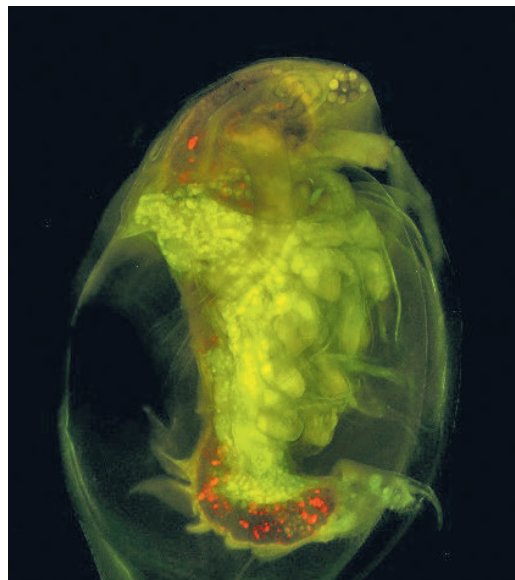


BMBF Research Focus

# Plastics in the Environment

## Sources • Sinks • Solutions

Overview of the Joint Research Projects



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The BMBF Research Focus

# Plastics in the Environment

## Sources • Sinks • Solutions

Plastics in the environment are a global problem and the evidence for this is hard to miss: huge waste deposits are seen in the oceans even in remote areas of the Arctic, plastic particles are found in the stomachs of fish and seabirds, and plastics of all sizes and shapes are clearly visible on almost any beach around the world.

Despite a range of activities and approaches, our knowledge of the full extent of plastic pollution is still limited: there is not enough validated knowledge on the origins of plastics in the ocean, their behaviour in oceans, inland waters and soils, and how they could affect animals and humans.

Germany's Federal Ministry for Education and Research (Bundesministerium für Bildung und Forschung – BMBF) addresses this issue with its current research focus, an initiative called “Plastics in the Environment – Sources • Sinks • Solutions”. The BMBF is thus supporting the transition to a resource and environmentally friendly economy, which is at the heart of the flagship initiative Green Economy within the BMBF-framework

programme “Research for Sustainable Development” (FONA<sup>3</sup>: [www.fona.de/en/](http://www.fona.de/en/)). With this research focus, the BMBF expands on work conducted in previous funding measures, e.g.: the international funding programme investigating microplastics in the oceans (part of JPI OCEANS), the ongoing joint research project “Microplastics in the water cycle” (MiWa) [part of the funding priority Sustainable Water Management], as well as the Social-ecological Junior Research Group PlastX working in this area.

The interdisciplinary nature of the research focus will enable a better understanding of the environmental impacts of plastic waste from river basins all the way to the oceans. The aim of the research is a first and comprehensive scientific assessment of the problem of plastic waste and to fill in existing knowledge gaps. In addition, solutions for reducing the emission of plastics into the environment are identified and implemented. For this purpose, the entire value chain of plastics, from production and use to disposal, is examined in order to identify opportunities for improvement and options for action, especially in an international context.

The spectrum of topics covered by this research focus ranges from the improvement of certain plastic materials with regard to their environmentally compatible degradability, the investigation of entry points into water bodies and the analysis of possible toxic effects on aquatic organisms to strengthening the environmental awareness of consumers. As main end-users and implementers of innovations, companies are involved in the development and realization of research projects right from the beginning.

In the period of 2017–2021, a total of 18 joint research projects and an accompanying scientific project will be funded with around €35 million. More than 100 institutions from science, industry, civil society, and public administration are involved in what is currently the world's largest research focus in the field of the effects of plastic on the environment. The research projects can be structured into five thematic areas, which are aligned along the entire lifecycle of plastics:

1. Green Economy
2. Consumption
3. Recycling
4. Limnic Systems
5. Seas and oceans

This general outline of the research projects shows how diverse and far-reaching the impacts of the plastic problem are and the variety of areas in research, business and society that are affected.

In order to address the various aspects in a targeted manner, approaches are needed in which research institutions cooperate with actors from business, civil society and administration. Following that, other departments and federal authorities can also be supported in developing strategies and measures for a more sustainable use of plastics. To promote the knowledge exchange and networking between the projects as well as to support the use and communication of research results, the accompanying

project PlastikNet was established. Furthermore, a Steering Committee and an Advisory Board are involved in the implementation of the research focus.

The Steering Committee serves the networking between the joint research projects as well as the discussion of general questions. Cross-cutting issues are defined, at which all interested joint research projects work together in the course of the research focus, e.g. in workshops. The six preliminary cross-cutting issues are:

1. Methods for sampling, sample preparation and analysis (incl. reference materials)
2. Evaluation methods of possible effects of plastics on the environment (incl. toxicology)
3. Terms & definitions
4. Social and political dimensions
5. Modelling (incl. life cycle assessment and data management)
6. Recycling / product design

In addition, joint activities are planned for the use and practical implementation of the project results and for public relations work. The Steering Committee is composed of the coordinators of all 18 joint research projects. Representatives of the BMBF, the project management agency and PlastikNet also take part in the semi-annual meetings.

The Advisory Board is organised under the leadership of the BMBF and includes important actors from the federal government, state governments, local authorities, industry, associations and civil society. The task of the Advisory Board is to link scientists from the research focus with stakeholders from industry, politics, society and administration as well as to disseminate the results. The Board thus serves on the one hand to multiply the results, i.e. transfer them to relevant institutions and political processes, and on the other hand, to inform the research projects with developments from practice.

# Research Sites of the Joint Research Projects

## Thematic area GREEN ECONOMY

### RAU

- 1 Empirical studies on tire abrasion
- 2 Identification of potential inputs through sampling road runoff, road sweepings and air particles at various locations in Berlin

**Coordination:** Prof. Dr.-Ing. Matthias Barjenbruch, Technical University of Berlin

### TextileMission

- 3 Conducting household laundry and wear tests
- 4 Particle quantification and laboratory wastewater treatment tests

**Coordination:** Nicole Espey, Federal Association of the German Sporting Goods Industry (BSI) e.V., Bonn

## Thematic area CONSUMPTION

### VerPlaPoS

Living lab for consumer decisions

**Coordination:** Dr. Thomas Decker, Stadt Straubing

### PlastikBudget

- 6 Development of plastic emission budget and LCA for plastic emission governance (Germany)

**Coordination:** Jürgen Bertling, Fraunhofer Institute for Environmental, Safety, and Energy Technology UMSICHT

## Thematic area RECYCLING

### ResolVe

- 7 Laboratory testing
- 8 Pilot plant

**Coordination:** Dr. Hannes Kerschbaumer, INEOS Styrolution Group GmbH, Frankfurt am Main

### KuWert

- 9 On-site analyses and workshops
  - 10 On-site analyses and workshops
- Coordination:** Dipl.-Ing. Christoph Rasewsky, TECHNOLOG Service GmbH, Hamburg

### MaReK

- 11 Pilot plant (sorting machine)
  - 12 Environmental impact assessments
- Coordination:** Prof. Dr.-Ing. Claus Lang-Koetz and Prof. Dr.-Ing. Jörg Woidasky, Pforzheim University, Institute of Industrial Ecology

### solvoPET

- 13 Solvolysis in the pilot plant

**Coordination:** Dipl.-Kfm. Carsten Eichert, RITTEC Umwelttechnik GmbH, Lüneburg

## Thematic area LIMNIC SYSTEMS

### RUSEKU

- 14 Laboratory infrastructure
- 15 Degradation plants
- 16 Running water simulation system and lysimeter
- 17 Laboratory infrastructure/ pilot plant
- 18 Laser process plants/analytix
- 19 Infrastructure/calculation capacities for simulations
- 20 Sampling strategies in the wastewater system

**Coordination:** Dr. Ulrike Braun, Federal Institute for Materials Research and Testing (BAM), Berlin

### SubuTrack

- 21 Analyses for the entry of microplastic from combined sewer relief systems and rainwater overflows

**Coordination:** Prof. Dr. Jörg E. Drewes, Technical University of Munich

### PLASTRAT

- 22 Experiments on the analysis and elimination of microplastic on waste water treatment plants
- 23 Analysis of the entry of microplastic from rain relief systems
- 24 Investigations on combined sewer relief systems

**Coordination:** Prof. Dr.-Ing. Christian Schaum, Bundeswehr University Munich

### EmiStop

- 25 Test series
- 26 Investigation of wastewater flows on microplastic

**Coordination:** Dr. Eva Gilbert, EnviroChemie GmbH, Rossdorf

### MicBin

- 27 Measuring campaigns for balancing the entries of plastic

**Coordination:** Dr. Nicole Zumbülte, DVGW – Water Technology Centre, Karlsruhe

### MikroPlaTaS

- 28 Mesocosm test facilities
- 29 Various tests and analyses

**Coordination:** PD Dr. Katrin Wendt-Potthoff, Helmholtz Centre for Environmental Research GmbH, Leipzig

### REPLAWA

- 30 Inventory of entry points into the water body
- 31 Effects of irrigation with treated wastewater and use of sewage sludge in agriculture

**Coordination:** Prof. Dr.-Ing. Holger Scheer, Emscher Wassertechnik GmbH, Essen

### ENSURE

- 32 Dismantling tests of a new plastic in a fermentation plant
- 33 Sampling in wastewater treatment plants
- 34 UAV experiments at the Leibniz Institute of Agricultural Engineering and Bioeconomics e.V. (ATB), Marquardt experimental site
- 35 Experimental areas at the agricultural cooperative
- 36 UBA river and pond simulation facility

**Coordination:** Prof. Dr. rer. nat. habil. Marc Kreutzbrück, University of Stuttgart

## Thematic area SEAS AND OCEANS

### PLAWES

- 37 Modelling and cross-system consideration of microplastic contamination in the Weser-Wadden Sea National Park system

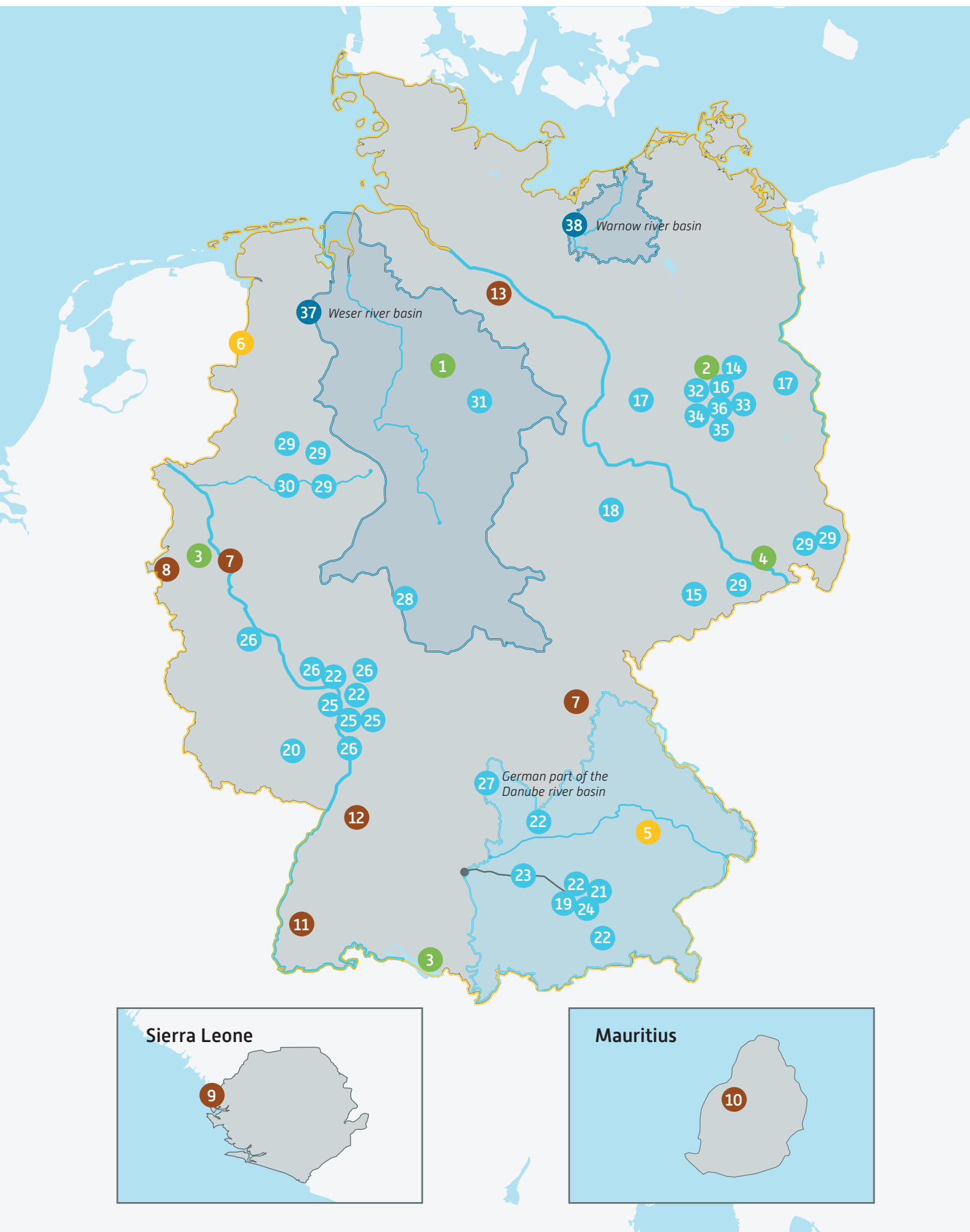
**Coordination:** Prof. Dr. Christian Laforsch, University of Bayreuth

### MicroCatch\_Balt

- 38 Sampling and investigation of the Warnow river basin for sinks and sources of microplastic

**Coordination:** PD Dr. Matthias Labrenz, Leibniz Institute for Baltic Sea Research, Warnemünde





## Tire Abrasion in the Environment

### Coordinator

*Prof. Dr.-Ing. Matthias Barjenbruch*

**Technical University of Berlin,**

**Institute for Civil Engineering,**

**Faculty VI Planning Building Environment,**

**Institute of Civil Engineering,**

**Chair of Urban Water Management /**

**TUB FG Siwawi**

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tu-berlin.de

### Partner institutions

» Technical University of Berlin,  
FG System Dynamics and Friction  
Physics / TUB FG Reibung

» Continental Reifen  
Deutschland GmbH / Continental

» GKD – Gebr. Kufferath AG / GKD  
Ingenieurgesellschaft  
Prof. Dr. Sieker mbH / IPS

» WESSLING GmbH / WESSLING

### Associated partners

- » ADAC e.V. / ADAC
- » Berliner Stadtreinigung / BSR
- » Berliner Wasserbetriebe / BWB
- » Volkswagen AG / VW
- » ORI Abwassertechnik GmbH  
& Co. KG / ORI

### Website

[www.siwawi.tu-berlin.de/menue/  
forschung/rau/parameter/en/](http://www.siwawi.tu-berlin.de/menue/forschung/rau/parameter/en/)

### Short description

Plastics in the environment are an increasingly serious challenge. As macroplastics deteriorate, such as through tire abrasion, the resulting microplastics can enter the aquatic environment through a variety of entry points. As vehicle traffic increases, there is an inevitable increase in microplastics from worn tires ending up in the environment. The amount of tire abrasion and the resulting microplastics entering the aquatic environment via road runoff have not yet been researched.

The joint research project RAU seeks to address this and will comprehensively describe tire particles throughout the useful service life of tires, closing the knowledge gaps on where particle loss occurs over the entire life cycle. The goal is to identify and assess the entry points of tire materials into the aquatic environment and to develop reduction measures. RAU will then verify selected measures for reducing the emission of tire material into the aquatic environment. On the basis of various influencing factors, an evaluation matrix will be developed for deriving the most suitable measures to reduce tire abrasion in different locations.

### Key areas of work

- » Development of a sampling basket for fractional sampling of individual rain events
- » Analytical evaluation of environmental samples for tire abrasion
- » Measurement of abrasion, quantification of subsets and subsequent qualitative examination
- » Further development of the pollution load simulation
- » Optimise the street cleaning



## Work packages

### WP 1.1

#### Analytical concept

##### **Contact person**

*Dr. Jens Reiber*, WESSLING GmbH, Oststraße 6,  
48341 Altenberge, e-mail: jens.reiber@wessling.de

##### **Project partners**

TUB FG Siwawi, Continental, GKD

##### **Short description**

The goal is to develop, implement and evaluate analysis concepts including chemical and physical methods to identify and quantify tire abrasion particles in road runoff, road sweepings and as air-borne particles. The sample preparation of aqueous and solid samples is particularly important. Due to the different compositions, the analysis concept should allow for determining the quantities and emissions into the environment, both in total and in part for individual groups of substances. This will be done using one or more defined control parameters.

### WP 1.2

#### Sampling concept

##### **Contact person**

*Prof. Dr.-Ing. Matthias Barjenbruch*, Technical University of Berlin, Faculty VI – Planning Building Environment, Institute of Civil Engineering, Chair of Urban Water Management, Gustav-Meyer-Allee 25, 13355 Berlin, e-mail: matthias.barjenbruch@tu-berlin.de

##### **Project partners**

Wessling, IPS, GKD, Continental, BWB

##### **Short description**

Environmental samples will be systematically obtained from road runoff, road sweepings and air, in such amounts that reproducible analysis can be carried out. For all tests, a sampling concept will be prepared in advance by the partners mentioned. As part of the sampling concept, a sampling area-dependent data collection plan was created. The sampling concept for the in situ measurement of the different catchment areas takes into account up to 30 rain events per year and a variety of measurement points. The challenge is to sample individual rain events and evaluate the runoff quantities.

### WP 1.3

#### Development of the sampling basket

##### **Contact person**

*Dipl.-Ing. Markus Knefel*, GKD – Gebr. Kufferath AG, Metallweberstraße 46, 52353 Düren, e-mail: markus.knefel@gkd.de

##### **Project partners**

Wessling, IPS, GKD, Continental, BWB

##### **Short description**

Tire abrasion particles will be collected from road run-off water in a targeted manner. For this purpose, GKD will design a sampling basket for street drains that allows fractional sampling of a rain event directly in the drainage shaft using defined mesh sizes (lower separation limit  $\leq 10 \mu\text{m}$ ).

Initially, development will be carried out virtually by creating various geometries and simulation models, on the one hand, to find an ideal flow path and, on the other hand, to ensure fractionation of the collected particles. The most promising design will then be realized in GKD's in-house filter construction facility. Below the sampling basket, an explosion-proof measurement technology from ORI will be implemented which records the flow rate data and transmits it wirelessly via GPRS. The function of the sampling basket will be verified under defined conditions at the test stand (FG Urban Water Management). The sampling basket will be examined with regard to its potential as a decentralised treatment plant for street drains. An appropriate backwashing device for the sampling basket will then be developed.

## WP 1.4

### **Analytical evaluation of the methodology and routine analysis**

#### **Contact person**

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#### **Project partner**

Continental

#### **Short description**

The samples taken by WESSLING and provided by the partners (road runoff, road sweepings, air particles) will be analysed according to the agreed and implemented analysis and sampling concept and through statistical evaluation. A significant amount of data will be generated for this purpose.

## WP 2.1

### **Production, use, recycling/recovering/disposing**

#### **Contact person**

*Prof. Dr.-Ing. Matthias Barjenbruch*, Technical University of Berlin, Institute for Civil Engineering, Faculty VI – Planning Building Environment, Institute of Civil Engineering, Chair of Urban Water Management, Gustav-Meyer-Allee 25, 13355 Berlin, e-mail: matthias.barjenbruch@tu-berlin.de

#### **Project partner**

Continental, TUB FG Reibung, ADAC

#### **Short description**

The goal is to prepare a literature study and evaluation of existing data from Continental on the tire's life cycle. The study will enable the assessment of the input of tire particles into the environment throughout the product life cycle. On a theoretical basis, gaps in knowledge on losses of tire particles in production, use and recycling/recovering/disposal are to be closed.

## WP 2.2

### **Identification of the influencing factors in the use phase**

#### **Contact person**

*Prof. Dr. Valentin Popov*, Technical University of Berlin, Faculty V of Mechanical Engineering and Transport Systems, Institute of Mechanics, Department of System Dynamics and Friction Physics, Straße des 17. Juni 135, 10623 Berlin, e-mail: v.popov@tu-berlin.de

#### **Project partner**

Continental, TUB FG Siwawi, ADAC, VW, IPS

#### **Short description**

The aim is to theoretically identify the influencing variables on abrasion quantities throughout the service life of the tire such as climate, road surface, speed, acceleration, braking behaviour, vehicle class and weight. The Department of System Dynamics and Friction Physics will conduct wear experiments and examine the resulting particles microscopically to generate reference points for theoretical analysis.

#### **WP 2.3**

##### **Laboratory abrasion test stand**

#### **Contact person**

*Dr. Frank Schmerwitz*, Continental Reifen Deutschland GmbH, Jädekamp 30, 30419 Hannover, e-mail: frank.schmerwitz@conti.de

#### **Project partner**

TUB FG Reibung

#### **Short description**

Wear mechanisms and rates will be determined through laboratory testing. For this purpose, tests are conducted for the following variables: six tread compounds, three loads, three temperatures, two lanes. The samples will be measured by the TUB FG Reibung.

#### **WP 2.4**

##### **Test drives**

#### **Contact person**

*Dr. Frank Schmerwitz*, Continental Reifen Deutschland GmbH, Jädekamp 30, 30419 Hannover, e-mail: frank.schmerwitz@conti.de

#### **Project partner**

TUB FG Siwawi, TUB FG Reibung, VW

#### **Short description**

The wear rates of the tires will be estimated depending on the driving dynamics. For this purpose, driving tests will be conducted on a Continental test track with the developed sampling basket installed on the test track. Continental will plan and carry out the tests together with the VW Department of Vehicle Dynamics and the TUB.

#### **WP 3.1**

##### **Investigations test stand**

#### **Contact person**

*Prof. Dr.-Ing. Matthias Barjenbruch*, Technical University of Berlin, Institute for Civil Engineering, Faculty VI - Planning Building Environment, Institute of Civil Engineering, Chair of Urban Water Management, Gustav-Meyer-Allee 25, 13355 Berlin, e-mail: matthias.barjenbruch@tu-berlin.de

#### **Project partner**

IPS

#### **Short description**

The goal is to describe the tire abrasion behaviour by conducting rinsing tests at a special test stand of FG Urban Water Management for different rain intensities and road surfaces. For these tests, the existing test stand for simulating different rain events of the FG will be equipped with an irrigation section specifically adapted for this project and different road surfaces will be integrated. These are loaded with tire abrasion particles and road sweepings and drained via a road drainage shaft. The whole test material can be separated again at the outlet via sieves. The runoff behaviour in the gutter and in the road drainage shaft can already be simulated on the test stand; the corresponding test materials will be added to the water flow in the gutter via metering units. Only with the additional irrigation unit consisting of atomisation and different road surfaces, can the removal behaviour be investigated and described in terms of area.

## WP 3.2

### Road investigation

#### **Contact person**

*Prof. Dr.-Ing. Matthias Barjenbruch*, Technical University of Berlin, Institute for Civil Engineering, Faculty VI - Planning Building Environment, Institute of Civil Engineering, Chair of Urban Water Management, Gustav-Meyer-Allee 25, 13355 Berlin, e-mail: matthias.barjenbruch@tu-berlin.de

#### **Project partner**

BSR

#### **Short description**

The aim is to describe the waste matrix of the road through sweeping tests and to estimate the input potential for substances in the road runoff. The FG Urban Water Management will continuously carry out sweeping tests on a defined area (approx. 40 m<sup>2</sup>) on the test track Clayallee (main road). In addition to the manual sweeping samples, samples will be collected by a small road sweeper from BSR.

## WP 3.3

### In situ measurement sampling basket

#### **Contact person**

*Prof. Dr.-Ing. Matthias Barjenbruch*, Technical University of Berlin, Institute for Civil Engineering, Faculty VI - Planning Building Environment, Institute of Civil Engineering, Chair of Urban Water Management, Gustav-Meyer-Allee 25, 13355 Berlin, e-mail: matthias.barjenbruch@tu-berlin.de

#### **Project partner**

GKD, IPS, BWB, Continental

#### **Short description**

The developed sampling basket will be used for street drains from a main road, side road, motorway, parking lot, airport and the Contidrom,

Continental's tire test facility. It may be possible to study an airport within Berlin, else an external airport will be used. Important decision criteria are the number of take-offs and landings as well as the size classes of the certified aircrafts. Sampling baskets are installed in the selected rainwater drains and in the event of a rain event, a notification will be automatically sent from the sampling point to the FG Urban Water Management and the quantities of rainwater flowing through the basket. This makes it possible to estimate the rain event and initiate the necessary transport of the samples.

## WP 3.4

### Air measurement

#### **Contact person**

*Dr. Jens Reiber*, WESSLING GmbH, Oststraße 6, 48341 Altenberge, e-mail: jens.reiber@wessling.de

#### **Project partner**

TUB FG Siwawi

#### **Short description**

The goal is to determine concentrations of airborne tire abrasion particles at the locations of WP 3.3 with the aid of mobile air sampling units (MVS - Medium Volume Sampler). The air measurements shall serve as a benchmark, therefore only random samples are planned. As part of the site selection for the road run-off drain sampling, the possibility to use existing infrastructures for fine dust measurements will also be checked.

## WP 4.1

### Street cleaning analysis

#### **Contact person**

*Dr. Harald Sommer*, Ingenieurgesellschaft Prof. Dr. Sieker mbH, Rennbahnallee 109A, 15366 Hoppegarten, e-mail: h.sommer@sieker.de



**Project partner**

BSR, TUB FG Siwawi

**Short description**

The effectiveness of street cleaning will be analysed focusing on the mechanical treatment of roads as well as walking and cycling paths. Vehicle types such as street washing vehicles, truck-mounted sweeping and small sweeping machines are used, which are prepared before each project-related use in order to prevent carry-over of sample material. After recording and examining the accumulated pollutants on the surface, conclusions can be drawn as to the effectiveness of street cleaning. This effectiveness is expected to be significantly influenced by the vehicle types used and the corresponding cleaning methods (wet/dry), the variability of the examination areas, the cleaning intervals, driving speeds and other various settings of the vehicle's technology. Cleaning services for different weather conditions will be investigated and their potential for improvement recorded and described.

**WP 4.2****In situ measurement of road drains****Contact person**

*Prof. Dr.-Ing. Matthias Barjenbruch*, Technical University of Berlin, Institute for Civil Engineering, Faculty VI - Planning Building Environment, Institute of Civil Engineering, Chair of Urban Water Management, Gustav-Meyer-Allee 25, 13355 Berlin, e-mail: matthias.barjenbruch@tu-berlin.de

**Project partner**

BSR, IPS, BWB

**Short description**

In the existing test section of the Clayallee (Berlin Steglitz-Zehlendorf) the FG Urban Water Manage-

ment will examine wet sludge traps with and without coarse material buckets. When sampling the wet sludge traps, the entire sludge trap volume will be pumped out and then a corresponding aliquot sample will be collected.

**WP 5.1****In situ measurement of road drains****Contact person**

*Dr. Harald Sommer*, Ingenieurgesellschaft Prof. Dr. Sieker mbH, Rennbahnallee 109A, 15366 Hoppegarten, e-mail: h.sommer@sieker.de

**Project partner**

BSR, IPS, BWB

**Short description**

The goal is to prepare and carry out pollution load simulations with the hydrological pollution load model STORM-SEWSYS. The model takes into account the accumulation of the emissions and the influence of rain events on the erosion for the calculation of particles entering into the sewer system. STORM-SEWSYS will be extended and adapted for use as part of the project. In addition to freight generation on the basis of DTV (Daily Traffic), approaches for freight generation at load points and road sections with different section characteristics, which are simulated during tire tests, are being developed. The load values correlate with the tire abrasion at the respective load points. This is integrated into SEWSYS via a load factor to be developed and parameterised for practical use. The further developed model will be tested using a sample area. The findings from BSR's street cleaning services are also going to be incorporated here. For the transfer to the investigated catchment areas, the hydrological pollution load models utilise an adapted model.

## WP 5.2

### **Potential estimation of de-/central rainwater treatment plants**

#### **Contact person**

*Dr. Harald Sommer*, Ingenieurgesellschaft Prof. Dr. Sieker mbH, Rennbahnallee 109A, 15366 Hoppegarten, e-mail: h.sommer@sieker.de

#### **Project partner**

TUB FG Siwawi, BWB

#### **Short description**

The aim is the integration and parametrization of decentralised treatment plants, such as filter inserts in road drainage shafts, rain clarifiers and retention soil filters in SEWSYS. The existing data for reducing the AFS/AFS63 content of technical treatment systems (decentralised/centralised) are used to estimate the retention potential for tire particles. For this purpose, the systems are integrated into the created models by IPS with STORM for specific catchment areas. An estimate of the cleaning performance of decentralised treatment plants should be made mainly with regard to AFS63 as a sum parameter. Conclusions on the retention of tire abrasion can then be drawn from the pro-

portions of the corresponding fractions determined in the project. The model created in WP 5.1 is used to simulate the catchment areas. The estimation of the potential of the plants is based on the results of existing research projects and the measurements within the framework of the RAU research project.

## WP 6

### **Establishment of the set of measures and evaluation tool**

#### **Project partners**

all

#### **Short description**

Based on the data and findings gained in the project, an initial recommendation for action (evaluation tool) and a catalogue of measures will be developed. For this purpose, the generated data sets will be scientifically analysed. The analysis is the basis for the evaluation of potential depressions of tire abrasion in the system of roadway and run-off drainage shafts and for the preparation of the set of measures. Important transfer variables are mass balance, particle size distribution and chemical properties.

Project partner	Main areas of work
Continental Reifen Deutschland GmbH <i>Dr. Frank Schmerwitz</i>	» Empirical studies on tire abrasion throughout the service life of the tire
GKD – Gebr. Kufferath AG <i>Markus Knefel</i>	» Development of a sampling basket for the in situ sampling of rain events on roads
ORI Abwassertechnik GmbH & Co. KG <i>Jörg Bödecker</i>	» Development of measurement technology for the sampling basket for in situ sampling of rain events on roads
Ingenieurgesellschaft Prof. Dr. Sieker mbH <i>Dr. Harald Sommer</i>	» Evaluation of the input of tire abrasion particles into the environment by simulation and potential estimation
WESSLING GmbH <i>Dr. Jens Reiber</i>	» Development of an analysis concept for the parameter tire abrasion from environmental samples
Technical University of Berlin <i>Prof. Dr.-Ing. Matthias Barjenbruch</i> <i>Prof. Dr. Valentin Popov</i>	» Basics, empirics and in situ investigations on tire abrasion in the environment
Associated partners	Main areas of work
Berliner Stadtreinigung <i>Björn Weiß</i>	» Optimisation of street cleaning as an avoidance measure
ADAC <i>Michael Niedermeier</i>	» Perspective of the consumer
VW <i>Dr.-Ing. Felix Kallmeyer</i>	» Support in the field of driving dynamics
Berliner Wasserbetriebe <i>Regina Gnirss</i>	» Expertise and infrastructure

# TextileMission

## Microplastics of Textile Origin – A Holistic Approach: Optimised Processes and Materials, Material Flows and Environmental Behaviour

### Coordinator

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### Partner institutions

- » Niederrhein University  
of Applied Sciences
- » Technical University of Dresden
- » Vaude Sport GmbH & Co. KG
- » WWF Germany
- »

### Associated partners

- » Adidas AG
- » Henkel AG & Co. KGaA
- » Miele & Cie. KG
- » Polartec LLC

### Website

[www.textilemission.bsi-sport.de](http://www.textilemission.bsi-sport.de)

### Short description

Textiles made of synthetic fibres can lose microparticles during household washing, which can then enter rivers, lakes and oceans. The goal of Textile-Mission is to reduce the related environmental impact. The project is pursuing an interdisciplinary approach with partners from the Sport Goods Industry, research, the detergent and household appliance sectors, and environmental protection. On the one hand, sport and outdoor textiles with significantly lower microplastic emissions than at present will be developed through textile technology research and the optimisation of production processes. Textile researchers and the sportswear manufacturers involved are also testing biodegradable fibres as an environmentally friendly alternative. With the support of the WWF, care is taken to ensure that other aspects of sustainability are considered. On the other hand, a contribution will be made to optimise wastewater treatment plant technology. Practical innovations at this level could also help to reduce microplastic inputs from non-textile sources. In parallel, data on the extent and range of microparticle emissions from different textiles are systematically collected through tests of washing and laboratory wastewater treatment plants to improve the understanding of the respective material flows.

### Main areas of work

- » Status quo analysis: the microplastic output of marketable textiles
- » Wastewater treatment plant technology: the retention capacity of different cleaning or purification steps
- » Holistic perspective: sustainability aspects of alternative materials
- » Textile research: biodegradable materials and new cutting and processing possibilities
- » Product development: production and testing of prototypes



## Work packages

### WP 1

#### **Project management, communication and project-related research**

##### **Contact person**

*Nicole Espey*, Federal Association of the German Sporting Goods Industry e.V., Adenauerallee 134, 53113 Bonn, e-mail: nicole.espey@bsi-sport.de

##### **Short description**

The Federal Association of the German Sport Goods Industry e.V. (BSI) will coordinate the project and is responsible for public relations in consultation with the WWF. In addition to maintaining the website and sending out press releases, this also includes organising multi-stakeholder events. The BSI will conduct a study on the spread of microparticles and the polyester-based microparticle emissions associated with household laundry and collect data on the annual emissions of textile polyester microparticles. Moreover, recommendations will be given on how new materials, manufacturing processes, optimised wastewater treatment plant technology, etc. can help to sustainably reduce microparticle emissions.

### WP 2

#### **Development of textile structures for sports and outdoor applications with reduced particle emission in textile washing and based on biodegradable polymers**

##### **Contact persons**

*Prof. Dr. Maike Rabe and Prof. Dipl.-Des. Ellen Bendt*, Niederrhein University of Applied Sciences, Faculty of Textile and Clothing Technology, Research Institute for Textile and Clothing, Reinartzstraße 49, 47805 Krefeld, e-mail: maike.rabe@hs-niederrhein.de

##### **Short description**

Starting with a status quo analysis, the risk of microparticle emissions from textiles during household laundry will be determined in cooperation with the Technical University of Dresden and the BSI. For this purpose, standard articles from German households, problem articles made of fleece and "top sellers" from the industrial partners involved are washed to quantify the microparticles released. Another focus lies on the development of alternative materials, cutting and processing possibilities. For this purpose, low-emission construction, processing and finishing methods are researched and materials made of or in combination with biopolymers are produced. Finally, as a recommendation for the textile industry, a method for predicting the emission risk of newly developed textile articles will be presented.

### WP 3

#### **Microplastics of textile origin – A holistic approach: optimised processes and materials, material flows and environmental behaviour**

##### **Contact person**

*Hilke Anna Patzwall*, VAUDE Sport GmbH & CO. KG, VAUDE Straße 2, 88069 Tett nang, e-mail: hilke.patzwall@vaude.com

##### **Short description**

The outdoor clothing specialist VAUDE will provide materials and finished products for status quo analysis and assist in the selection of other test materials and products. Niederrhein University of Applied Sciences will develop new materials and construction methods to be tested in coordination with the partners.

# TextileMission

After passing the performance test, the materials will then be assembled into prototypes.

The knowledge gained during the manufacturing process will in turn be reflected into the research network – here the question is about i.a. the processability of the materials using conventional sewing machines, among other things.

## WP 4

### **Polyester fibres: Reduction of microparticle release and material flow analysis in the environment**

#### **Contact person**

*Prof. Dr. Stefan Stolte*, Technical University of Dresden, Institute of Water Chemistry, Chair of Hydrochemistry and Water Technology, 01062 Dresden, e-mail: stefan.stolte@tu-dresden.de

#### **Short description**

At the TU Dresden, an analysis and sample preparation method is established that makes it possible to quantify microparticles from wastewater streams and fractionate them according to size. In addition, the researchers will investigate the retention capacity of textile (fluorescence-labelled) microparticles in the different stages of a laboratory wastewater treatment plant and identify efficient retention possibilities. Material flows are analysed including a first estimate of the Germany-wide textile microplastic emission from wastewater into water bodies /soils is made. In addition, biopolymer-based microplastics (obtained from washing tests with alternative materials at the Niederrhein University of Applied Sciences) will be tested according to their environmental stability to derive design proposals.

## WP 5

### **Consideration of other environmental issues related to the project, stakeholder involvement and communication at the end of the project**

#### **Contact person**

*Dr. Bernhard Bauske*, WWF Germany, Kaiserstraße 70, 60329 Frankfurt  
e-mail: bernhard.bauske@wwf.de

#### **Short description**

Throughout the course of this project, WWF Germany will ensure that sustainability aspects are taken into account even though they are not directly linked to the topic of microplastics. WWF will conduct a study about possible areas of tension that may arise with alternative fibres made of bio-based plastics and wood. For example, the cultivation of textile raw materials vs. cultivation of foodstuffs. Another study will focus on the retention of textile microfibre particles through various purification stages in wastewater treatment plants. At the same time, the WWF wants to involve important stakeholders from NGOs, consumer associations and academia in the project.

#### **Associated partners and their contributions:**

**adidas AG** will provide materials and finished products for status quo analysis and assist in the selection of additional test materials and products. The sporting goods manufacturer will examine the newly developed materials at the Niederrhein University of Applied Sciences, University of Applied Sciences for general marketability and participate in the production and testing of prototypes. The company will also support the BSI in its press and public relations work.

**Henkel AG & Co. KGaA** will advise the Niederrhein University of Applied Sciences on the construction of the test bench. The company will also support household laundry and wearing test by contributing its expertise on typical household washing and drying parameters.

**Miele & Cie. KG** will provide the Niederrhein University of Applied Sciences with four household washing machines for the course of the project. In cooperation with Henkel AG & Co. KGaA, the washing machine manufacturer will accompany

the household laundry tests and support the modification of the washing processes with its expertise.

**Polartec LLC:** The world's largest fleece manufacturer Polartec LLC will support the project with its expertise in the production of fleece and provide standard products for comparisons. In addition, materials developed by the Niederrhein University of Applied Sciences will be prototyped and tested for scalability at the Polartec production sites.

Project partners	Main areas of work
Federal Association of the German Sport Goods Industry e.V. <i>Nicole Espey</i>	<ul style="list-style-type: none"> <li>» Project coordination/communication</li> <li>» Data analysis for the annual output of textile polyester microparticles</li> </ul>
Niederrhein University of Applied Sciences, Faculty of Textile and Clothing Technology, Research Institute for Textiles and Clothing <i>Prof. Dr. Maike Rabe, Prof. Dipl.-Des. Ellen Bendt</i>	<ul style="list-style-type: none"> <li>» Status quo analysis of the microplastic output of synthetic textiles</li> <li>» Development of alternative materials, cutting and processing techniques</li> </ul>
VAUDE Sport GmbH & CO. KG <i>Hilke Anna Patzwall</i>	<ul style="list-style-type: none"> <li>» Supply of materials and finished products for status quo analysis</li> <li>» Testing alternative materials for scalability and packaging of prototypes</li> </ul>
Technical University of Dresden, Institute of Water Chemistry, Chair of Hydrochemistry and Water Technology <i>Prof. Dr. Stefan Stolte</i>	<ul style="list-style-type: none"> <li>» Investigation of the retention capacity of different cleaning steps of a wastewater treatment plant</li> <li>» Test of the biodegradability of alternative materials</li> </ul>
WWF Germany <i>Dr. Bernhard Bauske</i>	<ul style="list-style-type: none"> <li>» Scientific studies on the sustainability of alternative fibres, materials and the status quo of the retention capacity of wastewater treatment plants</li> <li>» Involvement of stakeholders from areas such as environment and water management</li> </ul>

## Development of New Plastics for a Clean Environment with Determination of Relevant Entry Points

### Coordinator

*Prof. Dr. habil. Marc Kreutzbruck*

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**Institute for Plastics Technology / IKT**

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### Partner institutions

- » Federal Environmental Agency / UBA
- » Federal Institute for Materials  
Research and Testing / BAM
- » Helmholtz Centre Potsdam – German  
Research Centre for Geosciences / GFZ
- » Technical University of Berlin / TUB
- » Osnabrück University, Institute of  
Environmental Systems Research / IUSF
- » Institute for Advanced  
Sustainability Studies / IASS

### Associated partners

- » BASF SE
- » Herrmann Ultraschalltechnik  
GmbH & Co. KG
- » Berliner Stadtreinigungsbetriebe / BSR
- » Berliner Wasserbetriebe / BWB
- » Hamm-Lippstadt University  
of Applied Sciences / HSHL

### Website

[www.ensure-project.de](http://www.ensure-project.de)

### Short description

The goal of this project is to develop plastics with environmentally optimised decomposition behaviour, which can degrade faster and in a more eco-friendly manner while maintaining the same stability. Furthermore, innovative methods are developed for (i) the quantification and characterisation of recent sources and sinks in the terrestrial sector, ii) the biological degradation of relevant plastics, and iii) the analysis of social perceptions and behaviour patterns.

### Main areas of work

- » Characterisation of relevant sources and sinks as well as area coverage in the terrestrial / semi-terrestrial range [“Traceability”]
- » Development of environmentally-friendly plastics
- » Investigation of the physical, chemical and biological stability of environmentally relevant plastics and testing of novel plastics through demonstration and practical tests [“Optimisability”]
- » Investigation of the effect of plastics on soil meso- and microfauna and on the biodegradability of plastics in substrates [“Degradability and environmental compatibility”]
- » Using transdisciplinary research practices as a basis for developing actor-related strategies to promote sustainable use of plastic products [“Perception and behaviour”]



## Work packages

### WP 1

#### Traceability

##### **Contact person**

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gerhard.bannick@uba.de

##### **Project partners**

University of Stuttgart IKT, UBA

##### **Short description**

In the "Traceability" module, undesirable plastic inputs in prioritised sectors (soils, wastewater treatment plants, composting plants and biogas plants) are detected and identified. In a first step, sampling strategies are developed so that in a second step representative investigations can be carried out to determine the current states of plastics in fermentation, compost and wastewater treatment plants. In addition, plastics in the environment are surveyed nationwide. Airborne exploration methods (remote sensing) will be used for mapping. The aim is to develop a multi-sensor system for quantifying and qualifying the potential environmental impact of plastics.

### WP 2

#### Optimisability

##### **Contact person**

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e-mail: marc.kreutzbruck@ikt.uni-stuttgart.de

##### **Project partner**

BAM

##### **Short description**

Within the scope of the module "Optimisability" relevant plastics (PE, PET and PBAT) should be designed sustainably with regard to their degradation behaviour by using suitable additives/modifiers, i.e. they should exhibit an optimised degradation behaviour. For this purpose, the plastics are to be compounded with specifically switchable additives. In order to cover the entire value-chain, these materials should be able to be processed into semi-finished products using standard plastics fabrication technologies. In practice, semi-finished plastic products are sealed or two parts are joined together. Therefore, the weldability of the newly developed materials based on ultrasonic joining processes shall be investigated and ensured.

### WP 3

#### Degradability and environmental compatibility

##### **Contact persons**

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##### **Project partners**

University of Stuttgart IKT, UBA, Osnabrück University IUSF, TUB

## Short description

The “Degradability and environmental compatibility” module includes work on the mechanical understanding of plastic and polymer degradation. Under various environmental conditions, relevant degradation processes are assessed. The aim is to evaluate the degradation behaviour of the materials developed.

## WP 4

### Perception and behavior

#### Contact persons

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## Project partners

University of Stuttgart IKT, UBA,  
Osnabrück University IUSF, TUB, GFZ, BAM

## Short description

The module “Perception and behaviour” supports the research of human motivations for the handling of plastic as well as the development of recommendations for behavioural offers and communication content to reduce plastics in the environment. Triangulation of related research methods is used for this purpose. By means of expert interviews, focus groups, qualitative in-depth interviews and an online survey with selected target groups, the current patterns of perception and behaviour in dealing with plastics are collected and analysed.

Project partners	Main areas of work
University of Stuttgart, Institute for Plastics Technology <i>Prof. Dr. habil. Marc Kreutzbruck</i>	» Modification and production of plastics, characterisation and investigation of joining behaviour
Federal Institute for Materials Research and Testing <i>Dr. Ulrike Braun</i>	» Aging behaviour of polymers, biological material damage and reference organisms
Helmholtz Centre Potsdam – German Research Centre for Geosciences <i>Prof. Dr. Dirk Wagner</i>	» Detection of plastic waste by remote sensing, microbial degradation
Federal Environmental Agency <i>Dr. Claus Gerhard Bannick</i>	» Laboratory tests for the simulation of degradation processes in fermentation and composting plants as well as wastewater treatment plants, experiments in practical plants in Berlin

Institute for Advanced Sustainability Studies <i>Prof. Dr. Ortwin Renn and Dr. Katharina Beyerl</i>	» Empirical social science studies on perception and behaviour, development of transdisciplinary approaches to the reduction of plastics in the environment
Technical University of Berlin <i>Prof. Dr. Martin Kaupenjohann</i>	» Soil biological experiments, occlusion, and biological degradation of microplastic particles by soil fauna and microflora
Osnabrück University <i>Dr. Jörg Klasmeier</i>	» Mathematical modelling of fragmentation behaviour, mechanical degradation in the semi-terrestrial range
BASF SE <i>Victoria Wessolowski</i>	» Scientific know-how and consulting in the development of a sustainable new degradable material, provision of materials
Herrmann Ultraschalltechnik GmbH & Co. KG <i>Christian Reitze</i>	» Technology supplier and consultant for joint analysis, development and construction of an optimised sonotrode
Berliner Stadtreinigungsbetriebe <i>Frieder Söling</i>	» In-house fermentation plant for dismantling tests of the new plastic material
Berliner Wasserbetriebe <i>Regina Gnirss</i>	» Berlin wastewater treatment plants for a series of samplings
Hamm-Lippstadt University of Applied Sciences <i>Prof. Dr. Sabine Fuchs</i>	» Synthesis of specifically switchable plastic additives

## Consumer Behaviour Related to Plastic and its Avoidance at the Point of Sale

### Coordinator

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### Partner institutions

- » Weihenstephan-Triesdorf University of Applied Sciences, Department for Marketing and Management of Renewable Resources
- » General and Textile Industry Research Institute, University of Muenster
  - » Fraunhofer Institute for Process Engineering and Packaging
  - » University of Stuttgart, Institute of Acoustics and Building Physics, Department of Life Cycle Engineering
  - » Philipps-University Marburg, Department of Bioinformatics
- » Ludwig Stocker Hofpfisterei GmbH

### Website

**[www.plastikvermeidung.de](http://www.plastikvermeidung.de)**

### Short description

Consumers buying products made of or wrapped in plastic play a decisive role in plastic consumption in Germany. A complete avoidance of plastic in everyday life, while unlikely to occur in full, would only be possible with extremely high restrictions. Moreover, many consumers are not aware of how much plastic is put into circulation or into the environment by buying a product. The consumer can, however, influence the use of plastics with targeted product selection at the point of sale [PoS] (e.g. the choice of plastic-free products).

Against this background, this project will investigate to what extent the consumer can avoid the generation of plastic waste by making a purchase decision at the PoS. Another aspect is to what extent help can be provided for this decision, e.g. through different avoidance strategies. This will be examined using food packaging and clothing textiles as examples. The former was chosen because food packaging has the highest capital costs for the environment in absolute terms [UNEP 2014]. Textiles were chosen because they are made of plastic, a high proportion of synthetic fibres is used and a lot of plastic is produced by packaging the textiles.

### Main areas of work

- » Investigating the understanding and behaviour of consumers when buying (or co-acquiring) plastics
- » Identification of plastic avoidance strategies along the textile and food supply chains
- » Holistic evaluation of different plastic alternatives (life cycle assessment)
- » Development of new products/processes that help to reduce plastic consumption/use
- » Information on product-specific plastic consumption using a plastic app



## Work packages

### WP 1

#### **Project coordination and project management**

##### **Contact person**

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e-mail: thomas.decker@straubing.de

##### **Project partners**

Weihenstephan-Triesdorf University of Applied Sciences, General and Textile Industry Research Institute, University of Muenster, Fraunhofer Institute for Process Engineering and Packaging, University of Stuttgart, Philipps-University Marburg, Ludwig Stocker Hofpfisterei GmbH

##### **Short description**

The City of Straubing will coordinate the consortium in the supervisory WP 1. This includes the coordination of content, operations (link between science and SMEs) and organisation (project meetings, telecons, reports, timetable, etc.). In addition, the City of Straubing is responsible for public relations (reciprocal and interactive communication with stakeholder groups in the study region and in Germany, presswork, Internet media, etc.).

### WP 2

#### **Consumer purchasing behavior when buying plastic articles**

##### **Contact person**

*Prof. Dr. Klaus Menrad*, Weihenstephan-Triesdorf University of Applied Sciences, Department of Marketing and Management of Renewable Resources, Petersgasse 18, 94315 Straubing,  
e-mail: klaus.menrad@hswt.de

##### **Project partners**

Stadt Straubing, Ludwig Stocker Hofpfisterei GmbH

##### **Short description**

The behaviour of customers in the shops of partners in the City of Straubing will be assessed in regard to food packaging and clothing textiles, with particular attention paid to plastic. The aim is, on the one hand, to capture the open, observable shopping and plastic behaviour of consumers. On the other hand, the knowledge and problem awareness in plastic matters shall be determined. Furthermore, common themes will also be examined when purchasing plastic-packed food or textiles.

### WP 3

#### **What role does plastic play in commerce?**

##### **Contact person**

*Dr. Thomas Decker*, Stadt Straubing, Theresienplatz 2, 94315 Straubing,  
e-mail: thomas.decker@straubing.de

##### **Partner institutions**

Weihenstephan-Triesdorf University of Applied Sciences, Ludwig Stocker Hofpfisterei GmbH

##### **Short description**

The respective offer at the PoS is very important for consumers' purchasing decisions. For this reason, the assortment of practical partners in the food and textile commerce as well as the disposal routes of plastic waste produced in shops are being investigated. This provides a business level overview of the respective volume of plastic. The selected shops are examples of different types of food retailing and textile merchandise management.

## WP 4

### **Plastics along the value chain**

#### **Contact person**

*Sven Sänglerlaub*, Fraunhofer Institute for Process Engineering and Packaging, Giggenhauser Straße 35, 85354 Freising, e-mail: sven.saengerlaub@ivv.fraunhofer.de

#### **Short description**

The aim of this work package is to obtain a general overview of the occurrence and use of plastics (especially intermediate packaging) in the supply chains for textiles, with a focus on functional textiles and men's fashion, and foodstuffs. The aim is to investigate the areas in which the use of plastic is necessary and where it can be reduced or avoided. Thus, there are various possibilities within the value chains to reduce or avoid the use of plastics, e.g. by optimizing the transport packaging systems between the individual stations.

## WP 5

### **Development and provision of alternative packaging options**

#### **Contact person**

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#### **Project partners**

Stadt Straubing, University of Stuttgart, Ludwig Stocker Hofpfisterei GmbH

#### **Short description**

For the practical testing of alternative packaging and communication with retailers and end customers, suitable materials are being developed, samples produced and appropriate specifications drawn up for incoming and outgoing processes for manufacture and recycling. Various packaging alternatives

for the food sector are then manufactured at IVV on a pilot-plant scale for pilot applications or produced by industrial partners. These patterns represent different approaches to avoid or reduce the use of plastics.

## WP 6

### **Avoidance of plastic along the entire textile supply chain**

#### **Contact person**

*Prof. Dr. Gerhard Schewe*, University of Münster, Chair of Business Administration, Universitätsstraße 14–16, 48143 Münster, e-mail: orga@wiwi.uni-muenster.de

#### **Project partners**

Stadt Straubing, University of Stuttgart

#### **Short description**

Within the scope of a business case, innovative strategies are developed for analysing the entire textile supply chain regarding avoidable plastic use, together with practice partners from the textile industry. First the object of investigation is defined and delineated to provide a specification sheet for the analysis of the actual state, for the formulation of the target state under consideration of cost positions, for monetary advantages, and non-monetary aspects, and for functional, and non-functional requirements.

## WP 7

### **Innovative recycling strategies for the textile sector**

#### **Contact person**

*Prof. Dr. Gerhard Schewe*, University of Münster, Chair of Business Administration, Universitätsstraße 14–16, 48143 Münster, e-mail: orga@wiwi.uni-muenster.de

#### **Project partners**

Stadt Straubing, University of Stuttgart

### **Short description**

For the unavoidable use of plastics in the textile supply chain, sustainable recycling strategies are developed in a business case in cooperation with practice partners from the textile commerce who see plastics as a promising resource for innovative manufacturing and production processes (for the areas of men's fashion and functional textiles). The focus is on additive manufacturing processes (colloquially: 3D printing) that offer innovative recycling solutions across divisions and industries thus forming a link to the research area of food packaging.

### **WP 8**

#### **Context-specific life cycle analysis of the product examples**

##### **Contact person**

*Dr.-Ing. Stefan Albrecht*, University of Stuttgart, Faculty 2: Civil and Environmental Engineering, Institute for Acoustics and Building Physics (IABP), Department of Life Cycle Engineering, Wankelstraße 5, 70563 Stuttgart, e-mail: gabi@iabp.uni-stuttgart.de

##### **Project partners**

Stadt Straubing, Weihenstephan-Triesdorf University of Applied Sciences, General and Textile Industry Research Institute, University of Muenster, Fraunhofer Institute for Process Engineering and Packaging, University of Stuttgart, Philipps-University Marburg, Ludwig Stocker Hofpfisterei GmbH

##### **Short description**

Which global problems are caused by plastics along their supply chain and how severe are these? This question is answered by means of a context-specific analysis with regard to the entire life cycle of possible product solutions (textile, food) or plastics (e.g. food packaging) and the entire range of problems based on the life cycle assessment method and information from the previous work packages. Various practice partners from the

textile and food commerce provide support.

### **WP 9**

#### **Testing "new solutions"**

##### **Contact person**

*Prof. Dr. Klaus Menrad*, Weihenstephan-Triesdorf University of Applied Sciences, Department of Marketing and Management of Renewable Resources, Petersgasse 18, 94315 Straubing, e-mail: klaus.menrad@hswt.de

##### **Project partners**

Stadt Straubing, General and Textile Industry Research Institute, University of Muenster, Fraunhofer Institute for Process Engineering and Packaging, University of Stuttgart, Philipps-University Marburg, Ludwig Stocker Hofpfisterei GmbH

##### **Short description**

The newly developed products/solutions of WP 5 and 6 are verified for consumer acceptance and tested in the stores of partner companies in the food and textile industry for a period of two weeks. In addition to the sales figures, further consumer reactions will also be collected in 300 personal interviews. The developed app (Android and iOS version) will also be included in the test and tested for applicability.

### **WP 10**

#### **Elaboration and documentation of practice-oriented recommendations for action**

##### **Contact persons**

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*Sven Sängerlaub*, Fraunhofer Institute for Process Engineering and Packaging, Giggenhauser Straße 35, 85354 Freising, e-mail: sven.saengerlaub@ivv.fraunhofer.de

*Prof. Dr. Klaus Menrad, Weihenstephan-Triesdorf University of Applied Sciences, Department of Marketing and Management of Renewable Resources, Petersgasse 18, 94315 Straubing, e-mail: klaus.menrad@hswt.de*

## **Project partners**

Stadt Straubing, Philipps-University Marburg, Ludwig Stocker Hopfsterei GmbH

## **Short description**

Based on the results obtained, recommendations for action will be formulated for the industries examined and then summarised into compact documentation. The recommendations for action

are derived in close coordination with all partners and on the basis of the strengths and weaknesses, opportunities and risks of the solutions and strategies jointly identified throughout the course of the project. The aim is to achieve a clear impact assessment for the solutions and strategies developed and thus contribute to a reduction in use of plastics on the consumer side.

## **Case Studies**

Several case studies in the areas of food packaging and textiles are conducted within this project. For example, alternative packaging variants are developed for the following areas: service packaging, bowls/trays and bags for baked goods. These packaging alternatives will be tested in the course of the project with regard to "quality", "consumer acceptance" and for improvement of the "plastic index".

In the field of textiles, innovative strategies for the analysis of the entire textile supply chain to identify avoidable use of plastics are established together with practice partners. In addition, sustainable recycling strategies are developed that consider plastics as a promising resource for innovative manufacturing and production processes (for men's fashion and functional textiles). The focus is on additive manufacturing processes (colloquially: 3D printing) that offer innovative recycling solutions across divisions and industries

Project partners	Main areas of work
Stadt Straubing <i>Dr. Thomas Decker</i>	<ul style="list-style-type: none"> <li>» Network and project coordination</li> <li>» Assessing the range of goods on offer in the retail trade and deriving the “plastic load”</li> </ul>
Weihenstephan-Triesdorf University of Applied Sciences, Department of Marketing and Management of Renewable Resources <i>Prof. Dr. Klaus Menrad</i>	<ul style="list-style-type: none"> <li>» Consumer surveys</li> <li>» Consumer experiments</li> </ul>
General and Textile Industry Research Institute, University of Muenster <i>Prof. Dr. Gerhard Schewe</i>	<ul style="list-style-type: none"> <li>» Textile value chain</li> <li>» Plastic avoidance &amp; innovative recycling of textiles</li> </ul>
Fraunhofer Institute for Process Engineering and Packaging <i>Sven Sangerlaub</i>	<ul style="list-style-type: none"> <li>» Value chain food packaging</li> <li>» Alternative packaging materials for foodstuff</li> </ul>
University of Stuttgart, Institute for Acoustics and Building Physics (IABP), Department of Life Cycle Engineering <i>Dr.-Ing. Stefan Albrecht</i>	<ul style="list-style-type: none"> <li>» Accounting</li> </ul>
Philipps-University Marburg, Department of Bioinformatics <i>Prof. Dr. Dominik Heider</i>	<ul style="list-style-type: none"> <li>» App programming</li> </ul>
Ludwig Stocker Hofpfisterei GmbH <i>Jochem Holterbosch</i>	<ul style="list-style-type: none"> <li>» Packaging of baked goods</li> </ul>

# PlastikBudget

## Development of Budget Approach and LCA Impact Assessment Methodology for the Governance of Plastics in the Environment

### Coordinator

*Jürgen Bertling*

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### Partner institution

- » Institute for Advanced Study  
in the Humanities / KWI

### Short description

In order to legitimise political decisions on the problem of plastic emissions into the environment, it is necessary to formulate a quantitative emission target. The budget approach for plastic emissions, will be developed within the framework of this project. The research work is guided by the following questions: What amount of plastics in the environment is still acceptable? How long are plastics present in the environment until they are completely degraded? How can a global budget derived from answering these two questions be equitably shared by national per capita budgets? The aim of the project is not to establish a budget itself, but to show ways of deriving it from empirically verified data and normative values. This creates a basis for future political decision-making processes. However, consistent governance also requires that the plastic emissions of various products, processes and consumption practices are accounted for in terms of quantity released and downstream environmental impacts. The second part of the project consists of developing an impact assessment methodology in order to adequately take plastic emissions into account in life cycle analyses.

### Main areas of work

- » Sources and sinks, history and dynamics of the plastic inputs into the environment
- » Use of various participation formats to discuss the issue of plastic emissions with stakeholders
- » Development of a budget approach for plastic emissions
- » Development of a method for the integration of plastic emissions in life cycle assessments
- » Dissemination and anchoring of results in politics, society, economy and science



## Work packages

### WP 1

#### **Review and discussion on the state of knowledge on plastic inputs into the environment**

##### **Contact persons**

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*Dr. Steven Engler and Anna Bönsch*, KWI, Goethestraße 31, 45128 Essen, e-mail: steven.engler@kwi-nrw.de, anna.boenisch@kwi-nrw.de

##### **Short description**

WP 1 focuses on the scientific, technical, ecological and economic as well as on the socio-cultural aspects. Furthermore, this work package develops the participation programmes in the project in detail.

### WP 2

#### **Development of a budget approach for plastic emissions**

##### **Contact persons**

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*Dr. Steven Engler and Anna Bönsch*, KWI, Goethestraße 31, 45128 Essen, e-mail: steven.engler@kwi-nrw.de, anna.boenisch@kwi-nrw.de

##### **Short description**

WP 2 involves researching and developing a budget approach for plastic emissions as well as conducting a stakeholder dialogue on the approach. Moreover,

this work package will utilise outreach dialogue with citizens and a living lab.

### WP 3

#### **Development of an impact assessment method for the integration of the plastic emissions in life cycle analysis**

##### **Contact person**

*Dr. Daniel Maga and Nils Thonemann*, Fraunhofer UMSICHT, Osterfelder Straße 3, 46047 Oberhausen, e-mail: daniel.maga@umsicht.fraunhofer.de, nils.thonemann@umsicht.fraunhofer.de

##### **Short description**

WP 3 will focus on research and elaboration of existing impact assessment methods. Additional focus will be on understanding the relationship between impact assessment methodology and the budget approach. For these purposes, expert dialogues and workshops will be conducted.

### WP 4

#### **Dissemination and establishing budget approaches and impact assessments for plastic emissions in science, politics and society**

##### **Contact person**

*Miriam Wienhold*, KWI, Goethestraße 31, 45128 Essen, e-mail: miriam.wienhold@kwi-nrw.de

##### **Short description**

WP 4 will involve selecting actors for the various dialogue formats and developing a socially robust communication strategy. Conferences and debates will be held with an overarching focus on public relations for this project.

Project partners	Main areas of work
Fraunhofer UMSICHT <i>Jürgen Bertling</i>	» Development of a budget approach for plastic emissions » Development of a method for integrating plastic emissions into life cycle assessments
Institute for Advanced Study in the Humanities (KWI) <i>Dr. Steven Engler</i>	» Development of a budget approach for plastic emissions » Governance and dialogues on plastic emissions

# PLASTRAT

## Strategies for Reducing the Entry of Urban Plastics into Limnic Systems

### Coordinators

*Prof. Dr.-Ing. Christian Schaum and  
apl. Prof. Dr.-Ing. Steffen Krause*

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### Partner institutions

- » Goethe University Frankfurt / UF
- » Institute for Social-Ecological Research/ISOE
  - » IWW Rheinisch-Westfälisches Institute  
for Water Research gGmbH / IWW
    - » German Federal Institute  
of Hydrology (BfG) / BfG
  - » aquadrat ingenieure GmbH / a2i
- » Technical University of Darmstadt,  
Institute IWAR / TUDa
  - » inge GmbH / inge
- » Leibniz Institute of Polymer  
Research Dresden / IPF
- » Leibniz Institute for Baltic Sea  
Research Warnemünde / IOW

### Associated partners and subcontractors:

- » Münchner Stadtentwässerung
- » Stadt Weißenburg in Bayern
  - » Entsorgungsbetriebe der  
Landeshauptstadt Wiesbaden
- » Stadt Weiterstadt, Eigenbetrieb Stadtwerke
  - » Gemeindliche Einrichtungen  
und Abwasser Holzkirchen
- » Autobahndirektion Südbayern
  - » CARAT GmbH
- » PlasticsEurope Deutschland e.V.
  - » Kelheim Fibres GmbH
- » DWA Landesverband Bayern
- » Technical University of Munich,  
Analytical Chemistry
- » The Sustainable People GmbH

### Website

[www.plastrat.de/project/](http://www.plastrat.de/project/)

### Short description

The common element of all investigations in PLASTRAT is the development of solution strategies for sustainable limitation of the spread of plastic residues in the aquatic environment on technical, environmental, scientific and social-ecological levels. The objective consists of developing a multi-criteria evaluation approach for the environmental compatibility of different types of plastics. In addition, a quality label for practical application shall be designed. The focus lies on the analysis and evaluation of the degradation stages of different types of plastics as well as leaching, adsorption and desorption in different wastewater treatment stages, the effects of different plastic species (in different degradation stages) and their additives on aquatic organisms in limnic systems, as well as a risk characterisation of the human toxicological effect of microplastics on consumers of drinking water. Furthermore, the emphasis is put on the quantification and technical reduction potential [e.g. use of membrane technology] of plastic emissions in urban water management, including sewage sludge/fermentation residue treatment, taking into account suitable sampling, treatment and analysis methods. Besides, studies are carried out on the social relevance, i.e. how plastics are handled in German households, what demands the consumer places on plastics, what possibilities exist for the use of substitutes and the resulting effects on commerce, logistics and consumers.

### Main areas of work

- » Determination and evaluation of microplastic pathways in limnic systems
- » Investigation and evaluation of technical measures for microplastic elimination
- » Sampling strategies for further processing and analysis of microplastics
- » Sample preparation for analysis of microplastics
- » Identification and quantification of microplastics in all samples
- » Automation of particle recognition, measurement and identification using databases

- » Adsorption/desorption of pollutants on microplastics
- » Degradation and leaching of polymers of different groups
- » Ecotoxicological studies of released substances from microplastics
- » Human toxicological investigations of released substances from microplastics
- » risk analysis of drinking water
- » Investigation of societal relevance
- » Development of a multi-criteria evaluation system
- » Development of a quality label through an accompanying stakeholder dialogue

## Work packages

### WP K

#### **Coordination and Communication**

##### **Contact persons**

*Prof. Dr.-Ing. Christian Schaum, apl. Prof. Dr.-Ing. Steffen Krause*, Bundeswehr University Munich, Institute of Hydrosience, Chair of Sanitary Engineering and Waste Management, Werner-Heisenberg-Weg 39, 85577 Neubiberg, e-mail: swa@unibw.de

##### **Short description**

In addition to the tasks of general scientific project management, internal communication between the network partners and external communication (increasing public awareness of the project) are also covered. This includes, among other things, uniform guidelines for public relations work by individual network partners and within the overall consortium, organisation of meetings, monitoring of work progress, document management and coordination of the associated partners.

### WP 1

#### **Microplastics in the urban water cycle**

##### **Contact persons**

*PProf. Dr.-Ing. Christian Schaum, apl. Prof. Dr.-Ing. Steffen Krause*, Bundeswehr University Munich,

Institute of Hydrosience, Chair of Sanitary Engineering and Waste Management, Werner-Heisenberg-Weg 39, 85577 Neubiberg, e-mail: swa@unibw.de

##### **Project partners**

UF, IWW, BfG, a2i, TUDa, inge, IPF, IOW

##### **Short description**

Basic data and definitions for PLASTRAT are specified in consultation with all project partners. This relates to the definition of the upper and lower limit of the particle size for microplastic particles to be examined, the selection of specific plastic species from the categories conventional plastics, recyclates, and biobased or biodegradable polymers. Further preliminary work includes the selection or determination of suitable sites for investigations of WP 2 and 3, taking into account the products considered in WP 5. In addition, the stakeholder analysis is prepared and a more detailed evaluation for developing the quality label.

### WP 2

#### **Degradation and material dynamics**

##### **Contact person**

*Prof. Dr. Thomas Ternes*, German Federal Institute of Hydrology (BfG), Am Mainzer Tor 1, 56068 Koblenz, e-mail: ternes@bafg.de

##### **Project partners**

UniBwM, TUDa

##### **Short description**

The environmental behaviour of biobased, synthetic and recycled plastics is analysed in WP 2. Original materials are examined, as well as artificially-aged materials. The release of pollutants (oligomers, additives and their transformation products) is analysed depending on the type of polymer and the degree of degradation. Furthermore, differences in the adsorption/desorption of environmental chemicals are investigated for different types of polymers and the role of wastewater treatment plants regarding the pollutant load of microplastics (enrichment or depletion).

# PLASTRAT

## WP 3

### Entry points and elimination

#### Contact persons

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#### Project partners

UniBwM, a2i, inge, IPF, IOW

#### Short description

Different entry points of microplastics into limnic systems are assessed, focusing on the analysis and evaluation of the waste water management system including measures for microplastic retention (e.g. membrane technology) that already exist or have been modified or developed in the course of the project. Core areas comprise rain and mixed water discharge, the assessment and evaluation of the entire wastewater treatment plant system, and an analysis of sewage sludge, digestate and compost as possible microplastic sinks. Emphasis is also put on the development and selection of suitable processing and analytical methods.

## WP 4

### Impact and hazard analysis

#### Contact persons

*Prof. Dr. Jörg Oehlmann, Dr. Ulrike Schulte-Oehlmann*, Goethe University Frankfurt, Max-von-Laue-Straße 13, 60438 Frankfurt, e-mail: oehlmann@bio.uni-frankfurt.de

#### Project partner

IWW

#### Short description

Comparative analyses are conducted for biobased, synthetic and recycled plastics in different degradation stages as well as for their additives and substances adsorbed/desorbed regarding their effects

applying various human and ecotoxicological methods. The results are used to derive threshold values and environmental quality objectives. These should contribute to the hazard analysis and evaluation of the different plastic species with regard to their relevance and environmental compatibility for the limnic environment. The experimental investigations are supplemented by a risk analysis of the drinking water system.

## WP 5

### Societal relevance

#### Contact person

*Dr. Immanuel Stieß*, ISOE - Institute for Social-Ecological Research, Hamburger Allee 4, 60486 Frankfurt, e-mail: stuess@isoe.de

#### Short description

The social perception, use and disposal of plastic-based products are analysed as well as the possibilities, conditions and obstacles for more sustainable consumption and disposal practices. The focus lies on applications in the non-food sector (hygiene articles, clothing and dog excrement bags) as their incorrect or informal disposal can lead to the emission of microplastics into limnic systems that may have negative effects on organisms and aquatic ecosystems. Analysing of the perception of environmental risks and product-specific use and disposal practices is carried out through qualitative exploration and standardised surveys.

## WP 6

### Evaluation system/quality label

#### Contact person

*Kristina Wencki*, IWW Rheinisch-Westfälisches Institute for Water Research gGmbH, Moritzstraße 26, 45476 Mülheim an der Ruhr, e-mail: k.wencki@iww-online.de

#### Project partners

ISOE, UniBwM, UF, BfG

### Short description

Within the project, a multi-criteria evaluation system for plastics regarding to their environmental compatibility with limnic systems is developed. At the same time, the identification of the evaluation criteria is used to initiate the critical discourse about the quality label that demonstrates this

environmental compatibility. To this end, a stakeholder dialogue will be conducted. In addition to synthesizing the outcomes of the preceding work packages, this is intended to make a significant contribution to transfer the newly acquired findings into research and business practice.

Project partners	Main areas of work
Bundeswehr University Munich <i>Prof. Dr.-Ing. Christian Schaum</i> <i>apl. Prof. Dr.-Ing. Steffen Krause</i>	<ul style="list-style-type: none"> <li>» Project coordination</li> <li>» Determination and evaluation of microplastic entry points in limnic systems</li> <li>» Investigation and evaluation of technical measures for microplastic elimination</li> <li>» Sampling strategies for further processing and analysis of microplastics</li> <li>» Degradation and leaching of polymers of different groups</li> </ul>
Goethe University Frankfurt <i>Prof. Dr. Jörg Oehlmann</i> <i>Dr. Ulrike Schulte-Oehlmann</i>	<ul style="list-style-type: none"> <li>» Ecotoxicological studies of released substances from microplastics</li> </ul>
ISOE – Institute for Social-Ecological Research <i>Dr. Immanuel Stieß</i>	<ul style="list-style-type: none"> <li>» Investigation of societal relevance</li> <li>» Development of a multi-criteria evaluation system</li> <li>» Development of a quality label through an accompanying stakeholder dialogue</li> </ul>
IWW Rheinisch-Westfälisches Institute for Water Research gGmbH <i>Dr. Anne Simon</i>	<ul style="list-style-type: none"> <li>» Human toxicological investigations of released substances from microplastics</li> <li>» Hazard analysis of drinking water</li> <li>» Development of a multi-criteria evaluation system</li> </ul>
German Federal Institute of Hydrology (BfG) <i>Prof. Dr. Thomas Ternes</i>	<ul style="list-style-type: none"> <li>» Degradation and leaching of polymers of different groups</li> </ul>
aquadrat ingenieure GmbH <i>Dr.-Ing. Tobias Günkel-Lange</i>	<ul style="list-style-type: none"> <li>» Investigation and evaluation of technical measures for microplastic elimination</li> </ul>
Technical University of Darmstadt, Institute IWAR <i>Prof. Dr. Liselotte Schebek</i>	<ul style="list-style-type: none"> <li>» Adsorption/desorption of pollutants on microplastics</li> </ul>
inge GmbH <i>Christian Staaks</i>	<ul style="list-style-type: none"> <li>» Investigation and evaluation of technical measures for microplastic elimination</li> </ul>
Leibniz Institute of Polymer Research Dresden <i>Dr. Dieter Fischer</i>	<ul style="list-style-type: none"> <li>» Identification and quantification of microplastics in all samples</li> <li>» Automation of particle recognition, measurement and identification via databases</li> </ul>
Leibniz Institute for Baltic Sea Research Warnemünde <i>PD Dr. Matthias Labrenz</i>	<ul style="list-style-type: none"> <li>» Sample preparation for the analysis of microplastics</li> </ul>

## Representative Investigation Strategies for an Integrative System Approach to Specific Emissions of Plastics into the Environment

### Coordinator

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### Partner institutions

- » Federal Environmental Agency / UBA
- » Technical University of Chemnitz / TUC
  - » Fraunhofer Centre for Silicon Photovoltaics / CSP
  - » Technical University of Kaiserslautern / TUK
  - » Fritz Haber Institute of the Max Planck Society / FHI
- » Technical University of Munich / TUM
  - » Technical University of Berlin / TUB
  - » SmartMembranes GmbH / SMB
  - » Kreuzinger und Manhart Turbulenz GmbH / KMT
- » Umwelt – Geräte – Technik GmbH / UGT

### Associated partners:

- » PlasticsEurope Deutschland e.V. / PlasticsEurope
- » Zentralverband Elektrotechnik- und Elektronikindustrie e.V. / SVEI
  - » GKD - Gebr. Kufferath AG
- » Westfalia Separator Group GmbH / GEA

### Website

<https://netzwerke.bam.de/ruseku>

### Short description

This project aims to develop representative investigation methods and strategies for an integrative system understanding of relevant plastic entry paths into the environmental compartment water. The sampling methods to be developed are evaluated in terms of their concentration concept, their local use, their sampling throughput, and their selectivity for particles of different properties, sizes, and shapes. For this purpose, defined microplastic particles will be produced with these varying characteristics and tested for representative recovery of sampling procedures in the laboratory and in semi-industrial simulation facilities. The methods developed in this way will be translated into specific investigation strategies, adapted and then applied to real environmental areas for different transport paths in the urban wastewater system. The adaptation is carried out with the aid of supporting simulation methods. In addition to the academic understanding of microplastic entry points, causes and pathways, market-ready methods for efficient microplastic sampling are developed in cooperation with the companies involved. These methods form a basis for evaluation by legislators and for standardisation.

### Main areas of work

- » Development of efficient, integrative and representative research methods and strategies [accuracy, repeatability, transferability] for the determination of relevant microplastic contents over the different areas of the water cycle
- » Establishment of goal-oriented, analytical methods for the detection of microplastic particles according to practical aspects
- » Simulations of the dynamics of particles in water bodies in semi-industrial laboratory tests
- » Further development of sampling to quantify the microplastic volume and transport in the



real, urban waste water system for the waste water fractions: precipitation water, domestic waste water, and industrial waste water

- » Generation of a simulation code for the dynamics of microplastic particles in waters

## Work packages

### WP 1

#### **Production of microplastics and microplastic suspensions**

##### **Contact person**

*Prof. Dr.-Ing. Michael Gehde*, Technische Universität Chemnitz, Institute for Materials Handling and Plastics, Reichenhainer Straße 70, 09126 Chemnitz, e-mail: michael.gehde@mb.tu-chemnitz.de

##### **Project partners**

BAM, TUB, PlasticsEurope

##### **Short description**

First, defined, heterogeneous microplastic mixtures are developed for the environmental testing in water and soil. After the initial use of existing materials [e.g. particles from cryogenic grinding, commercial products], plants for the realistic and defined production of microplastic particles will be set up during the project period: UV degradation systems for thin-walled, defined materials, dry or aqueous mechanical abrasion systems for fibres from textile applications, and abrasion simulation systems for the generation of spherical particles. The other project partners will contribute to the characterisation of these model materials by applying their analytical methods.

### WP 2

#### **Development of sampling methods**

##### **Contact person**

*Dr. Claus Gerhard Bannick*, Federal Environmental Agency, Corrensplatz 1, 14195 Berlin, e-mail: claus-gerhard.bannick@uba.de

##### **Project partners**

UGT, CSP, SMB, TUK, GEA, GKD, SVEI

##### **Short description**

In WP 2, efficient, reliable and reproducible sampling methods and strategies are developed for the microplastic model particles of different varieties, densities, sizes and shapes in the stream simulation facility at UBA. Their usability and reproducibility will also be investigated for routine operation and the methods will be evaluated based on the recovery rates of experiments. The individual project partners are optimising their analytical procedures: from the use of conventional flow-through centrifuges to the cascade filtration system, suspended matter traps, hydrodynamic modelling, and lysimeter tests to the control of possible input into groundwater.

### WP 3

#### **Simulations**

##### **Contact person**

*Prof. Dr.-Ing. Michael Manhart*, Technical University of Munich, Associate Professorship of Hydromechanics, Arcisstraße 21, 80333 München, e-mail: m.manhart@bv.tum.de

##### **Project partners**

KMT

##### **Short description**

The methodological developments from WP 2 are supported by accompanying simulations in WP 3. These simulations result in a description of the vertical distributions of spheroids at different particle sizes and shapes in a turbulent surface water or stream simulation facility. The models and results are integrated into a software that simulates geometrically complex, application-oriented cases. A sampling strategy is derived from the simulation results. Relevant material parameters of the particles such as size distribution, real density or surface properties from WP 1 as well as from partners from WP 5 are included.

## WP 4

### **Sampling of real environmental compartment**

#### **Contact person**

*Prof. Dr.-Ing. Heidrun Steinmetz,*  
Technical University of Kaiserslautern, Institute of Water – Infrastructure – Resources,  
Paul-Ehrlich-Straße 14, 67663 Kaiserslautern,  
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#### **Project partners**

UBA, TUM, KMT

#### **Short description**

The main focus of WP 4 is the quantification of the microplastic volume and transport in the real, urban wastewater system for the wastewater and precipitation water, domestic wastewater (partial flows grey and black water), industrial wastewater, and mixed wastewater. The findings from the sampling in WP 2 will be implemented and improved. Further work will focus on sample preparation and preservation to evaluate the comparability of different sampling strategies. The investigations focus on the quantities and the importance of microplastic volumes in the individual entry points of the urban wastewater system into the water bodies.

## WP 5

### **Analytics**

#### **Contact person**

*Dr. Ulrike Braun,* Federal Institute for Materials Research and Testing (BAM), Division 5.3 Mechanics of Polymers, Unter den Eichen 87, 12205 Berlin,  
e-mail: ulrike.braun@bam.de

#### **Project partners**

CSP, TUM, FHI

#### **Short description**

The analytics used in the individual work packages are based on the requirements for sample preparation and analytical procedures as well as on the necessary information to be generated, not on the general feasibility. WP 5 serves the intensive exchange of results generated with complementary analytical methods. In addition, the respective methods, supported by the results of the other project partners, will be further refined and adapted.

#### **Case studies**

As a real environmental simulation, individual components of the wastewater system of the city of Kaiserslautern are investigated. In concrete terms, precipitation water is sampled here on settlement and traffic areas as well as domestic and industrial wastewater.

In addition, air sampling will also be carried out at the limits of comparable sampling sites. Locations in Berlin and in the Halle/Leipzig area are planned. The planned lysimeter tests will be carried out in Berlin and thus allow an assessment of groundwater recharge in Berlin and Brandenburg.

Project partners	Main areas of work
Federal Institute for Materials Research and Testing <i>Dr. Ulrike Braun</i>	<ul style="list-style-type: none"> <li>» Overall coordination of the project</li> <li>» Standardisation of microplastic detection methods, implementation of analytical procedures and extension by new analytical developments (chemometric data analysis)</li> </ul>
Federal Environmental Agency <i>Dr. Claus Gerhard Bannick</i>	<ul style="list-style-type: none"> <li>» Sampling procedures: concept development, preliminary tests &amp; laboratory experiments, operation of stream water simulation plant &amp; lysimeter, optimisation of the developed sampling equipment, transfer of laboratory tests into field tests</li> <li>» Sampling of water, air &amp; soil for specific entries</li> </ul>
Technical University of Chemnitz <i>Prof. Dr.-Ing. Michael Gehde</i>	<ul style="list-style-type: none"> <li>» Provision of model materials with defined properties</li> <li>» Construction of degradation plants for realistically aged model materials</li> </ul>
Fraunhofer Centre for Silicon Photovoltaics CSP <i>Dr. Christian Hagendorf</i>	<ul style="list-style-type: none"> <li>» Optimisation of wafer treatment processes for new filter materials with variable properties (cascade filters)</li> <li>» Evaluation of optical properties and suitability for microplastic analysis</li> </ul>
Technical University of Kaiserslautern <i>Prof. Dr.-Ing. Heidrun Steinmetz</i>	<ul style="list-style-type: none"> <li>» Application of the new processes (cascade filter, particulate trap and flow centrifuge) in the real environmental compartment for precipitation and waste water</li> <li>» Evaluation of the relevance of the entry points in the urban wastewater system</li> </ul>
Fritz Haber Institute of the Max Planck Society <i>Dr. Thomas Lunkenbein</i>	<ul style="list-style-type: none"> <li>» Application of complex analytical methods for microstructure analysis of microplastic particles</li> </ul>
Technical University of Munich <i>Prof. Dr.-Ing. Michael Manhart</i>	<ul style="list-style-type: none"> <li>» Development of a simulation algorithm for the microplastic particle transport in waters</li> <li>» Application for sampling strategies in the real environmental compartment</li> </ul>
Technical University of Berlin <i>Dr.-Ing. Aki Sebastian Ruhl</i>	<ul style="list-style-type: none"> <li>» Provision of stable microplastic suspensions with defined properties</li> <li>» Evaluation of the influence of biological and chemical factors on particle behaviour</li> </ul>
SmartMembranes GmbH <i>Monika Lelonek</i>	<ul style="list-style-type: none"> <li>» Production of filter materials (product) with optimised properties (cascade filters)</li> </ul>
Kreuzinger und Manhart Turbulenz GmbH <i>Dr.-Ing. Florian Schwertfirm</i>	<ul style="list-style-type: none"> <li>» Production of a simulation algorithm (product) for representative sampling</li> </ul>
Umwelt- Geräte- Technik GmbH <i>Bernd Fürst</i>	<ul style="list-style-type: none"> <li>» Design and manufacture of optimised particulate traps (product)</li> </ul>

# SubμTrack

## Tracking of (Sub)Microplastics of Different Identities – Innovative Analysis Tools for Toxicological and Process-engineering Evaluation

### Coordinator

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**Technical University of Munich,  
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Engineering /  
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### Partner institutions

- » Technical University of Munich
- » Institute of Hydrochemistry, Chair of Analytical Chemistry and Water Chemistry / TUM-IWC
- » Chair of Animal Physiology and Immunology/ TUM-LTI
- » Chair of Aquatic Systems Biology / TUM-LAS
- » Assistant Professorship of Science and Technology Policy / TUM-MCTS
- » Helmholtz Centre Munich, Institute of Groundwater Ecology / IGOE
- » Bavarian State Office for the Environment / LfU
- » Federal Environmental Agency / UBA
- » Institute of Energy and Environmental Technology e. V. / IUTA
- » Postnova Analytics GmbH
- » BS-Partikel GmbH

### Website

[www.wasser.tum.de/en/submuetrack/startseite/](http://www.wasser.tum.de/en/submuetrack/startseite/)

### Short description

The methods currently available for the analysis of microplastics in environmental matrices are primarily designed for particles in the size range of 1 μm to 5 mm. Smaller particles below 1 μm have hardly been detected so far. However in contrast to larger particles, these are able to enter cells and have a higher potential for adsorption of pollutants due to their relatively larger surface. SubμTrack focuses on plastic particles between 50 nm and 100 μm, because of their higher ecotoxicological relevance. For this purpose, the previously available detection range has to be extended and new methods for sampling, sample preparation, and analysis have to be developed. Another focus of the project is the possible effects of submicroplastic particles on the aquatic environment and on human health. The results of these studies are complemented by an assessment of the social, political and legal dimensions of plastic emission into the environment. By analysing the perception of the problem and possible strategies for action, foundations are to be laid for active processes of social change. The results are also examined regarding to their implementation in legislation, standardisation, and their relevance for voluntary actions.

### Main areas of work

- » Characterisation of particles and comparison with reference materials
- » Impact on the aquatic environment and human health
- » Social, political and legal dimensions of plastic emission into the environment

## Work packages

### WP 0

#### **Organisation, coordination and public relations**

##### **Contact persons**

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Water Systems Engineering,  
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##### **Project partners**

TUM-IWC, TUM-LTI, TUM-LAS, TUM-MCTS,  
IGOE, LfU, UBA, IUTA, Postnova Analytics GmbH,  
BS-Partikel GmbH

##### **Short description**

In addition to the coordination of results and products within the consortium, WP 0 also includes the coordination of activities with partners outside the project. The goal is the sustainable implementation of the analytical techniques, the results and the instructions for action of harmonised strategies in close cooperation with national and international key institutions. The public relations work is mainly coordinated by TUM-SWW and effectively implemented by partners of different orientations.

### WP 1

#### **Selection and production of reference particles**

##### **Contact persons**

*Dr. Carmen Nickel, Dr. Jochen Türk,* Institute of  
Energy and Environmental Technology e. V. (IUTA),  
Bliersheimer Str. 58- 60, 47229 Duisburg,  
e-mail: nickel@iuta.de; tuerk@iuta.de

##### **Project partners**

LfU, BS-Partikel GmbH

##### **Short description**

Together with the partners of BS-Partikel and the leaders of the experimental WPs 2 – 5 the required reference particles are identified. In particular, the

size, material, marking and the availability of the particles play an important role. The reference particles are selected during the initial phase of the project in order to have enough time to fabricate or purchase the particles at the beginning of the experiments. The project partners BS-Partikel and IUTA then provide the corresponding particles.

### WP 2

#### **Comprehensive analysis of microplastic particles**

##### **Contact persons**

*Prof. Dr. Martin Elsner, Dr. Natalia P. Ivleva,*  
Technical University of Munich, Chair of Analytical  
Chemistry and Water Chemistry, Institute of  
Hydrochemistry, Marchionistrasse 17, 81377 Munich,  
e-mail: natalia.ivleva@ch.tum.de

##### **Project partners**

Postnova Analytics GmbH, BS-Partikel GmbH,  
TUMSWW, TUM-LTI, LfU, IUTA

##### **Short description**

Innovative and proven analytical detection methods (including sampling, preparation, identification and quantification) for microplastics (1 µm – 5 mm) are determined and tested with reference materials in the submicron range. The most successful techniques of the MiWa project running since 2016 serve as a starting point for this; standard methods from this project will be integrated and compared. Direct contact to actors of the MiWa project is guaranteed by partners of the consortium (TUM-IWC and UBA).

### WP 3

#### **Studies on aging, adsorption and desorption of organic trace substances on reference particles**

##### **Contact persons**

*PD Dr. Thomas Letzel, PD Dr. Johanna Graßmann,*  
Technische Universität München, Lehrstuhl für  
Siedlungswasserwirtschaft, Am Coulombwall 3,  
85748 Garching, e-mail: j.grassmann@tum.de

## Project partner

LfU

## Short description

The particles used in the method validation are subjected to systematic aging processes and biofilm growth. Furthermore, these particles and especially their (resulting) different surfaces are examined regarding their adsorption or desorption characteristics of organic molecules. For this analysis, adsorption and desorption kinetics, among other things, will be investigated. This is done applying TD-(Pyrolysis)-GC-MS and LC-MS/MS are used. Experiments with the aged particles are carried out in so-called batch approaches, but also in laboratory wastewater treatment plants operated at the LfU. All samples are also stored in the biological systems from WP 5 if required.

## WP 4

### Investigations on entry points and process-related evaluation

## Contact person

*Dr. Korbinian Freier*, Bavarian State Office for the Environment, Demollstraße 31, 82407 Wielenbach, e-mail: korbinian.freier@lfu.bayern.de

## Project partners

TUM-SWW, IUTA

## Short description

Using the methods developed and validated in WP 2, real scenarios are first simulated with reference particles in laboratory wastewater treatment plants at the partner LfU to analyse the fate of the particles within the system. Parallel to this, investigations will be carried out at various measuring points in real wastewater treatment plants. Water samples are certified by IUTA for micropollutants. The aim is to extend the existing sampling technologies to micropollutants. Finally, together with the other partners of the project and based on the expected results, a process-related evaluation will be carried out.

## WP 5

### Impact on aquatic environment and human health

## Contact person

*Prof. Dr. Michael Pfaffl*, Technical University of Munich, TUM School of Life Sciences Weihenstephan, Technical University of Munich, Chair of Animal Physiology and Immunology, Weihenstephaner Berg 3, 85354 Freising, e-mail: michael.pfaffl@wzw.tum.de

## Project partners

TAM-LAS, IGOE

## Short description

Potential negative effects of submicroparticles on different biological organisational levels will be investigated and compared to obtain a comprehensive ecotoxicological evaluation. This includes the use of model systems in vivo to determine effects on microbial diversity, communities and trophic structures and functions as well as to identify stress reactions on a higher organismic level. In vitro models extend this approach for the determination of effects on the cellular and molecular level. Based on this a mechanistic understanding of particle-induced stress reactions can be created and potential effects on human health are derived.

## WP 6

### Social, political and legal dimensions

## Contact person

*Prof. Dr. Ruth Müller*, Technical University of Munich, Assistant Professorship of Science and Technology Policy, Augustenstraße 46, 80333 Munich, e-mail: ruth.mueller@tum.de

## Project partner

UBA



### Short description

At TUM-MCTS current problem perceptions and coping strategies in society and politics with regard to plastic particles in the environment are analysed by means of qualitative social scientific methods. The focus lies on the perception of the specific ecotoxicological relevance of submicroparticles. UBA carries

out a screening of the relevant legal acts at national, European and intercontinental levels. The consideration goes beyond the pure media reference (water, soil and air) and the associated possible transport paths. In particular, the legally undefined range between nano- (limit: 100 nm) and microplastics (frequently stated limit: 1 µm) is of primary interest.

Project partners	Main areas of work
Technical University of Munich <i>PD Dr. Thomas Letzel</i> <i>PD Dr. Johanna Graßmann</i>	<ul style="list-style-type: none"> <li>» Project coordination</li> <li>» Analysis of particles and their adsorption and desorption properties (LC-MS/MS, TD-Pyrolysis-GC-MS)</li> <li>» Entry points and process-related evaluation</li> <li>» Analysis using Raman microspectroscopy (RM) or RM in combination with Flow Field Fractionation (FFF)</li> <li>» Validation of the separation methods using SEM</li> <li>» [Further] development of analytical procedures</li> <li>» Cellular and molecular biological investigations</li> <li>» Ultracentrifugation for the separation and concentration of nanoparticles and nanometry techniques</li> <li>» Studies on effects at population and organism level (in vivo)</li> <li>» Analysis of social and political dimensions</li> <li>» Problem awareness, strategies for action and social dialogue (public engagement)</li> </ul>
Helmholtz Centre Munich, Institute of Groundwater Ecology <i>PD Dr. Christian Griebler</i> <i>Dr. Yuxiang Zhou</i>	<ul style="list-style-type: none"> <li>» Investigation of the effect on microorganisms at the organisational and physiological levels</li> </ul>
Bavarian State Office for the Environment <i>Dr. Korbinian Freier</i>	<ul style="list-style-type: none"> <li>» Execution of tests in the laboratory wastewater treatment plant</li> <li>» Analytics using FTIR</li> </ul>
Federal Environmental Agency <i>Dr. Claus Gerhard Bannick</i> <i>Nathan Obermaier</i>	<ul style="list-style-type: none"> <li>» Evaluation of relevant legislative areas and standardisation projects for the implementation of measures for the reduction of submicroplastics</li> <li>» Proposals for implementing the results in legislation, standardisation and voluntary commitments</li> </ul>
Institute of Energy and Environmental Technology e. V. <i>Dr. Carmen Nickel</i> <i>Dr. Jochen Türk</i> <i>Matin Funck</i> <i>Bryan Hellack</i>	<ul style="list-style-type: none"> <li>» Sampling and nanometrology</li> <li>» Measurements using Pyr-GC-MS, GC-MS/MS, LC-MS/MS and LC-HRMS</li> </ul>
Postnova Analytics GmbH <i>Dr. Florian Meier</i> <i>Vanessa Sogne</i>	<ul style="list-style-type: none"> <li>» Support in fractionation and characterisation of submicroparticles</li> <li>» Development of an online linking of FFF technology with RM</li> </ul>
BS-Partikel GmbH <i>Dr. Kyriakos Eslahian</i> <i>Cornelia Hunger</i>	<ul style="list-style-type: none"> <li>» Provision and development of reference plastic particles of different sizes, chemical identities and markings</li> <li>» Nanometry</li> </ul>

## Recycling of Polystyrene by Raw Material Recovery

### Coordinator

*Dr. Hannes Kerschbaumer*  
**INEOS Styrolution Group GmbH**  
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ineos.com

### Partner institutions

- » INEOS Köln GmbH
- » RWTH Aachen University
- » Department of Processing  
and Recycling / I.A.R.
- » Institute of Plastics Processing / IKV
- » Neue Materialien Bayreuth  
GmbH / NMB

### Short description

In view of climate change, environmental pollution, population growth, and resource dependency, the transition from a linear economy to a closed-loop economy is both ecologically and economically necessary. The aim of the Resolve project is to develop a logistics and an industrial plant concept for the economic use of polystyrene waste as a raw material for high-quality new plastic products. Thermally-induced depolymerisation as material recycling of waste plastics can lead to the production of new polymers. In this process, the polymer is split thermally into low-molecular substances such as monomers and oligomers. In contrast to the conventional thermal recycling or material recycling of plastic waste, this project aims to actually close the loop. The depolymerisation process does not lead to the so-called "downcycling" of the recyclable materials. Since it places only moderate demands on the purity of the waste streams, many post-consumer waste streams can be used.

INEOS Styrolution manages the joint research project with the aim of using the styrene monomer, which is the main component of depolymerisation, in its own production process. To this end, the overall process is subjected to an intensive evaluation and the prerequisites for an investment are examined, too.

## Main areas of work

- » Logistical and economic evaluation
- » Preconditioning in processing technology
- » Depolymerisation of polystyrene wastes on a laboratory scale
- » Depolymerisation of polystyrene in the twin screw extruder
- » Distillative treatment
- » Investigations into the influence of impurities on the depolymerisation process of polystyrene
- » Utilisation of by-products through steam cracking

## Work packages

### WP 1

#### **Project leadership**

##### **Contact person**

*Dr. Hannes Kerschbaumer*, INEOS Styrolution Group GmbH, Mainzer Landstraße 50, 60325 Frankfurt am Main,  
e-mail: hannes.kerschbaumer@ineos.com

##### **Short description**

The successful implementation of the project requires a regular exchange of information between the partners and with the project management. The consortium consists of five partners and other subcontractors and thus requires careful management to ensure targeted and result-oriented co-operation. The individual tasks include: coordination of the project partners; thematic summaries of the developed results; reporting (including meeting minutes, milestone report and regular reports); organisation of project meetings and regular telephone conferences; organisation of the dispatch of hazardous substances between Aachen, Bayreuth and Cologne; and observation of parallel approaches to the raw material recycling of polystyrene.

### WP 2

#### **Procurement of waste samples and development of a recycling concept**

##### **Contact person**

*Prof. Dr. Thomas Pretz*, RWTH Aachen University, Department of Processing and Recycling, Wüllnerstraße 2, 52056 Aachen,  
e-mail: pretz@ifa.rwth-aachen.de

##### **Project partner**

INEOS Styrolution

##### **Short description**

In dialogue with relevant waste disposal companies, the most important material flows are detected and samples procured. These are examined, processed and evaluated with regard to their suitability for chemical recycling. Specific logistics concepts are developed for these material flows so that a high recycling rate can be achieved. In addition, existing contacts with other research groups dealing with the collection of marine plastic waste are used. Other contacts are established to integrate the availability of material flows from the environment into the logistics concept.

### WP 3

#### **Depolymerisation of pure polystyrene granules with targeted variation of relevant material parameters**

##### **Contact person**

*Prof. Dr. Hans-Werner Schmidt*, Neue Materialien Bayreuth GmbH, Gottlieb-Keim-Straße 60, 95448 Bayreuth, e-mail: hans-werner.schmidt@uni-bayreuth.de

##### **Project partners**

RWTH Aachen University IKV, INEOS Styrolution, INEOS Köln

## Short description

The aim is to gain basic knowledge about the type of products resulting from the depolymerisation of polystyrene. For this purpose, depolymerisation is carried out on model substances on a laboratory scale. Parallel to this, a suitable extruder arrangement with separator is set up and depolymerisation is carried out in order to determine achievable yields and parameter influences. The reaction products are investigated by means of GC-MS. First experiments with real samples are carried out and the distillative separation of styrene is demonstrated. The by-products are evaluated for their suitability for the cracking process. The process parameters are optimised in both depolymerisation plants.

## WP 4

### **Depolymerisation of pure polystyrene granules with targeted variation of relevant impurities**

#### Contact person

*Maximilian Adamy*, RWTH Aachen University, Institute of Plastics Processing, Seffenter Weg 201, 52074 Aachen, e-mail: maximilian.adamy@ikv.rwth-aachen.de

#### Project partners

RWTH Aachen University I.A.R., INEOS Styrolution, Neue Materialien Bayreuth

#### Short description

The material to be recycled generally contains a wide range of different impurities. These are characterised and their influence on the depolymerisation process of polystyrene will be investigated. Possible sources of polystyrene waste are: the polystyrene fraction from household waste (dual system), polystyrene from commercial waste collection, and samples of marine plastic waste. The next steps include: pre-sorting, conditioning of the waste, depolymerisation process in the piston and in the extruder, adaptation of the real samples to the optimum process conditions, and determina-

tion of the optimum operating mode depending on the material source.

## WP 5

### **Fractionating distillation and utilisation of styrene monomers and by-products**

#### Contact person

*Dr. Ralf Gesthuisen*, INEOS Köln GmbH, Alte Straße 201, 50769 Köln, e-mail: ralf.gesthuisen@ineos.com

#### Project partners

Neue Materialien Bayreuth, INEOS Styrolution

#### Short description

Depolymerisation does not produce a pure monomer stream, but rather a mixture of monomers, oligomers and other volatile components. For repolymerisation, the monomers must be separated from this mixture by fractionated distillation. Further fractions remain, which can be converted into recyclable substances by a suitable steam cracking process. The resulting products are examined qualitatively and quantitatively. Based on this, the cracking process is optimised by adjusting the process parameters and possibly adding naphtha and/or hydrogen.

## WP 6

### **Economic and ecological considerations of the recycling concept**

#### Contact person

*Dr. Hannes Kerschbaumer*, INEOS Styrolution Group GmbH, Mainzer Landstraße 50, 60325 Frankfurt am Main, e-mail: hannes.kerschbaumer@ineos.com

#### Project partner

RWTH Aachen University I.A.R.

#### Short description

The knowledge gained in the project is used to adapt the logistics concept developed in WP 2. The costs of the entire value chain, including collection

and recycling, are determined. The question of the location of a depolymerisation plant should have a major influence on the overall calculation: the provision of sufficient raw materials in terms of quantity and quality will show differences in their

feasibility according to certain regions and countries. A special case takes into account whether collected plastic from the environment is also suitable for economic use. An ecological assessment (CO<sub>2</sub> footprint) of the depolymerisation will be carried out.

Project partners	Main areas of work
INEOS Styrolution Group GmbH <i>Dr. Hannes Kerschbaumer</i>	<ul style="list-style-type: none"> <li>» Logistics and economic-ecological estimation</li> <li>» Development of a logistics concept</li> <li>» Economic and environmental evaluation of this concept</li> </ul>
INEOS Köln GmbH <i>Dr. Ralf Gesthuisen</i>	<ul style="list-style-type: none"> <li>» Utilisation of the depolymerisation by-products in the steam cracking process</li> </ul>
RWTH Aachen University, IKV <i>Maximilian Adamy</i>	<ul style="list-style-type: none"> <li>» Depolymerisation process</li> <li>» Depolymerisation in a twin-screw extruder</li> <li>» Removal of the resulting monomers by multi-stage degassing</li> </ul>
RWTH Aachen University, I.A.R. <i>Prof. Dr. Thomas Pretz</i>	<ul style="list-style-type: none"> <li>» Pre-conditioning in processing technology</li> </ul>
Neue Materialien Bayreuth GmbH <i>Prof. Dr. Hans-Werner Schmidt</i>	<ul style="list-style-type: none"> <li>» Depolymerisation process of polystyrene and distillative processing</li> <li>» Investigation and optimisation of the depolymerisation of polystyrene waste on a laboratory scale</li> <li>» Distillative treatment of the obtained fractions</li> </ul>

# solvoPET

## Development of a Recycling Technology for PET Waste Plastics from Multilayer Material and Other Waste Composites

### Coordinator

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**RITTEC Umwelttechnik GmbH**

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### Partner institutions

- » Technical University of Braunschweig
- › Institute for Chemical and Thermal Process Engineering / ICTV
- › Institute of Machine Tools and Production Technology / IWF
- » Fraunhofer Institute for Chemical Technology, Department of Environmental Engineering / ICT
  - » Reclay Materials GmbH
  - » SCHILLER Apparatebau GmbH
  - » VTU Engineering Deutschland GmbH

### Website

<https://solvopet.de/?lang=en>

### Short description

solvoPET aims to develop a solvolytic recycling process for materials made of PET (Polyethylene Terephthalate) in multilayer or mixed materials and to carry out experimental trials. Inactive patents for solvolysis of single-variety PET waste form the basis for this research: those solvolytic processes will be enhanced into a continuous waste treatment concept that can recycle PET waste. This enables the recycling of the PET materials present in the mixed waste and the separation of differing amounts of interfering substances, with the latter being redirected to other uses. The recycling process generates the basic components of PET: monoethylene glycol and terephthalic acid. The flexibility of the process enables sorting of waste from very inhomogenous materials sources such as marine and technical PET wastes. The new recycling process will be tested and evaluated in a pilot plant. The data from this testing is included into continuous economic and ecological assessments of the procedure and its integration into the value chain.



## Main areas of work

- » Development of the technical basis for continuous solvolysis
- » Operation of the pilot plant for experimental development and technological protection of the solvolysis process
- » Development of a mass and energy balances of the continuous processing methods (for pure and mixed PET waste)
- » Development of a model-based tool for the analysis and assessment of environmental impacts
- » Determination of market requirements with regard to recycling routes and required specifications for new streams of recyclable materials
- » Opening up new sources of supply for PET waste composites from post-consumer collections and technical applications

## Work packages

### WP 1

#### **Basic research, process and apparatus design**

##### **Contact person**

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e-mail: s.scholl@tu-braunschweig.de

##### **Project partners**

Fraunhofer ICT, Reclay Materials GmbH, RITTEC Umwelttechnik GmbH, SCHILLER Apparatebau GmbH, VTU Engineering Deutschland GmbH

### Short description

The technical basis for continuous solvolysis of single-variety PET, multilayer PET and mixed PET is developed in WP 1. This includes laboratory tests of the critical process steps for dissolving, separating impurities, and purifying. The aim is to identify the required process functions, quantify advantageous processes and operating parameters and thus develop the main features of the continuous process. The data serve as a basis for the planning, design, construction and commissioning of a modular pilot plant, which enables investigations of different devices.

### WP 2

#### **Pilot studies**

##### **Contact person**

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##### **Project partners**

Fraunhofer ICT, TU Braunschweig ICTV, Reclay Materials GmbH, SCHILLER Apparatebau GmbH, VTU Engineering Deutschland GmbH

##### **Short description**

The central experimental design and technological validation of the solvolysis process takes place through the operation of the pilot plant. The process engineering solutions found in the basic investigations in WP 1 are implemented here. First, PET of a higher purity is processed. For this purpose, the continuous operation is represented. The final goal is the continuous operation of the pilot plant for mixed PET waste streams.

## WP 3

### **Accounting and multi-criteria rating**

#### **Contact person**

*Prof. Dr.-Ing. Christoph Herrmann*, Technical University of Braunschweig, Institute of Machine Tools and Production Technology, Langer Kamp 19B, 38106 Braunschweig, e-mail: c.herrmann@tu-braunschweig.de

#### **Project partners**

TU Braunschweig ICTV, RITTEC Umwelttechnik GmbH, Reclay Materials GmbH

#### **Short description**

The aim is to establish a closed and consistent mass and energy balance of the continuous processing method [for single-variety and mixed PET waste] parallel to the experimental development of the recycling process. This must first be created for the continuous operation of the pilot plant, compared with the operating data and then scaled to potential market scenarios. Based on the formulated requirements and the data from the pilot plant, a model-based tool for the analysis and evaluation of environmental impacts will be developed.

## WP 4

### **Market analysis and technology implementation**

#### **Contact person**

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#### **Project partners**

Fraunhofer ICT, TU Braunschweig ICTV, TU Braunschweig IWF, Reclay Materials GmbH, SCHILLER Apparatebau GmbH, VTU Engineering Deutschland GmbH

#### **Short description**

The market requirements with regard to recycling routes and required specifications for new streams of recyclable materials will be determined. By means of potential analysis, the proportion of recyclable technical waste in machine tools and industrial plants in Germany is also estimated. Based on this, new sources of supply for PET waste composites from post-consumer collections and technical applications will be developed. New potential partners for the implementation of the newly developed solvolysis process in the value chain and the new disposal channels will be identified.

Project partners	Main areas of work
RITTEC Umwelttechnik GmbH <i>Carsten Eichert</i>	» Overall concept, pilot plan operation and market launch
Reclay Materials GmbH <i>Mark Steiner</i>	» Collection and sorting processes and integration of technology
SCHILLER Apparatebau GmbH <i>Andreas Schröder</i>	» Development and construction of the special devices
VTU Engineering Deutschland GmbH <i>Thorsten Harnaut</i>	» Basic and detail engineering, plant design
Technical University of Braunschweig » Institute for Chemical and Thermal Process Engineering » Institute of Machine Tools and Production Technology <i>Prof. Dr.-Ing Stephan Scholl</i> <i>Prof. Dr.-Ing. Christoph Herrmann</i>	» Basic research (ICTV) » Process evaluation and global recycling streams (IMF)
Fraunhofer Institute for Chemical Technology <i>Dipl.-Ing. Jens Forberger</i>	» Process development for separating, sorting, and processing PET waste composites

## Marker-Based Sorting and Recycling System for Plastic Packaging

### Coordinator

*Prof. Dr.-Ing. Claus Lang-Koetz und  
Prof. Dr.-Ing. Jörg Woidasky,*  
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### Partner institutions

- » Polysecure GmbH
- » Werner & Mertz GmbH
- » Der Grüne Punkt – Duales System  
Deutschland GmbH
- » Karlsruhe Institute of  
Technology, Institute of  
Microstructure  
Technology / KIT-IMT

### Subcontractors:

- » CMO-SYS GmbH
- » Nägele Mechanik GmbH

### Associated partners:

- » Umwelttechnik BW GmbH,  
State Agency for Environmental  
Technology and Resource Efficiency  
Baden-Württemberg / UTBW

### Website

[www.hs-pforzheim.de/marek](http://www.hs-pforzheim.de/marek)

### Short description

The goal of this project is to set up a marker-based system for sorting and recycling that involves every stage from packaging development and sorting technology to high quality material reuse. The MaReK project demonstrates the usefulness of fluorescent markers for waste management applications. TBS technology, developed and patented by project partner Polysecure, will be piloted and tested in an industrially relevant context as a solution for the challenges of sorting Large Volume Parenterals (LVP) in particular. This will contribute to fulfilment of the requirement of the new packaging law that a higher proportion of waste be recycled. The project will investigate pace, effectiveness, and economic performance of sorting various waste constellations of waste collection under framework conditions applicable to industry. The project addresses the entire value chain of the packaging lifecycle – from design, to process development for marker application and sorting, to material reclamation. The results will lead to new approaches in packaging governance, which will be worked out with relevant stakeholders – together with the technical results of the project, these will serve as a basis for a more sustainable packaging use in the medium term.

## Main areas of work

- » Representative recycling of lightweight plastic packaging including determination of the technical residual value (material properties) and the added value potential
- » New or further development and industrial testing of the “tracer-based sorting” method with real batches from separate collection (pilot plant), for this purpose further development of tracer and detection technology
- » Applied innovation research for the investigation of drivers and obstacles of the developed technology and their application in the complex structure of stakeholders
- » Comprehensive analysis of energy and material flows and an assessment of possible environmental impacts of the developed technology taking into account the life cycle perspective

## Work packages

### WP 1

#### Packaging design and supply

##### Contact person

*Immo Sander*, Werner & Mertz GmbH,  
Rheinallee 96, 55120 Mainz,  
e-mail: isander@werner-mertz.com

##### Project partners

Der Grüne Punkt – Duales System Deutschland,  
INEC – Pforzheim University, Polysecure

##### Short description

Development and provision of plastic packaging marked with markers from the non-food sector for the subsequent tests as well as the derivation of transferability potentials for further areas of application.

### WP 2

#### Marker technology

##### Contact person

*Prof. Dr. Bryce S. Richards*, Karlsruhe Institute of Technology, Institute of Microstructure Technology,  
Hermann-von-Helmholtz-Platz 1,  
76344 Eggenstein-Leopoldshafen,  
e-mail: bryce.richards@kit.edu

##### Project partner

Polysecure

##### Short description

Adaptation of the fluorescence markers to the intended application.

### WP 3

#### TBS sorting technology

##### Contact person

*Jochen Moesslein*, Polysecure GmbH,  
Engesserstr. 4a, 79108 Freiburg,  
e-mail: jochen.moesslein@polysecure.eu

##### Project partners

Der Grüne Punkt – Duales System Deutschland,  
INEC – Pforzheim University

##### Short description

Development of a TBS sorting machine for packaging including construction of a sorting pilot plant (sorting machine plus material feed and discharge as well as inline sensors).

### WP 4

#### Sorting tests

##### Contact person

*Stefan Wiethoff*, Der Grüne Punkt – Duales System Deutschland GmbH,  
Frankfurter Straße 720–726, 51145 Köln (Porz-Eil),  
e-mail: stefan.wiethoff@gruener-punkt.de

**Project partners**

INEC – Pforzheim University, Polysecure,  
Werner & Mertz

**Short description**

Large-scale validation tests including determination of the quality and material properties of the sorted fractions.

**WP 5****Innovation and sustainability analysis****Contact person**

*Prof. Dr.-Ing. Claus Lang-Koetz*, Pforzheim University, Institute of Industrial Ecology, Tiefenbronner Straße 65, 75175 Pforzheim, e-mail: claus.lang-koetz@hs-pforzheim.de

**Project partners**

With the cooperation of all partners

**Short description**

Development of an energy and material flow model (economic, ecological, technical) and determination of the ecological and economic framework conditions as well as drivers and obstacles for a successful process on the market.

**WP 6****Development of governance approaches****Contact person**

*Prof. Dr.-Ing. Claus Lang-Koetz*, Pforzheim University, Institute of Industrial Ecology, Tiefenbronner Straße 65, 75175 Pforzheim, e-mail: claus.lang-koetz@hs-pforzheim.de

**Project partners**

With the cooperation of all partners

**Short description**

Development of stakeholder-specific approaches to increase recycling rates and to improve material flow quality.

**WP 7****Transfer of results and external impact****Contact person**

*Prof. Dr.-Ing. Jörg Woidasky*, Pforzheim University, Institute of Industrial Ecology, Tiefenbronner Straße 65, 75175 Pforzheim, e-mail: joerg.woidasky@hs-pforzheim.de

**Project partners**

With the cooperation of all partners

**Short description**

Informing the public about the results.

Project partners	Main areas of work
<p>Pforzheim University, Institute of Industrial Ecology</p> <p><i>Prof. Dr.-Ing. Claus Lang-Koetz,</i></p> <p><i>Prof. Dr.-Ing. Jörg Woidasky</i></p>	<ul style="list-style-type: none"> <li>» Innovation and sustainability analysis</li> <li>» Studies on closed-loop economy</li> </ul>
<p>Polysecure GmbH</p> <p><i>Jochen Moesslein</i></p>	<ul style="list-style-type: none"> <li>» Development of the sorting concept, synthesis of the fluorescence markers in cooperation with KIT, further development of the TBS sorting machine</li> </ul>
<p>Der Grüne Punkt – Duales System Deutschland GmbH</p> <p><i>Stefan Wiethoff</i></p>	<ul style="list-style-type: none"> <li>» Cooperation in the development and implementation of marker placement, monitoring and evaluation of sorting tests</li> </ul>
<p>Karlsruhe Institute of Technology, Institute of Microstructure Technology</p> <p><i>Prof. Dr. Bryce Richards</i></p>	<ul style="list-style-type: none"> <li>» Development and synthesis of new fluorescence markers, characterisation of the new materials and support for the detection concept in the sorting machine</li> </ul>
<p>Werner &amp; Mertz GmbH</p> <p><i>Immo Sander</i></p>	<ul style="list-style-type: none"> <li>» Development, testing and processing of suitable packaging</li> </ul>



## Ship-Based Treatment of Plastics for the Implementation of Value Chains in Less Developed Countries as well as for the Prevention of Plastic Inputs into the Environment and Especially in Marine Ecosystems

### Coordinator

*Christoph Rasewsky*

**TECHNOLOG Services GmbH**

Vorsetzen 50

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### Partner institutions

» Hochschule Bremen – City  
University of Applied Sciences,  
Institute for Energy, Recycling and  
Environmental Protection / IEKrW

» Nehlsen GmbH & Co. KG

### Website

**[www.KuWert.hs-bremen.de](http://www.KuWert.hs-bremen.de)**

### Short description

Since it is technically and economically impossible to reduce the amount of plastic waste in oceans, solutions to cut the entry of such substances into the environment must be developed. Developing countries, however, often lack land-based approaches to such solutions. Unused plastic waste actually represents a missed work and income opportunities in less-developed countries, particularly for less-educated people. Valuable plastic wastes usually enter into the environment in these areas, which in turn constitute a significant point of entry into the oceans. The goal of the project is to develop concepts and implementation planning of an infrastructure for recording, boat-based processing, and marketing of plastic wastes in order to reduce their entry into the environment and marine ecosystems. The programme targets less-developed countries, with an aim to create supply chains for trade and utilisation of plastic waste as well as to create added value for the people in the target countries. The programme targets the source of the problem and thus reduces entry of plastic waste into the ecosystem.

## Main areas of work

- » Data collection, analysis and evaluation [local conditions in less developed countries]
- » Preliminary planning of waste treatment plants
- » Design of a concept for suitable ship and plant technology
- » Development of strategies for the implementation of value chains in less developed countries
- » Analysis and evaluation of results [economic, ecological]

## Work packages

### WP 1

#### **Basic evaluation – recording of plastic waste**

##### **Contact person**

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##### **Project partners**

TECHNOLOG, Nehlsen, University of Mauritius,  
University of Sierra Leone

##### **Short description**

It is of utmost importance for the processing of the entire project to gain knowledge of the composition of the plastic waste that potentially will be collected in less developed countries. To this end, data and information (types, qualities, quantities, framework conditions, logistics, etc.) are first collected, analysed and evaluated, including on site in the example countries Sierra Leone and Mauritius.

### WP 2

#### **Pre-design of a treatment and recovery plant**

##### **Contact person**

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##### **Project partners**

TECHNOLOG, IEKRW, University of Mauritius,  
University of Sierra Leone

##### **Short description**

In this WP, waste treatment plants are to be planned in various variants. For this purpose, national and international framework conditions connected with the construction and operation of the ship-based facilities to be developed are determined. Various known procedures are evaluated and tested for their suitability, as are requirements for operation, maintenance and repair. On this basis, the objectives for the treatment of plastic waste are defined, followed by the development of conceptual designs.

### WP 3

#### **Concept development (ship and plant engineering)**

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##### **Project partners**

IEKRW, Nehlsen

## Short description

Preliminary designs for up to three variants of carrier vessels/semi-submersibles for the treatment of plastic waste are developed with alternative ship-bound logistics concepts. Rough planning includes room planning and process-oriented arrangement of facilities, equipment for maritime technology, equipment for waste treatment plants, etc. The production costs and energy requirements are also determined and the variants are compared economically.

## WP 4

### **Marketing potential of secondary raw materials**

#### **Contact person**

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#### **Project partners**

IEKrW, TECHNOLOG

#### **Short description**

The market for secondary raw materials is examined, since these are fundamentally valuable. Tradeable products from plastic waste are identified and the quality requirements to be met specified. Possible revenues will also be estimated. The resulting technical requirements for processing technology and quality management are taken into account in the other WPs. Based on the results, strategies for the most economical processing and marketing of products made from plastic waste are developed.

## WP 5

### **Profitability analysis and life cycle assessment**

#### **Contact person**

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#### **Project partners**

TECHNOLOG, Nehlsen

#### **Short description**

The concepts and preliminary planning for the ship-based collection, processing and marketing of plastic waste from less developed countries developed in the project are evaluated under economic and ecological aspects. On the basis of the results, the ecological advantages (reduction of the input of plastics into the environment, protection of resources by recycling plastic waste) are determined. The evaluation of the economic efficiency is intended to assess the chances of realisation and provide a planning framework for potential investors, funding providers and operators of a ship-based collection and treatment plant for plastic waste.

## WP 6

### **Project management, public relations, recycling concept**

#### **Contact person**

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## Project partners

IEKrw, Nehlsen

## Short description

WP 6 covers work on internal and external communication (project meetings, workshops, communication between national and international partners including maintaining contacts with interested shipping companies/owners, public relations work etc.) and project management (administrative and content reporting, work and progress control and coordination etc.).

Project partners	Main areas of work
<b>TECHNOLOG Services GmbH</b> <i>Christoph Rosewsky</i>	» Design of a concept for suitable ship and plant technology including logistics concepts
<b>Institute for Energy and Environmental Services at the University of Applied Sciences Bremen GmbH</b> <i>Dr. Martin Wittmaier</i>	» Development of strategies for the implementation of value chains in less developed countries » Analysis and evaluation of results (economic, ecological)
<b>Nehlsen GmbH &amp; Co. KG</b> <i>Dr. Sven Rausch</i>	» Preliminary planning of waste treatment plants » Marketing potential of secondary raw materials

# REPLAWA

## Reduction of the Input of Plastics via Wastewater into the Aquatic Environment

### Coordinator

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### Partner institutions

- » Technical University of Berlin,  
Department of Urban Water  
Management / TU Berlin FG Siwawi
- » Technical University of Braunschweig,  
Institute of Sanitary and Environmental  
Engineering / ISWW
- » Technical University of Braunschweig,  
Institute for Social Sciences / IB-ISW
  - » Nordic Water GmbH
- » MARTIN Membrane Systems AG
  - » Lippeverband

### Subcontractor:

- » Mecana Umwelttechnik GmbH
  - » Stadtentwässerung  
Braunschweig GmbH

### Website

[www.replawa.de](http://www.replawa.de)

### Short description

The REPLAWA project covers questions of water resource protection in connection with wastewater treatment. The project will investigate and quantitatively assess entry points into water bodies through treatment plants, storm water drainage, and combined sewer overflows as well as swales at treatment facilities and in sewage sludge. It will test and rate various practical methods of reducing and eliminating plastic emissions into waterways during wastewater treatment. Based on the results of these investigations and of assessments regarding international regulatory approaches in this field, the project will derive strategies for reducing plastic release from wastewater treatment into waterways. Furthermore the sensitization of policymakers as well as plant operators to this problem is also relevant.

The pollutant in focus of this project is microplastic, which poses the greatest challenges to reach the project's goals.

The expected results can be of immediate environmental and economic use, as they will spread technical expertise regarding the choice and integration of technologies suitable for retaining plastic in wastewater treatment. Relevant political and administrative decision makers will benefit from the inventory the project inherently provides and from suggested strategy developments of urban water management.

## Main areas of work

- » Further development and testing of suitable sampling, preparation and analysis methods for plastic particles in wastewater and sewage sludge
- » Inventory and classification of discharges into water bodies via combined sewer overflows, precipitation water, sewage plant effluents and diffuse sources
- » Inventory and balancing on large-scale wastewater treatment plants
- » Evaluation and further development of various technical solutions for the separation of plastics during wastewater treatment by means of comparative tests
- » Social science analysis and classification of wastewater-related regulatory proposals and measures worldwide
- » Recommendations for action on strategy development in the field of urban water management and the associated regulation of plastic input

## Work packages

### WP 1

#### Sampling and analysis methods

##### Contact person

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##### Project partners

Emscher Wassertechnik, TU Braunschweig ISWW, Lippeverband

##### Short description

Definition and application of sampling and analysis methods, comprising i.a. the following tasks:

- » Compilation of requirements for sampling, sample preparation and analysis for microplastic
- » Selection of suitable analytical techniques for the joint research project
- » Establishment of technical and personnel capacities at the Berlin location
- » Definition of sampling and preparation methods for wastewater and sewage sludge
- » Further development, validation of sampling and analysis
- » Development of the methodical procedure for microplastic doping in separation investigations

### WP 2

#### Inventory of entry points for plastics in water bodies

##### Contact person

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##### Project partners

TU Berlin FG Siwawi, TU Braunschweig ISWW, Lippeverband, Stadtentwässerung Braunschweig GmbH

## Short description

Inventory and evaluation of the pathways microplastic takes into water, agriculture and groundwater, which includes the following tasks:

- » data collection, review and selection of appropriate river basin sections, groundwater bodies, and agricultural land
- » definition of a detailed measurement and sampling programme
- » representation and verification of discharges and boundary conditions
- » sampling and analyses
- » supplementary surveys and data evaluation with regard to wastewater input
- » analysis of measured data, quantitative assessment of entry points, evaluation

## WP 3

### **Inventory and balancing on large-scale wastewater treatment plants**

#### **Contact person**

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#### **Project partners**

Emscher Wassertechnik, TU Braunschweig ISWW, Lippeverband, Stadtentwässerung Braunschweig GmbH

#### **Short description**

Investigation, evaluation and optimisation approaches for microplastic retention in large-scale wastewater treatment plants with the following individual tasks:

- » Compilation of requirements for wastewater treatment plants with conventional activated sludge process and process with further solids retention
- » Selection and coordination with large-scale plants
- » Detailed recording of plant characteristics and boundary conditions
- » Sampling and analyses
- » Evaluation of measured data, balancing of material flows, evaluation
- » Derivation of further requirements: technical and operational optimisation approaches for large-scale plants and for the semi-technical investigations (WP 4) with regard to the retention of microplastics



#### WP 4

### **Semi-technical investigations for the further development of technical solutions for the deposition of plastics**

#### **Contact person**

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#### **Project partners**

Emscher Wassertechnik GmbH, TU Berlin FG Siwawi, Mecana Umwelttechnik GmbH, Nordic Water GmbH, MARTIN Membrane Systems AG, Stadtentwässerung Braunschweig GmbH

#### **Short description**

Evaluation and optimisation of the retention performance of microplastics in wastewater treatment plants by investigations on a semi-technical scale for the (downstream) filtration of wastewater and for sewage sludge digestion with doped microplastics. The following steps are carried out for this purpose:

- » selection of plant technology for separation processes using membrane, cloth filter and sand filter
- » setting up the test and measurement programme
- » construction of semi-technical test facilities for comparative investigations at the Braunschweig site
- » execution of the experimental operation, sampling and analyses
- » technical and operational optimisation of the plants with regard to the retention of microplastics
- » final evaluation and assessment of measurement data and plant operation

#### WP 5

### **Social science analysis of regulatory projects and measures worldwide**

#### **Contact person**

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#### **Project partners**

Emscher Wassertechnik GmbH

#### **Short description**

Compilation of international regulatory concepts on microplastics in wastewater, with analysis of stakeholder interests, evaluation of political measures with regard to problem solving and compilation of political options for action in the field of urban water management.

- » Interviews with national, European and global actors
- » Networking with the other key actors of the research focus
- » Analysis of stakeholder interests (state, private) and their effects on regulation (descriptive and causal)
- » Causal analysis of regulatory results (qualitative and – depending on data quality – statistical)
- » Evaluation of policy measures with regard to problem-solving

## WP 6

### **Recommendations for action on strategy development in the field of urban water management**

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#### **Project partners**

TU Berlin FG Siwawi, TU Braunschweig ISWW, TU Braunschweig IB-ISW, Mecana Umwelttechnik GmbH, Nordic Water GmbH, MARTIN Membrane Systems AG, Lippeverband, Stadtentwässerung Braunschweig GmbH

#### **Short description**

Elaboration of recommendations for strategy development regarding the evaluation and reduction of the input of microplastics via wastewater into the natural environment, including the classification of regulatory approaches:

- » Recommendations for action on water discharges, rainwater treatment, and agricultural utilisation
- » Description of technical possibilities for elimination and reduction in wastewater treatment plants, upgrading of wastewater treatment plants
- » Upscaling of the results for different wastewater treatment plant size classes
- » To show how regulatory approaches and changes can be initiated or influenced
- » Development of further recommendations for action and information on the overall strategy development, including the results of the social science analyses

## WP 7

### **Coordination of the joint research project**

#### **Contact person**

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#### **Project partners**

TU Berlin FG Siwawi, TU Braunschweig ISWW, TU Braunschweig IB-ISW, Mecana Umwelttechnik GmbH, Nordic Water GmbH, MARTIN Membrane Systems AG, Lippeverband, Stadtentwässerung Braunschweig GmbH

#### **Short description**

Technical and organisational coordination of the joint research project regarding result determination and support in disseminating findings.

Among other things, the following steps are carried out for this purpose:

- » Technical coordination of cross-cutting topics
- » Coordination with the accompanying project
- » Organisation of project meetings and workshops overarching the research network
- » Creation and implementation of a communication concept
- » Support for the dissemination of results
- » Tracking of time and work planning

Project partners	Main areas of work
Emscher Wassertechnik GmbH <i>Prof. Dr.-Ing. Holger Scheer</i>	» Engineering investigations and coordination of the joint research project
with (subcontract as equipment supplier for the pilot plant): Mecana Umwelttechnik GmbH <i>Dr.-Ing. Ulrich Grabbe</i>	» Cloth filter for separating microplastics in the wastewater treatment plant and in mixed water overflows
TU Berlin, Department of Urban Water Management <i>Prof. Dr.-Ing. Matthias Barjenbruch</i>	» Sampling, analysis methodology and investigation of large-scale plants
TU Braunschweig, ISWW <i>Prof. Dr.-Ing. Norbert Dichtl</i> with (provision of examination sites): Stadtentwässerung Braunschweig GmbH <i>Dipl.-Ing. Andreas Hartmann</i>	» Development of methods and semi-technical investigations for further microplastic elimination in wastewater treatment and sewage sludge treatment
TU Braunschweig, IB-ISW <i>Univ.-Prof. Dr. phil. habil. Anja P. Jakobi</i>	» Social science analysis of regulatory proposals and measures worldwide
Nordic Water GmbH <i>Andreas Sack</i>	» Sand filters and microsieves for the separation of microplastics
MARTIN Membrane Systems AG <i>Dipl.-Kfm. Daniel Crawford</i>	» Use of membrane technology for the separation of microplastics
Lippeverband <i>Dr.-Ing. Issa Nafo</i>	» Investigations on plastic emissions into water and from wastewater sewage treatment plants

# EmiStop

## Identification of Industrial Plastic Emissions by Means of Innovative Detection Methods and Technology Development to Prevent the Input into the Environment via the Wastewater Pathway

### Coordinator

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### Partner institutions

- » Technical University of Darmstadt, Institute IWAR, Department of Wastewater Engineering
- » Technical University of Darmstadt, Institute IWAR, Department of Wastewater Technology
- » RheinMain University, Institute for Environmental and Process Engineering / HSRM
- » inter 3 GmbH-Institute for Resource Management
- » BS-Partikel GmbH

### Website

[www.emistop.de/page8.html](http://www.emistop.de/page8.html)

### Short description

This project systematically detects emissions of plastics into wastewater from relevant industries. Emissions levels will be analysed along all points of the value chain (production, transport, processing, and cleaning of synthetic materials).

The goal is to select wastewater treatment technologies that will optimise reduction of emissions of plastics for the respective value chain. The project will evaluate existing technologies for separating particles, investigate deposition rates, and develop approaches for technical optimisation. Optimisation also includes technological developments such as flocculants. Researchers will conduct tests in both laboratory and pilot project settings – selected large scale technical wastewater treatment plants will be investigated at industrial facilities.

Due to the existing analytical uncertainties, the following detection methods are used to evaluate the existing and developed technologies:

- » Dynamic differential calometry for qualification and quantification (concentrations)
- » Raman spectroscopy for qualification and quantification (particle numbers)
- » Correlations of the plastic concentrations to routine water chemical analyses (for a retrospective estimation of the plastic loads)
- » Tracer test with magnetic plastic particles (simple and reliable quantification in large dilutions) for balancing in laboratory and pilot tests

Apart from the technical aspects, the focus of this project is also on socio-economic aspects. Thus, measures to prevent economic losses and retain value will be reviewed together with the associated industrial enterprises and evaluated with partners from the scientific community and other interest groups.

### Main areas of work

- » Standardisation of sampling and sample preparation for industrial wastewater (in alignment with Plastik-Net and other joint research projects)
- » Quantitative and qualitative measurement of plastic concentrations in industrial wastewater using Raman spectroscopy and dynamic differential calorimetry
- » Extended data collection at the sampled industrial waste water treatment plants for the derivation of the plastic loads and testing of a correlation between the measurement results and routine water chemical analyses
- » Development of magnetic plastic particles in the micrometre range with the physical properties of relevant types of plastic
- » Development of a tracer test with magnetic plastic particles
- » Assessment of technologies for particle separation with regard to the retention of (micro-) plastic particles
- » Optimisation of particle separation technologies
- » Development of flocculants for the targeted improvement of the retention of individual types of plastics and their mixtures
- » Delphi surveys of industry and sector associations as well as of politics and science to identify perceived risks and obstacles as well as opportunities and the willingness to participate
- » Multi-criteria analysis for the development of weighted, ecological and socio-economic criteria for the sustainability assessment of the project results

## Work packages

### WP 1

#### Development of analytical methods for plastic particles

##### Contact persons

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##### Project partner

EnviroChemie

##### Short description

A routinely applicable sampling and sample preparation procedure will be developed in order to create a uniform and comparable database for industrial wastewater. For the subsequent qualification and quantification of microplastics in (industrial) wastewater samples, the methods of dynamic differential calorimetry and Raman spectroscopy are adapted to industrial wastewater. The respective analysis results will be compared with standardised routine measurements and operational self-analysis to determine correlations.

## WP 2

### Tracer test

#### Contact persons

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#### Short description

In order to balance individual process technologies for plastic particle retention in real water matrices, a method for the quantification of magnetic plastic particles by means of magnetic susceptibility scales is established. For this purpose, particles in the size range from 1 µm to 300 µm are synthesised with the greatest possible magnetic susceptibility, which imitate the morphologies and chemical properties of environmental plastic particles.

Furthermore, a continuous method for the production of these particles is established in order to ensure the best possible reproducibility and scalability for subsequent applications.

## WP 3

### Identification of industrial entry points

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#### Project partners

EnviroChemie, inter 3

#### Short description

The entry points of microplastics from industrial wastewater into surface waters are determined by uniform characterisation and quantification of the plastic emissions of individual industrial plants. The evaluation of plastic emissions on the basis of mass flows, variations and production information with key figure system and balance tools, hotspots and temporal variations of the particle input are identified.

## WP 4

### Balancing of technical systems

#### Contact persons

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#### Project partners

TU-AW, inter 3, HSRM

### Short description

In laboratory and pilot tests, various process techniques (filtration in various filter units such as membrane plants, double-layer filters, cloth filters; flocculation in combination with filtration, flotation or sedimentation) are evaluated with regard to plastic particle removal. For this purpose, the tracer particles developed in WP 2 are used, which enable the use of synthetic and real industrial waste water. Furthermore, the existing industrial process technology is evaluated at one or two industrial sites and, if possible, optimised with regard to the separation of plastic particles.

### WP 5

#### Optimisation of plastic retention

##### Contact persons

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##### Project partners

TU-AW

##### Short description

Based on the results of WP 4, the pilot plants are adapted by specific design changes (e.g. flow control, sludge removal, conveyor technology) and the success of these optimisations is evaluated in further balancing experiments.

For the industries considered, in addition to constructive optimisation of process engineering, production-integrated measures to reduce plastic emissions are derived. The production information collected in WP 3 serves as the basis for this.

### WP 6

#### Development of flocculants for plastics sorts

##### Contact persons

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##### Project partners

TU-AT, TU-AW

##### Short description

In experiments with beakers, individual polymers for the targeted flocculation of particles of different types of plastic in the size range from 10 to 300 µm are tested. The results are used to test specific blends of polymers and, if necessary, to develop new polymers to produce the most stable flakes of particles of individual plastic types. With these results, the tests and developments are extended to mixtures of different types of plastics.

The laboratory test results will then be supplemented by pilot tests using tracer particles developed in WP 2.



## WP 7

### Risk and potential analysis

#### Contact person

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#### Project partners

TU-AT, TU-AW, EnviroChemie, HSRM, BS-Partikel

#### Short description

To maximise the broad application of the EmiStop optimisation approaches and avoidance strategies, the risks and potentials are identified from the perspective of the key actors, evaluated and fed into the project at an early degree of technology maturity.

Furthermore, an expert-supported set of socio-political, economic, and ecological evaluation criteria and a meaningful set of indicators are derived in order to analyse and evaluate the multicriterial optimisation approaches and avoidance strategies and in a next step measures for implementation and diffusion.

## WP 8

### Management and communication

#### Contact persons

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#### Project partners

TU-AT, TU-AW, HSRM, BS-Partikel

#### Short description

In order to disseminate and implement the project results, industrial companies are actively involved and dialogue is carried out with experts from relevant industry associations (e.g. PlasticsEurope e.V., IK Industrievereinigung Plastikverpackungen e.V., GKV Gesamtverband Plastikverarbeitende Industrie e.V.). The collaboration is to be commissioned to a) develop the results into a consensual overall perspective, b) prepare these into action-oriented and implementable guidelines and c) make them available via established channels and multipliers, e.g. the Responsible Care Initiative of the chemical industry.

#### Project partners

EnviroChemie GmbH  
*Dr.-Ing. Eva Gilbert*

#### Main areas of work

- » Assessment and optimisation of technologies for particle separation with regard to the retention of (micro-) plastic particles
- » Development of flocculants for the targeted improvement of the retention of individual types of plastics and their mixtures

Technical University of Darmstadt, Institute IWAR,  
Department of Wastewater Engineering  
*Prof. Dr. Susanne Lackner*

- » Quantitative and qualitative measurement of plastic concentrations in industrial wastewater using dynamic differential calorimetry
- » Development of a tracer test with magnetic plastic particles

Technical University of Darmstadt, Institute IWAR,  
Department of Wastewater Technology  
*Prof. Dr.-Ing. Markus Engelhart*

- » Assessment of technologies for particle separation with regard to the retention of (micro-) plastic particles
- » Extended data collection to derive the plastic loads and check a correlation of the measurement results with routine hydrochemical analyses.

RheinMain University, Institute for  
Environmental and Process Engineering,  
Department of Wastewater Treatment  
*Prof. Dr. Jutta Kerpen*

- » Standardisation of sampling and sample preparation for industrial wastewater (in alignment with PlastikNet and other joint research projects)
- » Quantitative and qualitative detection of micro-plastic particles in industrial wastewater using Raman spectroscopy

inter 3 GmbH – Institute for Resource  
Management  
*Dipl.-Ing. Wolf Raber*

- » Delphi surveys of industry and industry associations as well as of politics and science to identify perceived risks and obstacles as well as opportunities and willingness to participate
- » Multi-criteria analysis for the development of weighted ecological and socio-economic criteria for the sustainability assessment of the project results

BS-Partikel GmbH  
*Dr. Kyriakos Eslahian*

- » Development of magnetic plastic particles in the micrometre range with the physical properties of relevant types of plastic

# MikroPlaTaS

## Microplastics in Dams and Reservoirs: Sedimentation, Spread, Effects

### Coordinator

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### Partner institutions

» University of Münster / WWU

» University of Potsdam / UP

» Bielefeld University

» Ecosa

Institute for Water Protection

Mesocosm GmbH

### Website

[www.uni-muenster.de/  
Mikroplatas/en/index.html](http://www.uni-muenster.de/Mikroplatas/en/index.html)

### Short description

The spread of microplastics in rivers shows that along a given waterway there are sources as well as sinks. Thus, dams and reservoirs constitute important but until now hardly investigated parts of a water system that serve as examples for risk vs. usefulness of sedimentation of microplastics. Biofilms, which grow on microplastics, have a special significance for their transport and sedimentation. The goals of this project are (I) to identify and characterise microplastic in water and sediment, (II) to understand how biofilms form on plastic and how sedimentation occurs on these grown-over particles, (III) to record how microplastics affect and are taken up by individual organisms as well as by entire communities in model ecosystems, and (IV) to synthesise the scientific results and draft practical recommendations based on them. This synthesis should emphasise identifying pathways to eliminate microplastics and to derive practical measures and risk assessments together with the project partners.

### Main areas of work

- » Distribution and sedimentation of microplastics and fauna in situ
- » Characterisation of microplastics with regard to biofilm communities and sedimentation mechanisms
- » Direct effects of microplastic on invertebrate species and complex biocenoses
- » Influence of plastics on the food quality of biofilms for Grazer

## Work packages

### WP 1

#### **Survey plastics and meio- and microfauna in dams and reservoirs**

##### **Contact person**

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##### **Project partners**

WWU, Bielefeld University

##### **Short description**

The aim is to estimate the contamination of various dammed waters with microplastics, to identify the relevant polymers and to determine the respective typical macro- and meiofauna. The service water reservoirs Bautzen, Quitzdorf and Malter in Saxony as well as the dammed Ems, the Lippe and the former Rieselfelder Münster in North Rhine-Westphalia are adhesive investigated.

### WP 2

#### **In situ experiments on sedimentation rates and settlement**

##### **Contact person**

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##### **Project partners**

WWU, Bielefeld University

##### **Short description**

The aim is to determine field sedimentation rates in the course of a year with regard to total mass and microplastics. For this purpose, sediment traps are applied to the deepest points of the waters, at minimum, and evaluated monthly with regard to the total mass of plastics and organisms of the meiofauna. As a result, a relationship is established between plastic load in the water column, total sedimentation rate and plastic sedimentation rate.

### WP 3

#### **Characterisation of biofilms on different polymers**

##### **Contact person**

*Prof. Dr. Bodo Philipp*, University of Münster, Institute of Molecular Microbiology and Biotechnology, Corrensstraße 3, 48149 Münster, e-mail: [bodo.philipp@uni-muenster.de](mailto:bodo.philipp@uni-muenster.de)

##### **Project partners**

UFZ, UP, Bielefeld University

##### **Short description**

In this work package, the microbial communities on plastic particles are examined with regard to taxonomic composition and function in order to derive hypotheses on processes at the sites that can be checked in WPs 4 – 6. Particular attention is paid to whether there is a characteristic microflora on microplastic particles and whether individual types of plastic differ. Furthermore, mechanisms of biofilm formation on microplastic particles shall be explained. Cultivation-dependent and -independent investigations are carried out with samples from WP 1 and WP 2 and later with mesocosmic samples [WP 5]. A collection of strains is to be generated in the first project year so that it can be used for WP 5 and WP 6.

### WP 4

#### **Influence of biofilm colonisation, light and redox processes on microplastic sedimentation**

##### **Contact person**

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##### **Project partners**

WWU, Bielefeld University

## Short description

Experiments under controlled conditions shall determine how light and redox ratios (concentration of O<sub>2</sub> and iron) influence the sedimentation of plastic particles either directly or by controlling colonisation. The influence of these factors on sedimentation is studied to simulate the transition from pelagic to benthic habitat. To what extent light or darkness and oxic or anoxic conditions per se, but also their change, can control the sinking behaviour of plastic particles must be determined.

## WP 5

### **Direct effect of plastic particles on invertebrates**

#### Contact person

*Prof. Dr. Walter Traunspurger*,  
Bielefeld University, Department of Animal Ecology,  
Konsequenz 45, 33615 Bielefeld,  
e-mail: traunspurger@uni-bielefeld.de

#### Project partners

WWU, UP, Ecosa, Mesocosm

#### Short description

The uptake and effect of microplastics for aquatic organisms is going to be tested in experimental systems (single-species to model ecosystems) to assess risks for pelagic and benthic fauna. A harmful effect in the organism requires an uptake into the body, either through the ingestion of the particles themselves or through transfer in the food chain (biomagnification). In case of harmful effects, indirect effects (top-down, bottom-up) can occur and thus affect organisms not directly affected by microplastic. In order to evaluate the food web as fully as possible, experiments with increasing ecological complexity and relevance are planned for pelagic and benthic invertebrates to elucidate the effect on organisms, populations and communities and to reduce the interpretation gap between laboratory and field results.

## WP 6

### **Influence of plastics on the food quality of biofilm for meio and macro grazers**

#### Contact person

*Dr. Friederike Gabel*, University of Münster,  
Institute of Landscape Ecology, Heisenbergstraße 2,  
48149 Münster, e-mail: gabelf@uni-muenster.de

#### Project partners

UP, Bielefeld University, UFZ

#### Short description

The aim of this WP is to identify indirect effects of microplastic on meio and macrofauna organisms by influencing the nutritional basis. Biofilms (especially bacteria, fungi, protozoa) form an important food basis for meio and macrofauna in waters. The quality of these biofilms can therefore have a significant influence on the composition and vitality of the organisms grazing them. For grazing experiments, macro invertebrates are offered different overgrown plastic strips for grazing. Ingestion and excretion rates, growth and, in the case of snails, the reproduction of organisms are investigated.

## WP 7

### **Coordination, public relations, knowledge transfer**

#### Contact person

*Dr. Friederike Gabel*, University of Münster,  
Institute of Landscape Ecology, Heisenbergstraße 2,  
48149 Münster, e-mail: gabelf@uni-muenster.de  
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Lake Research, Brückstraße 3a, 39114 Magdeburg,  
e-mail: katrin.wendt-potthoff@ufz.de

#### Project partners

UP, Bielefeld University, Ecosa, Mesocosm

### Short description

The aim is to communicate project results to specific target groups both within the consortium and to the general public (children, students, authorities and scientists).

The practical partners (The State Reservoir Administration of Saxony, Lower Water and Landscape Authority of the City of Hamm, Academy of nature

and Environmental Protection NRW) play an important role here. It is expected that the multiplier effect of the addressed target groups will promote the project results and the topic of plastics in the environment and that this sensitisation will create a broader acceptance for the recommendations for action that arise from the project as a synthesis product.

Project partners	Main areas of work
Helmholtz-Centre for Environmental Research – UFZ <i>PD Dr. Katrin Wendt-Potthoff</i>	<ul style="list-style-type: none"><li>» Distribution of microplastic in waters</li><li>» Biofilm growth and sedimentation processes of microplastic</li></ul>
University of Münster <i>Prof. Dr. Bodo Philipp</i> <i>Dr. Friederike Gabel</i>	<ul style="list-style-type: none"><li>» Taxonomy and physiology of biofilm organisms</li><li>» Distribution of plastics in water and effect on benthic grazer</li></ul>
University of Potsdam <i>PD Dr. Guntram Weithoff</i>	<ul style="list-style-type: none"><li>» Effect of microplastic on planktonic organisms and biocenoses</li></ul>
Bielefeld University <i>Prof. Dr. Walter Traunspurger</i>	<ul style="list-style-type: none"><li>» Ecology and taxonomy of nematodes and other meiofauna</li><li>» Spectroscopic analysis of microplastic in meiofauna</li></ul>
Ecossa <i>Dr. Sebastian Höss</i>	<ul style="list-style-type: none"><li>» Impact and toxicity tests with meiofauna and sediments</li><li>» Indirect food web effects on meiobenthos</li></ul>
Institute for Water Protection Mesocosm GmbH <i>Prof. Dr. Klaus Peter Ebke</i>	<ul style="list-style-type: none"><li>» Impact and toxicity tests with meiofauna and sediments</li><li>» Indirect food web effects on meiobenthos</li></ul>

## Microplastics in Inland Waters – Investigation and Modeling of Entries and Whereabouts in the Danube Area as a Basis for Action Planning

### Coordinator

*Dr. Nicole Zumbülte*

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### Partner institutions

- » German Federal Institute of Hydrology (BfG) / BfG
- » DVGW-Technologiezentrum Wasser / TZW
- » Cologne Technical University, STEPs / THK
  - » BKV GmbH / BKV
- » Bavarian State Office for the Environment / LfU
- » University of Augsburg / UniA
  - » Osnabrück University / UOS

### Website

**[www.micbin.de](http://www.micbin.de)**

### Short description

The goal of this project is to achieve a first-ever accounting of macro-, meso- and microplastics released into the German part of the Danube river basin, with measuring stations at its main tributaries. Microplastic particles (particles < 5 mm) are examined by using various, complementary analytical methods. The focus lies on specifically small particles that are invisible to the naked eye with diameters less than 300 µm as there is currently a distinct lack of data about these particles. This project is mapping the sources, sinks, transport processes and fragmentation of plastics in separate material flow models for micro- and macroplastics. Targeted, standardised sampling and supplementary laboratory experiments are clarifying the relevance of previously neglected input paths such as agricultural land or atmospheric deposition. Results will be implemented into existing models, the models will be validated and a plastic balance for the German Danube watershed will be prepared. Through scenario analyses, the identification of measures to reduce plastic pollution at the level of entire river basins is possible.

### Main areas of work

- » Entry balancing of macro-, meso- and particularly microplastic in the German Danube river basin through uniform sampling campaigns, modelling and supplementary laboratory tests
- » Balancing of previously unconsidered sources and sinks, such as the input of plastic by agriculture, atmospheric deposition of microplastic and degradation processes of plastics in the environment
- » Derivation of minimisation strategies



## Work packages

### WP 1

#### **Coordination**

##### **Contact person**

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##### **Project partners**

UOS, UniA, BfG, THK, LfU, BKV

##### **Short description**

The TZW is responsible for the scientific and general internal coordination within the project, ensures the exchange of information between the internal and external partners and research networks. This includes the preparation of a cooperation agreement between the partners, the organisation of sampling campaigns and sample distribution to the individual partners, the coordination of sample analysis, the organisation of project meetings for exchange between the partners and the maintenance of scientific exchange with other projects at national and international levels.

### WP 2

#### **Analysis of plastics in environmental samples**

##### **Contact person**

*Prof. Dr. Thomas Ternes*, German Federal Institute of Hydrology (BfG), Am Mainzer Tor 1, 56068 Koblenz, e-mail: ternes@bafg.de

##### **Project partners**

LfU, TZW, UOS

##### **Short description**

In this work package, the samples from WP 3 and WP 4 are analysed using three complementary methods. Starting from a high sample volume,

these are pre-selected in advance by BfG using an effective screening procedure (low sample preparation effort, sample analysis using pyrolysis gas chromatography coupled with mass spectrometry). Samples with contents above a threshold value to be defined are subjected to a much more complex and precise analysis using Raman (TZW) and IR spectroscopy (LfU). These processes provide detailed information on particle properties (concentration, size, polymer type, and shape).

### WP 3

#### **Identification of entries / sources**

##### **Contact person**

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##### **Project partners**

THK, BKV, UOS

##### **Short description**

The first step in mass balancing of the selective and diffuse input of microplastics requires a characterisation of all potential sources. The aim of WP 3 is therefore to investigate and quantify entries from points and areas in limnic systems. The results are incorporated in WP 5. The focus is on atmospheric deposition, linear inputs in connection with littering, wastewater treatment plants, landfill leachates, and the weathering of plastics.

### WP 4

#### **Transport, distribution and fate: Process understanding of water, soil, air**

##### **Contact person**

*Prof. Dr. Thomas Ternes*, German Federal Institute of Hydrology (BfG), Am Mainzer Tor 1, 56068 Koblenz, e-mail: ternes@bafg.de

##### **Project partners**

BKV, LfU, UniA, TZW, UOS, THK

## Short description

In addition to sinks such as hydroelectric power plants, this WP will look at transport and relocation processes of microplastics and possible intermediate reservoirs for microplastics such as soils or water sections with low flow. In addition, degradation and comminution processes of plastics are investigated in laboratory experiments. Sinks or reservoirs for microplastics are identified by coordinated sampling in the water body and mass balancing of a water body section. The results of WP 4 are incorporated into the models of WP 5.

## WP 5

### **Drawing up balance sheets by modelling and deriving measures**

#### **Contact person**

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#### **Project partners**

LfU, UniA, BKV, TZW

#### **Short description**

Entries in water bodies are accounted for considering the various sources and sinks and allowing for an estimation of the total freight in the Danube River System. Process-oriented small to medium scale models for microplastic (UniA, UOS) and supra-regional models for micro-, meso- and macroplastic (BKV) are fed with the experimental data and existing data on wastewater treatment plants (LfU, UOS) obtained in the various work packages. From the results of all work packages, a summary evaluation of the sources and sinks with recommendations for measures to reduce water pollution is carried out.

## WP 6

### **Communication**

#### **Contact person**

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#### **Project partners**

LfU, THK

#### **Short description**

The MicBin project homepage informs about project contents, actions and results. In addition, a short film will be produced and made available to the public. The public will be made aware of this issue through a waste collection campaign on the water and participation in the German Sustainability Action Days (DAN). Stakeholders from research, authorities and industry will be informed and involved in workshops.

### Case Studies

The MicBin project focuses on balancing the input of macro-, meso- and particularly microplastics for the German Danube river basin with measurement campaigns at the main Danube tributaries. Among other things, agricultural entries as well as transport and relocation processes are also taken into account.

Project partners	Main areas of work
TZW: DVGW-Water Technology Centre <i>Dr. Nicole Zumbülte</i>	<ul style="list-style-type: none"><li>» Coordination and public relations</li><li>» Analytics using Raman microspectroscopy</li></ul>
Osnabrück University, Institute of Environmental Systems Research <i>Dr. Jörg Klasmeier</i>	<ul style="list-style-type: none"><li>» Weathering and crushing tests</li><li>» Modelling and balancing</li></ul>
University of Augsburg, Institute of Geography <i>Prof. Dr. Peter Fiener</i>	<ul style="list-style-type: none"><li>» Microplastics in agricultural soils</li><li>» Field tests and small to medium scale modelling of the transport of microplastics via soil erosion</li></ul>
German Federal Institute of Hydrology (BfG) <i>Prof. Dr. Thomas Ternes</i>	<ul style="list-style-type: none"><li>» Experiments and modelling on soil, erosion, transport, and agriculture</li><li>» Analytics using pyrolysis gas chromatography coupled to mass spectrometry, process understanding of water/soil/air</li></ul>
Cologne Technical University, STEPs <i>Prof. Dr. Astrid Rehorek</i>	<ul style="list-style-type: none"><li>» Landfill leachate</li></ul>
Bavarian State Office for the Environment <i>Dr. Korbinian Freier</i>	<ul style="list-style-type: none"><li>» Identification of entry points/sources, analytics using FT-IR spectroscopy</li></ul>
BKV GmbH <i>Stephanie Cieplik</i>	<ul style="list-style-type: none"><li>» Modelling</li><li>» Consultation of practitioners</li></ul>

# PLAWES

## Microplastic Contamination in the Weser-Wadden Sea – National Park Model System: an Ecosystem-Wide Approach

### Coordinators

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### Partner institutions

- » Coast Research Centre at the Lower Saxony State Enterprise for Water Management, Coastal Protection and Nature Conservation / NLWKN
- » Jülich Research Centre / FZJ
- » Goethe University Frankfurt / GU
- » Johann Heinrich von Thünen Institute – Federal Research Institute for Rural Areas, Forestry and Fisheries / TI-LR
- » Carl von Ossietzky University of Oldenburg, Institute of Chemistry and Biology of the Sea / UOld

### Website

[www.bayceer.uni-bayreuth.de/PLAWES/en](http://www.bayceer.uni-bayreuth.de/PLAWES/en)

### Short description

In PLAWES, the modelling system of the German national park Weser-Wadden Sea is the first large European river basin that is investigated in detail regarding its microplastic pollution to. PLAWES will conduct a pioneering study of the microplastic contamination from the headwaters to the North Sea (northern Atlantic Ocean) that comprises an interdisciplinary and integrated ecosystem approach and accounts for various point sources (wastewater treatment plants, separation systems) and diffuse sources (drainage, atmosphere) of pollution. The results are integrated into a model for identifying primary transport mechanisms and accumulation zones. The research will investigate the effects of microplastics on ecosystems in the Weser-Wadden Sea system by analysing the interaction of microplastic with pathogens in biofilm and aquatic invertebrates. Outcomes of this particularly ecologically relevant aspects will be used to estimate the environmental risk of microplastics for the model system, and subsequently make it transferable to other systems. In addition, the results of the analysis will become part of new teaching materials in order to provide a knowledge platform for teachers, students, and parents across Europe. PLAWES will generate unique data about the effects of microplastics on a large European river basin and its environment. This will be significant not only for policymakers and stakeholders, but also as a fundament for science-based solutions to address the microplastics problem.

## Main areas of work

- » Microplastics in the Weser-Wadden Sea
- » Model-based balancing of diffuse and point sources of microplastic entries
- » Interaction of microplastics with pathogens and biota
- » Training measures to raise awareness of plastic waste

## Work packages

### WP 0

#### **Management, communication and dissemination**

##### **Contact person**

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##### **Project partners**

AWI

##### **Short description**

WP 0 ensures the targeted and efficient support of the consortium with regard to project management, communication and dissemination. WP 0 coordinates both the public relations work and the exploitation of the results achieved.

WP 0 continues to coordinate the cooperation of all project partners and is therefore in close contact with all project partners. WP 0 coordinates the harmonisation with the joint research project MicroCatch\_Balt with regard to sampling and processing, modelling, public relations, and data storage as well as communication with the other projects.

### WP 1

#### **Microplastics in the Weser-Wadden Sea model system**

##### **Contact person**

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##### **Project partners**

UBT, UOld

##### **Short description**

The aim of WP 1 is to investigate the entire Weser river system into coastal waters with regard to microplastic pollution. The final determination of the exact sampling points is carried out taking into account the real data required for RAUMIS-mGROWA-MePhos and "Tidal Model" (WP 3). The entire Weser including the Lower Weser and the Wadden Sea will be investigated with regard to exposure to microplastic. Two campaigns are planned at different seasons with different water conditions on the Weser.

### WP 2

#### **Entry points – point sources and diffuse entry**

##### **Contact person**

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##### **Project partners**

AWI

## Short description

The aim of WP 2 is an exemplary consideration of the input paths for microplastics by investigation of important point sources such as wastewater treatment plants and separation water sewer systems as well as the diffuse input from drains and atmosphere. For this purpose, selected sampling points in the Weser river basin are characterised taking into account different landscape areas and land use types. The focus is on quantifying the entry points of microplastics. Sampling is synchronised with the campaigns at the Weser.

## WP 3

### **Model-based accounting of diffuse and point-shaped MP entries**

#### **Contact person**

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#### **Project partners**

TI, NLWKN

#### **Short description**

The aim is a spatially resolved quantification of the microplastic emissions from diffuse and point sources and the identification of spatial load centres and accumulation zones within the river basin and estuary. The microplastic entries are modelled from different types of diffuse entry points and point sources. The work is based on the models mGROWA, MEPhos, RAUMIS, as well as a transport modelling considering the estuarine hydro- and sediment dynamics. Within the framework of the project, the model chain will be improved in a targeted manner according to microplastic entry modelling in the inland and the further distribution of the microplastics in the lower reaches, estuary and apron.

## WP 4

### **Interaction of microplastic with pathogens und biota**

*Prof. Dr. Jörg Oehlmann*, Goethe University Frankfurt, Max-von-Laue-Straße 13, 60438 Frankfurt am Main, e-mail: oehlmann@bio.uni-frankfurt.de

#### **Project partners**

AWI, UBT, UOld

#### **Short description**

In WP 4, the ecosystem effects of microplastic on the Weser-Wadden Sea model system are described on the basis of the two ecologically relevant aspects "Interaction with pathogens and antimicrobial resistance" and "Interaction with aquatic invertebrates".

Interaction with pathogens and antimicrobial resistance: Since biofilms are sites of increased genetic exchange and increased antimicrobial resistance occurs below wastewater treatment plants, plastics could not only contribute to the dispersion of pathogenic organisms, but also of resistance genes. The consequences of such a transfer are currently unknown. AWI will therefore use molecular microbial source tracking techniques (DNA/RNA arrays for the detection of pathogenic bacteria, viruses, protozoa and virulence/resistance genes) to investigate plastic samples from the Weser region. Interaction with aquatic invertebrates: In order to generate exposure data, different mollusk species are applied in situ in the Weser, the tidal area and the Wadden Sea. Absorbed microplastic is examined in the digestive tract and in tissue samples and confirmed in parallel by pyrolysis-GC-MS and spectroscopic methods. Historical mussel samples (since 1986) from the Federal Environmental Specimen Bank (UBA) are examined using pyrolysis-GC-MS. The chronic toxicity of microplastic is characterised in laboratory experiments with mussels and worms. Different polymers are conditioned in situ and toxicologically characterised in chronic exposure experiments.

## WP 5

### **Training measures to raise awareness of plastic waste**

#### **Contact person**

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Didactics of Biology, Universitätsstraße 30, 95447  
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#### **Project partners**

AWI, UOld

#### **Short description**

In addition to the ethical assessment skills of students, WP 5 will incorporate existing individual environmental knowledge. Innovative teaching materials with a sound reference to everyday life are evaluated for a holistic understanding regarding the burden of plastics in the model system and disseminated via an Internet teaching/learning portal. Within the work package, UBT provides a handbook for teachers and "public relations workers".

Project partners	Main areas of work
University of Bayreuth <i>Prof. Dr. Christian Laforsch</i>	<ul style="list-style-type: none"> <li>» Project coordination, management and communication</li> <li>» Sampling, processing, analysis</li> <li>» Toxicity tests</li> <li>» Plastic input via the atmosphere</li> <li>» Innovative teaching materials, dissemination and multiplication via teaching/learning portal, development of internet portal</li> </ul>
Alfred Wegener Institute <i>Dr. Gunnar Gerds</i>	<ul style="list-style-type: none"> <li>» Project coordination</li> <li>» Sampling, processing, analysis</li> <li>» Pathogens and antimicrobial resistance</li> <li>» Learning sequences for the education sector, OPENSEA school lab</li> </ul>
Carl von Ossietzky University of Oldenburg <i>Dr. Barbara Scholz-Böttcher</i>	<ul style="list-style-type: none"> <li>» Analytics</li> <li>» Sampling/processing</li> <li>» Teaching materials for educational actors</li> </ul>
Jülich Research Centre <i>Prof. Dr. Frank Wendland</i>	<ul style="list-style-type: none"> <li>» Modelling inland/catchment area</li> </ul>
Johann Heinrich von Thünen Institute <i>Dipl.-Ing. Peter Kreins</i>	<ul style="list-style-type: none"> <li>» Modelling of agricultural sources of input</li> </ul>
Coast Research Centre of the Lower Saxony State Agency for Water Management, Coastal and Nature Conservation <i>Dr. Andreas Wurpts</i>	<ul style="list-style-type: none"> <li>» Modelling for the estuary area/marine system</li> </ul>
Goethe University Frankfurt <i>Prof. Dr. Jörg Oehlmann</i>	<ul style="list-style-type: none"> <li>» In-situ exposure, effect studies</li> <li>» Risk evaluation</li> </ul>

# MicroCatch\_Balt

## Investigation of Sinks and Sources of Microplastics from a Typical Catchment Area to the Open Baltic Sea

### Coordinator

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### Partner institutions

- » Leibniz Institute of Polymer Research Dresden / IPF
- » Jülich Research Centre, Institute for Bio- and Geosciences / FZJ-IBG
- » Johann Heinrich von Thünen Institute - Federal Research Institute for Rural Areas, Forestry and Fisheries / TI-LR
- » Fraunhofer Institute for Computer Graphics Research IGD Rostock / FhIGD

### Website

[www.io-warnemuende.de/  
microcatch-home.html](http://www.io-warnemuende.de/microcatch-home.html)

### Short description

This project determines sources and sinks of microplastic in the Warnow river basin, as well as relevant dissemination processes on its way to the open Baltic Sea. Separate models will be linked so that the resulting model covers the entire river basin including estuary and coastal waters. The linked models serve to identify hotspot areas of microplastic entry and to estimate the effects of microplastic reduction measures in parts of the river basin. By converting the models into a hands-on multitouch table, project participants can make interactive, creative learning modules that can be presented in the form of a traveling exhibition in communities around the German Baltic coast from Stralsund to Flensburg. Further, MicroCatch\_Balt includes the examination of anti-fouling paint and extreme weather events as sources and higher organisms as sinks. Based on this, MicroCatch\_Balt will cover the most important aspects of microplastic contamination of limnic to marine systems in northern Germany, thereby offering interest groups the expertise with which to develop future monitoring and strategies for reduction.

### Main areas of work

- » Sampling in the Warnow river basin and estuary, extraction and identification of microplastics
- » Modelling of microplastic input into the Warnow system of diffuse and point sources
- » Development of two multi-media modules for a multi-touch table and organisation of a traveling exhibition



## Work packages

### WP 1

#### **Sampling of microplastic from the environment**

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##### **Project partners**

IPF

##### **Short description**

In WP 1, environmental samples (water, sediment, soil, benthic and pelagic higher organisms) are collected, processed and identified in the Warnow area. Of particular interest are potential sources such as wastewater treatment plants / sewage separation, drainage ditches, erosion areas, industrially influenced areas as well as extreme events like Hanse Sail, New Year's Eve, heavy rain and storm events. Potential sinks, including higher organisms (mussels, worms, fish), beaches and sediments are also sampled. In all samples, the microplastic particles are identified and quantified using spectroscopic methods.

### WP 2

#### **Modelling of the Warnow estuary and the catchment area**

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##### **Project partners**

FZJ, IOW

##### **Short description**

By adapting and combining different regional models, spatially high-resolution modelling of landside diffuse and point source of microplastic emissions into the river basin of the Warnow will take place. In this way, on the one hand the hot-spots of pollution in the Warnow river area are identified and on the other hand the entire land-side microplastic entries into coastal waters are quantified.

### WP 3

#### **Microplastics Touring Exhibition**

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##### **Project partners**

FhIGD

##### **Short description**

In WP 3 a traveling exhibition with an interactive multimedia learning module will be developed, which presents the project results in the form of animations. The traveling exhibition will be shown in Stralsund, Rostock, Hamburg, Kiel, Eckernförde and Flensburg. The respective exhibition openings will be accompanied by plenary discussions with representatives of the local environmental authorities and scientists.

# MicroCatch\_Balt

## WP 4

### Project management

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#### Short description

WP 4 covers project management and ensures efficient and productive execution of the project. The tasks of WP 4 include coordination with the other "Plastics in the Environment" projects PLAWES, PLASTRAT and the BONUS project MICROPOLL, as well as monitoring finances and work results, organising regular project meetings, disseminating project results to the public, and supporting the project manager with regard to internal and external scientific communication.

Project partners	Main areas of work
Leibniz Institute for Baltic Sea Research Warnemünde <i>PD Dr. habil. Matthias Labrenz</i> <i>Prof. Dr. habil. Gerald Schernewski</i> <i>Dr. Barbara Hentzsch</i>	» Microplastic in the Baltic Sea catchment area: sampling and processing » Estuary modeling » Public participation, traveling exhibition
Leibniz Institute of Polymer Research Dresden <i>Dr. Dieter Fischer</i>	» Identification and quantification of microplastic <5 mm in all samples » Automation of particle recognition, measurement and identification via databases
Johann Heinrich von Thünen Institute <i>Dipl.-Ing.agr. Peter Kreins</i>	» Development of a model to estimate the microplastic emissions from agricultural land in the Warnow river basin
Jülich Research Centre, Institute for Bio- and Geosciences <i>Prof. Dr. Frank Wendland</i>	» Model-based determination of microplastic emission or entries into the river system of the Warnow from diffuse and point sources
Fraunhofer Institute for Computer Graphics Rostock <i>Prof. Dr.-Ing. Uwe Freiherr von Lukas</i>	» Interactive visualisation of microplastic in the catchment area of the Baltic Sea

# Accompanying Scientific Research Project – PlastikNet



PlastikNet

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**Website of the  
accompanying scientific research  
project as well as  
website of the research focus  
[www.bmbf-plastik.de/en](http://www.bmbf-plastik.de/en)**

## **Short description**

PlastikNet accompanies the 18 projects under the BMBF research focus by facilitating networking among them through conferences and issue-specific workshops. It supports the synthesis of results across the various projects and, through its knowledge transfer activities, increases their societal and political impact.

A steering committee, consisting of the coordinators of the 18 research projects as well as client representatives and the Project Management Agency Karlsruhe, was created as a forum for exchange among the institutions involved. It serves to prepare and coordinate the synthesis of results as well as overall knowledge transfer.

In order to ensure effective long-term dissemination of the results and findings of these projects,

## **Plastics in the Environment – Scientific Coordination & Transdisciplinary Knowledge Network**

PlastikNet will oversee project weeks at schools, university seminars, traveling exhibitions and advanced training for specialists.

The public relations work of the overall research programme is also carried out via PlastikNet, i.e. when a corporate design is developed, PlastikNet creates a website as well as informational material and serves the common social media channels.

## **Main areas of work**

- » Exchange of knowledge and networking of joint research projects
- » Synthesis of cross-project results from the joint research projects through synthesis papers and special issues in scientific journals
- » Development of recommendations for action
- » Public relations
- » Transfer into educational concepts and strategies

## **Work packages**

### **WP 1**

### **Coordination and topic-specific networking of joint research projects**

## **Short description**

WP 1 serves to coordinate the content of the projects among themselves. To this end, a steering committee for the research priority will be established and coordinated by Ecologic Institute. There will be an annual networking conference and usually two thematic cluster workshops, which will primarily serve to structure the exchange processes and synthesis.

## WP 2

### **Public relations**

#### **Short description**

The public relations work will compile, summarise, make available and disseminate information on the research focus. In the first project phase, a corporate design is developed, a website created and social media channels created and established. These instruments will later be used to disseminate project results to specific target groups.

## WP 3

### **Preparation and synthesis of research results**

#### **Short description**

In WP 3, cross-project synergy potentials between the various joint research projects and their findings are identified and made usable as a synthesis of the research results by processing them. On the one hand, the synthesis will develop written products for stakeholders from science and practice, e.g. a joint documentation of results in the form of thematic brochures or policy papers (e.g. on future research needs). On the other hand, the research results are also prepared for societal transfer in dissemination materials such as short videos, traveling exhibitions, an international conference and formats for education in schools, companies, universities and professional associations.

## WP 4

### **Participation in scientific conferences, congresses and trade exhibitions**

#### **Short description**

An essential goal of the accompanying scientific research is to make the synthesis of the various projects better known, also in the scientific landscape. To this end, the Ecologic Institute staff actively participates in two scientific conferences per year. To inform the professional public, the dissemination products are presented at various trade fairs and congresses in Germany and abroad on a PlastikNet exhibition stand. Posters and videos will be shown on the stands, informational material will be distributed and questions will be answered to the interested expert audience. There are plans to participate in two specialist congresses per year.

## WP 5

### **Transfer into educational concepts and strategies**

#### **Short description**

With a view to the long-term and society-wide transfer of the findings from the joint research projects, the aim of this work package is to prepare relevant results and findings for application in school education, higher education, as well as in vocational education and training and to identify possible channels through which the prepared findings can be incorporated into educational concepts or strategies.

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