house dust, in surface waters as well as on sea surfaces. Ingestion mainly occurs via contaminated food (Further information (in German): https://www.bund.net/fileadmin/user_upload_bund/publikationen/chemie/chemie_achtung_plastik_broschuere.pdf).

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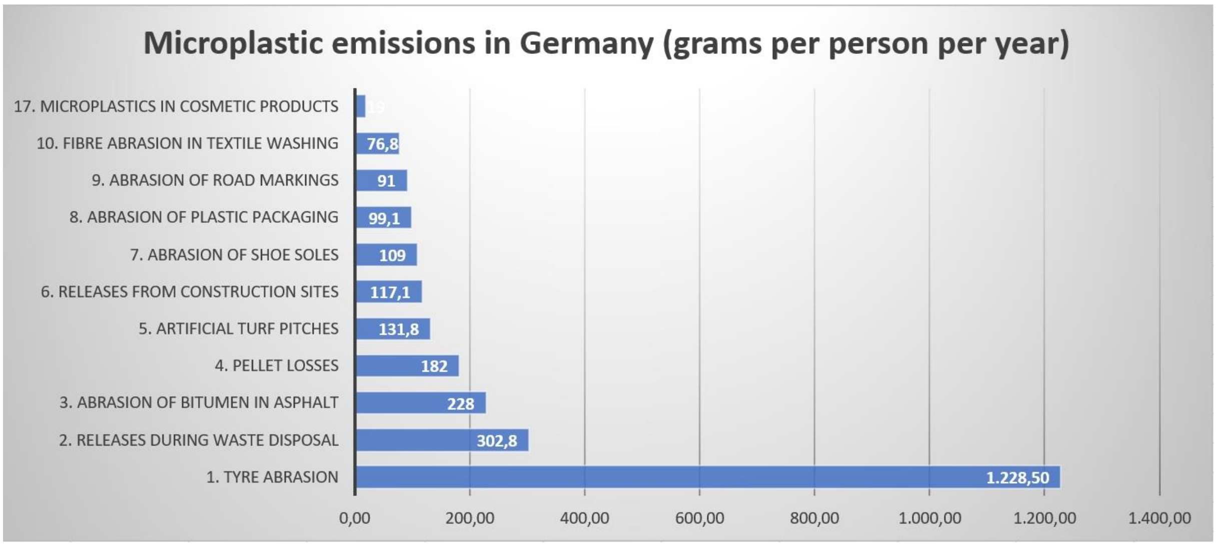
Where does microplastic come from?

There are various sources of microplastics. The following diagram shows the most important sources of microplastics in Germany.



Data source: Consortium study on microplastics (Bertling 2018), Fraunhofer Institute for Environmental, Safety and Energy Technology UMSICHT (own graphic presentation)

Road and tyre abrasion

Tyre abrasion from cars, trucks, bicycles, motorbikes, etc. accounts for by far the largest share of microplastic inputs. In addition, there is the abrasion of bitumen in asphalt and road markings. This is confirmed by a study of the Fraunhofer Institute UMSICHT (Bertling 2018) for microplastic emissions in Germany. On average, around 998 g of these particles are produced per person and year by car tyres, around 89 g by truck tyres, 15.6 g by bicycle tyres and 228 g by the abrasion of bitumen in asphalt. It is interesting that even the abrasion of shoe soles plays a role that should not be underestimated.

Textiles

Although the textile industry rarely uses primary microplastic particles within the production process, the industry has an influence on the formation and distribution of microplastics in the environment (Bertling 2018). The textile industry has been undergoing a change for some time: the share of synthetic fibres, especially in the outdoor industry and sports textiles, is steadily increasing (CIRFS 2021). In order to achieve certain functions (for example, quick dry), various chemicals are added to the fibres. Dyeing or impregnation can also make fibres of textiles made from renewable raw materials (e.g. wool, cotton) difficult to degrade.

When textiles made of synthetic materials are washed, fibre fragments are released and enter the sewage system with the wash water. However, it has been proven that a proportion that should not be underestimated is also released into the air when the textiles are worn (CIA 2020). In Germany, an

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average of about 76.8 g of fibre fragments are emitted per person and year through textile washing (e.g. clothing) and about 66 g through household laundry (towels, dishcloths, etc.) (Bertling 2018).

Cosmetics and detergents

The public is probably most aware of the use of microplastics in cosmetics and cleaning products. The tiny particles are intentionally added here, e.g. as abrasives in toothpaste or scouring agents, as exfoliating particles, binders, film formers and fillers in shampoos, shower gels, creams and decorative cosmetics in a wide variety of sizes and shapes. Since we usually rinse these agents off with water, the microplastics then enter the sewage system directly via local wastewater (BUND 2019). Micro and nano particles in sun creams, which are supposed to protect our skin from sunburn, are washed directly into the water when we swim in a lake or river.

Artificial turf

Artificial lawns are also a source of microplastics that should not be underestimated. In Germany, they represent the fifth largest source of microplastic input into the environment. Among other things, a synthetic turf system consists of an infill layer filled with plastic granules. Since the plastic granules are not firmly attached to the artificial turf, they can get into the surrounding environment under certain weather conditions. Likewise, the granules can stick to the clothes and shoes of the athletes and thus be carried on to households, where they can enter the sewage system. Granules also enter marginal waters or sewers through adjacent asphalted areas (BUND Background 2019). In the study ECHA 2020: "Microplastics as filler for artificial turf fields", Germany was named as the EU's largest source of microplastic discharge into the environment, with a value of 16,000 tonnes per year and an average loss of 500 kg per year per large playing field (BRÜMMER 2021). Concrete recommendations for action as well as organisational and structural changes represent possible solutions to this problem. For example: Proper and regular maintenance of artificial turf surfaces, collection gutters at the edge of the surfaces and brushing-off stations for sports shoes (BRÜMMER 2021; BUND Background 2019). The Scottish environmental organisation Fidra has drawn up concrete recommendations for action for athletes, operators and designers of artificial turf pitches as part of the PITCH project (BRÜMMER 2021). (Further information at: https://www.fidra.org.uk/artificial-pitches/).

Sewage treatment plants

With the rainwater, microplastics from roads and artificial turf surfaces either directly enter the environment or via sewers together with domestic wastewater into sewage treatment plants. Technologies are now available to filter out most of the tiny particles in wastewater treatment plants, but these are not yet widespread. Wastewater treatment plants with so-called fourth or fifth treatment stages can remove some, but still not all such trace substances (BUND 2018). The intention is to expand these technologies, but the costs are still very high (IWW 2021).

Accordingly, it is obvious not only to catch the emissions that have already occurred (end-of-pipe), but also to develop (technological) approaches as quickly as possible to reduce the creation and spread of microplastics as early as the product development stage.

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Agriculture

Even for those microplastics that can be caught by the filters in sewage treatment plants, it is not always guaranteed that they will not be released back into the environment. This is because only a certain proportion of the sewage sludge from the plants is incinerated. Of the total of 1.7 million tonnes of sewage sludge (dry matter) from municipal wastewater treatment plants in Germany in 2017, for example, over 28 % was used as fertiliser in agriculture or landscaping measures (BMU 2017). In a recent study by the Fraunhofer Institute in cooperation with German environmental organisation NABU, plastic emissions to agricultural soils were examined in more detail. The following results are presented in the study: The researchers estimate plastic inputs into agricultural soils in Germany at about 19,000 tonnes per year. Of this, 19 % is caused directly by agriculture, for example in the form of fertilisers, soil conditioners, pesticides or seeds as well as, for example, planting aids, planting containers or irrigation systems. Of the 81 % plastic emissions that arise outside of agriculture, 54 % are spread by sewage sludge, 38 % arise from plastic waste blowing away and a further 8 % come from misthrows and plastic waste in composts. (Bertling et al. 2021). In addition, the use of foils (mulch foils) in agriculture, when growing fruit and vegetables under sheeting, but also through the use of silage foils for animal feed, can release macroplastics into the environment, which can then degrade into microplastics (Brandes 2020, Waldschläger 2019). A study published in 2018, for example, detects 150,000 microplastic particles per hectare in German fields (Piehl 2018). Wind and nearby bodies of water then distribute the microplastics further into the environment (Brandes 2020). What proportion of this ultimately finds its way back into surface waters and groundwater - and thus into our food chain - is still completely unclear at the present time. However, one study found that microplastics in soils have a negative impact on the natural Earth system and can, for example, lead to changes in the primary production of plants or greenhouse gases (Rilling 2020).

Plastic from fisheries management practices

Oceans are often the final destination for plastic. It is therefore important to highlight that plastic waste not only accumulates in lakes and rivers, but ultimately also significantly affects marine ecosystems. Interestingly, a high proportion of plastic in the oceans comes from improper fishing practices. Leftover fishing gear such as lines, ropes or nets pose a massive threat to marine life and ecosystems. The phenomenon of "ghost fishing" refers to fishing materials that are abandoned, lost or intentionally discarded and in which marine animals can then become entangled (Jepsen and Bruyn 2019). However, many scientific articles on the sources of microplastics do not yet clearly highlight fisheries as a significant source of microplastics. What influence inland fisheries have in relation to microplastic emissions to waters is currently unknown.

Measures of the Blue Lakes project in the study areas

So far, there are hardly any adequate monitoring programmes for microplastics in lakes. Experience to date shows that it is useful and necessary to work with a uniform protocol for sampling and analysis methods. In this way, it is possible to collect and assess useful data for the evaluation and management of the phenomenon of microplastics in inland waters. The studies so far showed that microplastics could be detected in all water samples investigated. In order to provide an overview for the project areas of

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"Blue Lakes", the results of already existing studies were combined. However, due to the use of different investigation and evaluation methods, the comparability of the results obtained is very limited.

Lake Chiemsee, Germany

In a pilot study by the Bavarian Federal Office for the Environment 2019 (LfU Bayern 2019), Germany, macroplastics were not found in any of the samples in Lake Chiemsee. However, a slightly higher microplastic load was detected than in other Bavarian lakes investigated in the study. The particles were in the range of 20-300 µm. The load was between 4 and 42 particles/m^3. Polyethylene (PE) and polypropylene (PP) were predominant. The microplastics were almost exclusively present as fragments. Especially the shore sediments showed a high load. In one bay, 124,796 particles/m^3 were detected, mainly PP and PE.

Lake Constance, Germany

In a study conducted by the International Commission for the Protection of Lake Constance (IGKB) in 2020 in Lake Constance, the microplastic load at two measuring points was 0.8 - 2.6 particles/m^3 water volume and thus relatively low compared to other lakes. Polyethylene and polypropylene were detected most frequently (IGKB 2020).

Lake Garda, Lake Trasimeno, Lake Bracciano, Italy

The Italian study lakes, despite different morphological and ecosystem characteristics, indicate that the average concentration of plastic microparticles per km^2 of lake surface has increased in recent years. In Lake Garda, the average concentration of plastic microparticles per km^2 has increased from about 10,000 in 2017 to over 130,000 in 2019. In Lake Trasimeno from 8,000 to 25,000, while in Lake Bracciano it has increased from 117,000 to over 390,000. In all lakes, the predominant form over the three years is fragments from the decay of plastic waste left behind. This is followed by foils (mostly from packaging) in the two central Italian lakes, while fibres (associated with washing clothes) and polystyrene balls (often associated with the decay of boxes and packaging) were found in Lake Garda. The most common type of polymer is polyethylene, which is one of the most common synthetic polymers. The only exception is observed in Lake Garda in 2018, where a relevant presence of polystyrene was found.

LIFE Blue Lakes - Multi-faceted solutions for a multi-faceted problem

Municipalities

In the project regions, the involvement of the neighbouring communities plays an important role. Together, a Lake Paper is to be developed that shows numerous potentials for reducing plastic consumption and microplastic pollution in the communities.

Company

In a participatory process, companies from the tyre, cosmetics and outdoor industries are involved in the search for solutions and alternatives. The consideration of current research approaches plays an important role here.

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Test procedure, standard monitoring protocol and technical protocol

As the topic of microplastics is still relatively new, there is currently a lack of generally accepted, uniform definitions, standards and test procedures. Driven by the scientific partners of the Life Blue Lakes project, a standard protocol for the monitoring of microplastic contamination as well as for the exact recording of the microplastic content in water bodies is to be designed and tested in the two pilot regions of Lake Trasimeno and Lake Bracciano. In essence, the standard protocol serves as a template regarding the format and implementation of a microplastic monitoring programme. In general, plastic waste in freshwater systems is not included in any of the EU freshwater legislation. The European Water Framework Directive (WFD), which came into force in 2000, defines the achievement of good ecological and chemical status as a key environmental objective for surface waters: rivers, lakes, transitional waters and coastal waters. However, it does not contain any specific targets for litter or microplastics in water bodies. Unfortunately, there are also no corresponding management objectives in the river basin management plans and programmes of measures that are currently being drawn up nationwide for the period 2021 to 2027. In the indicative list of the Marine Strategy Framework Directive of 2008 (MSFD 2008), the description of the good status of the marine environment under point 10 states that the properties and quantities of waste in the sea must not have any harmful effects on the coastal and marine environment. The status report on the North Sea states that about 90 % of the litter on the beach and on the seabed of the southern North Sea consists of plastics. The amounts of litter found in the stomachs of fulmars are far above the limit for the North Sea. The proportion of input via rivers was not further specified. From this, the need to monitor the input of waste, including microplastics, can be deduced, at least for the flowing waters that discharge into the sea. It stands to reason to assume that inland lakes have load levels similar to those of the North Sea. In the absence of harmonised monitoring methods at international or European level, guidance on monitoring freshwater litter is needed to provide guidelines for the relevant water quality management authorities and policy frameworks. The process for providing the protocol includes preliminary investigation, planning of monitoring, field monitoring activities and finally laboratory activities. The draft is expected to be ready by the end of 2021, to be tested in a second phase (by April 2022).

The technological side of sewage treatment plants will also be considered in the project in order to filter out microplastics there more efficiently. A technical protocol for reducing the release of microplastics from sewage treatment plants is to be developed, which will initially be applied in a pilot plant at Lake Garda as part of the project. The occurrence and fate of microplastics in the urban water cycle, which includes drinking water production and distribution, the sewage system and wastewater treatment, is a current challenge that needs to be critically analysed in order to plan and take actions and appropriate remedial measures. Both drinking water treatment plants and wastewater treatment plants are not specifically designed to remove emerging micropollutants such as microplastics. But other anthropogenic impacts on the urban water cycle also affect freshwater quality. All these impacts are extremely relevant when surface water is used for drinking water production. Furthermore, a relationship exists between municipal discharges, urban runoff and rainwater entering the sea from the river and lake system. It is therefore important to determine how to reduce the role of the freshwater system as a major source of microplastics in the marine environment.

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Legal framework conditions

At the policy level, the project will also work to adapt legal frameworks to the new challenge of microplastics in order to effectively regulate and reduce the production and use of microplastics and consequently sanction violations. To this end, a White Paper on Lakes will be developed and presented to the relevant authorities (Ministries of Environment, Agriculture, Health, Development, etc.) to advance legislative initiatives to protect lakes from microplastics at national and European level.

Environmental education

Plastic waste production is increasing. An important part of the project is therefore an education campaign for consumers. The aim is to inform them about what each individual can do to reduce consumption and the production of plastic and microplastics.

Initiatives of the European Union

To tackle the plastic problem, the European Commission adopted a Circular Economy Action Plan a year ago. The plan includes 35 initiatives to make products more sustainable. New rules were adopted in the process. The goal is that by 2030 all packaging on the EU market should be reusable or recyclable in an economically viable way. Among other things, a directive was created to promote the avoidance of packaging waste. Likewise, the focus is to be on bio-based plastics that have a benefit for the environment as well as respect the principles of the internal market. In addition, restrictions have been set by the European Chemicals Agency on intentionally added microplastics in products to prevent them from entering the environment. To this end, measures to reduce and methods to measure the unintentional release of microplastics from plastic granules, tyres and textiles have been designed.

A good approach is, for example, the "Plastic Repair System" of a Spanish company that specialises in the repair and maintenance of objects made of plastic. A certified and patented welding method has been developed to transform old plastic objects into new, reusable products. Currently, this method is considered the most efficient in the plastic repair market. In 2019, the company was able to repair more than 100,000 plastic products (around 1,600 tonnes), saving around 7,100 tonnes of CO_2. The system offers a possible solution to reduce macro- and microplastic input into the environment.

More information at: https://ec.europa.eu/environment/awards/newsletters/202104.html

How can microplastics be reduced?

Worldwide, more than 350 million tonnes of plastic are produced every year. Germany is one of the sad leaders in Europe with almost 19 million tonnes (2018). However, consumers can do a lot to reduce plastic and microplastic consumption.

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Approaches

Research and generate knowledge

In general, it should also be important for companies to generate knowledge, i.e. to ensure that the causes of microplastic emissions can be researched further. Even though science, e.g. the research project conducted by the Fraunhofer Institute (Bertling 2018), has already made great progress, the participation of companies in research is still insufficient. This includes, for example, understanding which production processes, materials, processing steps or usage behaviour cause particularly high levels of microplastics, for example through tyre abrasion. But issues such as research into alternative materials are also important. If companies rely on research results, these should nevertheless be thoroughly examined.

Finding solutions together

Researching and tracking sustainability risks can be time-consuming and expensive. A good way to deal with this challenge is to act together with actors who have similar goals. Well-coordinated dialogue processes are a necessity when it comes to initiating sustainability processes. Nevertheless, such exchange formats remain ineffective if they are not used to implement the measures envisaged. Cooperation with environmental organisations, scientists and other actors is almost always useful in order not to lose sight of the goal of sustainability.

Consumer education and concrete recommendations for action

What can each and every individual do?

As part of the Life Blue Lakes project, an interactive information platform was created where consumers can find out what microplastics are and where they come from. Numerous concrete tips show how to reduce plastic and microplastic consumption in everyday life, e.g. when shopping, doing the laundry or in the household. The following link will take you directly to the interactive platform:

https://prezi.com/view/eCPHgok2iMMJYxLwRrDR/

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Contact

Global Nature Fund
Bettina Schmidt
Project manager
Fritz Reichle Ring 4
78315 Radolfzell
schmidt@globalnature.org
www.globalnature.org

Lake Constance Foundation
Dimitri Vedel
Project manager
Fritz Reichle Ring 4
78315 Radolfzell
dimitri.vedel@bodensee-stiftung.org
www.bodensee-stiftung.org

Status: June 2021

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