# Waste in German Rivers

## - input- and output-pathways, amount, key figures and avoidance measures-

## Background

- Littering of the seas and oceans in particular by plastic waste is a growing problem with many negative environmental impacts
- Waste entries worldwide by shipping or from land
- Landbased entries from inland areas carried to the seas and oceans via rivers
- Via the German rivers an entry of waste into the seas and oceans is suspected which could have also negative impacts to the rivers itself

## Objectives

- Determination of waste types for macro waste (> 5 mm) and micro waste (1 - 5 mm)
- Determination of input- and output-pathways for the waste in the rivers
- Determination of the amount of waste in selected rivers
- Determination of specific key figures for the amount of waste
- Development of avoidance measures based on the research results

## Research methods

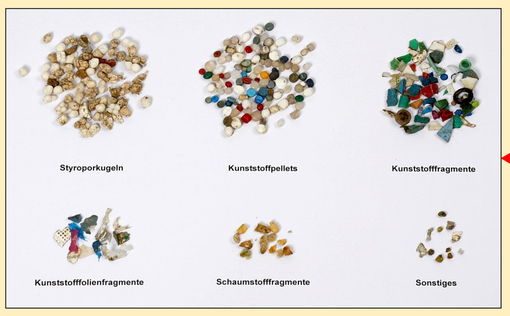
### Input- and output-pathways

**Macro waste (> 5 mm)**

- Product analysis of screenings and flotsam
- Comparison of product categories and -types of waste in the rivers and riparian zones and the adjacent areas

**Micro waste (1 – 5 mm)**

- Product analysis of screenings and flotsam
- Tracking of from the finding place to the source
- Product drilldown
- Detecting of operational processes in plastics-processing or plastics-using companies




Product classes micro waste 1 – 5 mm

### Sorting analyses

**Macro waste (> 5 mm)**

- Classification in product-, material- and size -classes

| Product-classes | Material-classes | Size-classes |
|---|---|---|
| 1 Beverage packaging | 1 Plastic | 1: 0,5 cm to 5 cm |
| 2 Food packaging | 2 Metal | 2: 5 cm to 10 cm |
| 3 Other packaging | 3 Glas | 3: 10 cm to 20 cm |
| 4 Foils/ bags and sacks | 4 Paper | 4: 20 cm to 30 cm |
| 5 Objects from waste water plants | 5 Textile | 5: 30 cm to 40 cm |
| 6 Sports- and leisure-objects | 6 Composit | 6: 40 cm to 50 cm |
| 7 Objects from gardens | 7 Others | 7: > 50 cm |
| 8 Construction materials | | |
| 9 Others | | |

**Micro waste (1 – 5 mm)**

- Classification in product-classes

| Product-classes | Definition |
|---|---|
| Styrofoam balls | Spherical particles of expanded polystyrene, which arise from the decomposition of large packaging materials or insulating panels |
| Plastic pellets | Spherical particles of various plastics which are used as raw material for the plastics processing industry and as a filler material in various products |
| Plastic fragments | Fragments from the fragmentation of large plastic items, with the exception of foils |
| Plastic foils fragments | Fragments from the fragmentation of large Plastic foils |
| Foam fragments | Fragments of polyurethane, which result from the fragmentation of building foam |
| Others | Fragments which do not consist of plastic material (e.g., aluminum foil fragments or glass fragments) |

### Amount of waste

**Macro waste (> 5 mm)**

- Via screenings of hydroelectric power plants
- Via flotsam in the water and in riparian zones
- Via litter at riverbanks and the surrounding areas
- In the water column in aquatic systems of 2nd or 3rd order

**Micro waste (1 – 5 mm)**

- Via screenings of hydroelectric power plants
- Via flotsam in the water and in riparian zones
- In the water column with nets
- In wastewater treatment plants

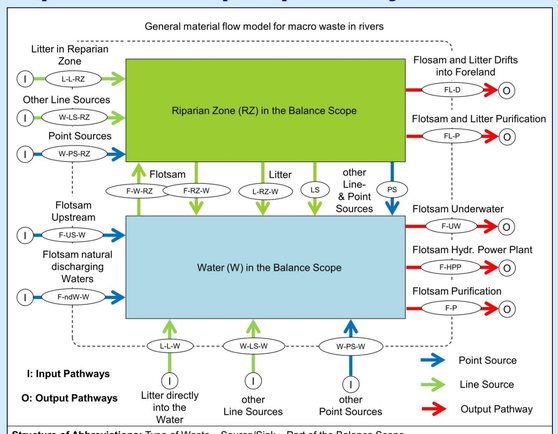
Screenings of hydroelectric power plants

Flotsam in the water and in riparian zones

## Results

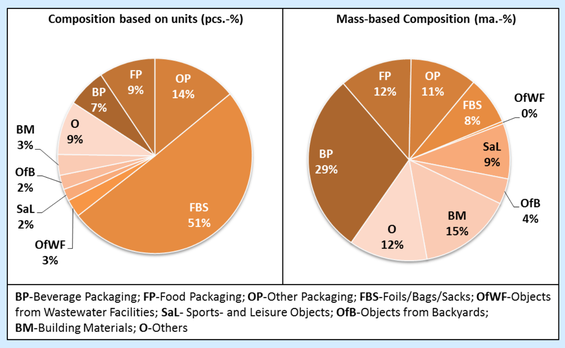
### Macro waste > 5 mm

#### Input- and output-pathways



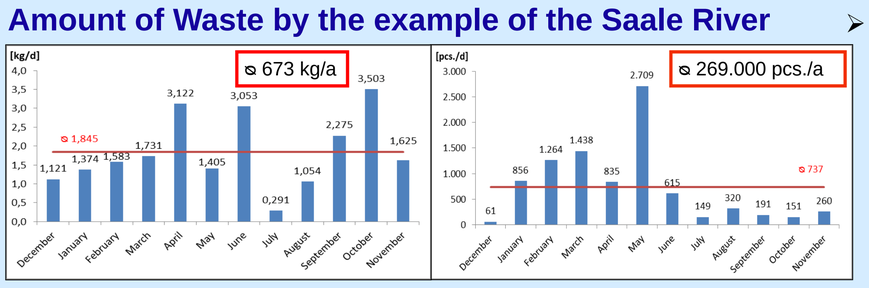

- Littering is the major input-pathway for macro waste in rivers
- Other input-pathways are e.g. waste from Construction sites, illegal waste deposits and rain overflow basins
- Screenings of hydroelectric power plants are the major output-pathways
- In some areas purification is another output-pathway
- Exchange of wastes between waters and riparian zones by level variations and wind

#### Waste composition by the example of the Saale River




- Based on units
  - Foils, bags and sacks (51%) due to a rapid fragmentation most common fraction, followed by packaging (30%)
- Mass-based
  - Packaging (52%) most common fraction
  - 90 % of beverage packaging deposit-free

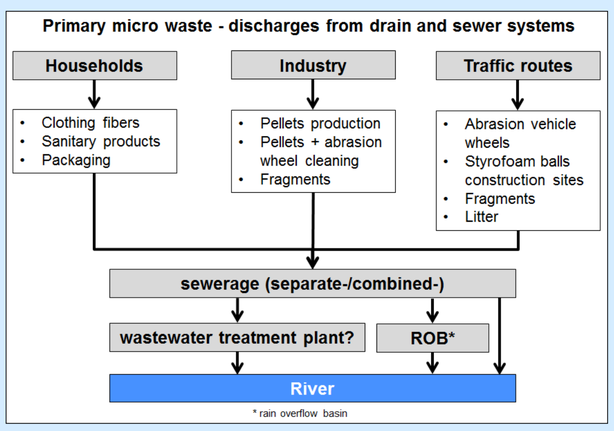
#### Amount of Waste by the example of the Saale River




- An average of 1.8 kg or 740 waste particles per day results in an annual freight of approx. **673 kg** or approx. **269,000** waste particles

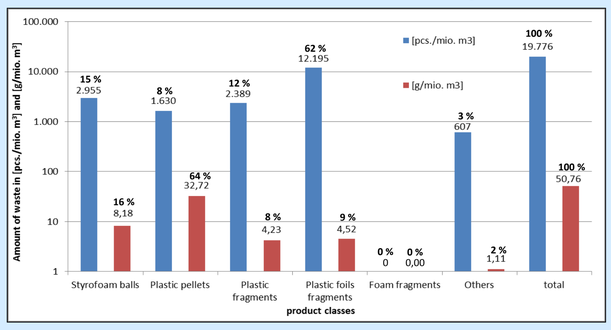
### Micro waste 1 – 5 mm

#### Input- and output-pathways



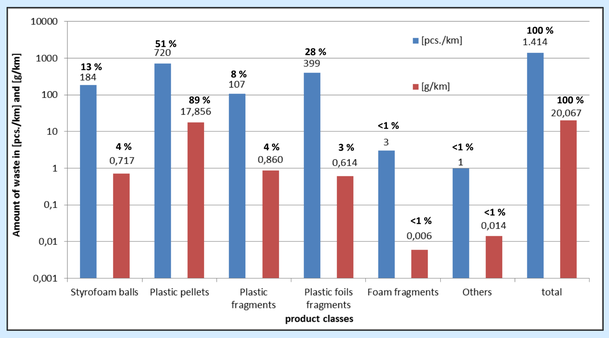

- Secondary micro waste caused by fragmentation of macro waste → see input-pathways for macro waste
- Entry of primary micro waste takes place by discharges from Drain and Sewer Systems
- Direct input via rainwater sewers and discharges from rain overflow basins from combined sewers
- Output via Screenings of hydroelectric power plants

#### Amount of Waste in the river by the example of the Werra River




- Approx. 19,800 pcs. or approx. 51 g per 1 mio. $m^3$
- Total approx. **10 mio. pcs./a** or approx. **25,6 kg/a**
- Based on units
  - Plastic foils fragments (62%) most common fraction, styrofoam balls (15%) and plastic fragments (12%) rank 2 and 3
- Mass-based
  - Plastic pellets (64%) most common fraction, styrofoam balls (16%) second common fraction

#### Amount of Waste in riparian zones by the example of the Werra River




- Flotsam in riparian zones: approx. 1,400 pcs. or approx. 20 g per km
- In the research area (31 km length): approx. **622 g** or approx. **43,800 pcs.**
- Plastic pellets based on units (51%) as well as mass-based (89%) most common fraction
- Plastic pellets are more common washed ashore as plastic foils fragments which are the dominant fraction in waters

### Scheme for avoidance measures with examples

| Type of measure | Polluter (actor-based) | Type of waste (product-based) | Location (situation-based) |
|---|---|---|---|
| legal | Administrative offences,… | Deposit systems, taxes, stipulated limits,… | Administrative offences,… |
| informative | Information campaigns, Clean-ups,… | Indications on products,… | Information campaigns,… |
| monetary | Deposit systems, taxes,… | Taxes on products,… | Local deposit systems,… |
| technical | Retention measures on discharging companies,… | Product design, substitution of plastic materials,… | Position, size and type of waste bins, systematical purification, retention in rain overflow basins, filtration in wastewater treatment plants,… |

- Avoidance measures are derived on basis of the acquired knowledge about typical waste products and their pathways

### Summary

- For both, macro- and micro waste, plastic ist the major part of all materials
- Littering is the major input pathway for macro waste
- The entry of primary micro waste takes place by discharges from Drain and Sewer Systems
- The removal of screenings of hydroelectric power plants is the major output pathway for macro waste and due to adhesions for micro waste as well
- Packaging materials are dominating the amount of macro waste by mass and units
- plastic pellets (mass-based) and plastic foil fragments (by units) are domiating the micro wastes
- On basis of the acquired knowledge, several avoidance measures are derived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