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PLASTIC FREE DANUBE: COMPOSITION OF MACRO PLASTIC WASTE IN THE PROJECT AREA OF DONAU-AUEN NATIONALPARK

Johannes Mayerhofer [1], Gudrun Obersteiner [1] and Sabine Lenz [1]

[1] *University of Natural Resources and Life Sciences (BOKU), Institute of Waste Management, Vienna, Austria*

ABSTRACT: The worldwide problem of plastic waste in the environment is an explosive topic, which is currently being discussed intensively in the media. Rivers are one of the main entry paths for marine pollution (e.g. Great Pacific Garbage Patch). However, sources and pathways as well as environmental impacts in fluvial systems are largely unknown. The project goal of "PlasticFreeDanube" is the establishment of a well-founded knowledge base on macro plastic pollution as well as the definition of standardised methods for the assessment of input sources, quantity, transport behaviour and environmental impacts in and along the Danube. The following article deals with the method development of standardized sampling and sorting of plastic waste in fluvial systems as well as the results of 13 sorting analyses in the project area of Donau-Auen Nationalpark.

Keywords: plastic pollution, riverine input, Danube, Donau-Auen Nationalpark

1. INTRODUCTION

Plastic waste in marine ecosystems is increasingly posing a serious environmental concern at both regional and global level. Worldwide estimations on plastics entering the oceans via rivers vary strongly in literature, the quantities range from 0.4 to 12.7 million tons anually (Jambeck et al., 2015; Lebreton et al., 2017; Schmidt, Krauth, & Wagner, 2017). Nevertheless, it is widley used that around 80% of marine debris orginates from land and in this context rivers are recognized as the main pathways of pollution (IMO et al., 1990; Jambeck et al., 2015). The sources and paths as well as the environmental impacts in rivers and the fluvial environment are largely unexplained. Most of the existing studies focus on microplastics (≤ 5 mm). Previous studies on the generation and origin of plastic waste in rivers use different methods for sampling, measurement and sorting and therefore are largely not comparable. However, reliable estimates are essential in order to develop measures to reduce plastic pollution. For this reason, the cross-border project "PlasticFreeDanube", co-funded by the European Regional Development Fond within the framework of Interreg Slovakia-Austria, aims to gain new insights on this topic for the Danube. Characterized by the largest cross-border European river basin, the Danube represents an optimal project area. As the main artery, the Danube has a direct and significant influence on the Black Sea. Lechner et al. (2014) estimates the annual quantity of plastics via the Danube into the Black Sea at 1,530 tons (focussing more on micro plastic). Information on the amount and composition of macro plastic (> 5mm) is still missing.

2. PROJECT AREA

The investigation area covers the Danube basin including its adjacent riperian area (areas affected by 30 years of flooding - HQ30) from the conurbation of Vienna and Bratislava down to the Slovak hydropower plant (HPP) Gabčíkovo. Thus, the project area extends over almost 100 river kilometers (HPP Freudenau 1,921 to HPP Gabčíkovo 1,823).

With more than 9,600 hectares and a distance of approx. 36 km, the Donau-Auen Nationalpark presents the last remaining major wetland landscape in Central Europe. The free-flowing Danube is in part very different from the other river sections in Austria. The decisive factor is the dynamic change of water level, which can sometimes exceed 7m, and the resulting constant reformation and recreation of the wetland landscape (NPDA, 2011).

Figure 1. Map of Donau-Auen National Park with Sampling Zones (red marks)

3. METHODOLOGY

Based on a comprehensive literature search, existing guidelines, recommendations for action, concepts and reports concerning the monitoring of (marine) plastic pollution were evaluated. The knowledge gained in this way was taken into account for a standardised method development. Output of this implementation progress are a sampling and sorting protocol of plastic waste in and along river systems.

3.1 Sampling

Different approaches were used to determine the origin of the plastic waste and its approximate amount in and along the Danube River. On the one hand, collected plastic from voluntary collection campaigns were used to provide information about the composition of the waste. On the other hand, standardised sampling methods (at the shore zone as well as hinterland of the alluvial forest) were developed in order to collect, weigh, count and assign plastics to a certain size class at regular intervals. In this paper, only the results of the volunteer collections are discussed.

The sampling of the plastic waste is carried out on the Austrian side in cooperation with the project partner National Park Donau-Auen (NPDA). Together with volunteers (school classes, companies, associations, etc.), all waste is collected in different areas depending on the size of the group, average age, weather conditions and vegetation. Thereby, they separate the plastic from other (residual) waste. The eight main collection points (Figure 1) were chosen on the basis of yearlong observations and experiences by the NPDA Rangers, as plastic deposits regularly occur here. In addition, the areas are easily accessible for the collection teams. In some sections of the National Park, more punctual accumulation zones can be observed. Increased quantities of plastic occur within a few square meters, while in the surrounding areas no plastic waste can be detected.

These collection campaigns represent a complete survey in the selected areas. In dependence of the group size and available time, the collection teams usually clean a "defined" length (up to several hundred meters) in current direction. This covers the bank zone (50-100m) directly under the influence of the Danube. On average, each person collected 0.5– 2 kg of plastic per hour.

3.2 Sorting Analysis

With regard to the monitoring of anthropogenic marine pollution, a large number of waste classifications already exist (Cheshire et al., 2009; OSPAR, 2010; van der Wal et al., 2015). These served as a starting point for a comparison of existing catalogues and the plastic fractions defined therein. In order to determine the input paths of plastics and to develop and evaluate avoidance measures, it is necessary to classify plastic waste.

The first "preliminary" sorting of plastic waste from the Donau-Auen National Park initially provided a rough overview of the material composition of the existing plastic items. Based on these findings, an attempt was then made to establish a preliminary categorisation of plastic waste in flowing waters by summarising, simplifying and standardising similar (product) groups or categories of pre-sorting and the reviewed protocols. Due to the project-specific question of the origin of the plastic waste, a preliminary functional classification was carried out in order to be able to assign the respective fractions to the emitting sector or source in the best possible way. Plastic objects or categories which, due to their chemical composition, added additives or physical structure, indicate an increased environmental hazard potential, were additionally subdivided at material level.

Table 1: PlasticFreeDanube Master List - Classification and subdivision of plastic waste

Main-group	Sub-group	No.	Category	No	Sub-Category
Packaging	Drink bottles	1	PET drink bottles + caps		
	Food packaging	2	Food packaging	2a	Flexible packaging
				2b	Hard plastic containers
				2c	Liquid packaging boards
				2d	Composite packaging
				2e	Foamed food containers
	Other non-food packaging	3	Cosmetic bottles & containers		
		4	Cleaner bottles & containers		
		5	Single-use tableware		
		6	Shopping bags		
		7	Building & construction packaging		
		8	Packaging films and sheets		
		9	Other plastic packaging		
Foamed	Foamed plastic	10	Foamed packaging / insulation / undefinable foamed plastic items		
Non-packaging	Household / toys / sport / leisure	11	Toys, sport & leisure article		
		12	Streetwear		
		13	Fishing gear		
		14	Cigarettes inkl. packages		
		15	Lighters		
		16	Housewares / household like items		
	Sanitary & medical article	17	Sanitary waste	17a	Feminine hygiene articles
				17b	Wet wipe/cleaning tissue
				17c	Cotton buds
				17d	Other sanitary waste
		18	Medical & pharmaceutical waste		
	Other non-packaging items	19	Ropes and strings		
		20	Tapes		
		21	Shipping items		
		22	Other plastic items		
		23	Other rubber items		
		24	Car parts		
	Construction waste	25	Building & construction waste		
Others	Hazardous waste	26	Hazardous plastic waste		

Currently, 26 different categories (see Table 1) are defined, which are checked for traceability and plausibility in the course of continuous sorting analyses and adapted if necessary. Subsequently, a sorting protocol for plastic waste in and along fluvial systems shall be developed in such a way that laypersons without special background knowledge can use it, also to compare plastic composition / quantities of their collected waste. Finally, a manual records recommendations as well as details on the correct handling of the sorting protocol.

4. RESULTS AND DISCUSSION

Over one year (autumn 2017 - autumn 2018), around 820 kg of pure plastic waste were removed from the main collection points of the Donau-Auen National Park. The subsequent sorting analyses provided first information on the composition of this plastic waste. The diagrame below (Figure 2) shows the results of 13 samples taken by volunteer's collection campaigns. To simplify matters, the individual categories were combined into sub-groups. The definition of the sub-groups is based on the usual subdivision of plastic waste generated by the plastics industry (PlasticsEurope, 2018) as well as the additional identification of categories that have been explicitly highlighted with regard to their mass and volume-related occurrence.

The results of the sorting analyses (Figure 2) show that PET beverage bottles and foamed plastics are the two largest fractions in terms of volume, but also account for over 30% by weight in more than half of the samples. PET bottles make up the largest category for 7 of the 13 samples, for the others they are at least among the top 3. The foamed plastics also rank among the top 4 with 10 samples.

In addition to household-like waste and sports and leisure waste, the non-packaging sub-group accounts for a significant share. The majority of this sub-group can be traced back to the mixed and undefinable category "Other plastic items". Construction waste includes only those items that are normally installed in buildings (e.g. pipes, cable sheath), with the exception of foamed building materials, like insulating panels. Since it often concerns already strongly weathered and smaller foam material parts, usually the original use purpose of the article cannot be determined. Thus, the allocation to the respective category (e.g. EPS insulation board → cat. "Construction waste" but EPS packaging → cat. "other plastic packaging") is not possible or very difficult. So it was decided to initially record all foamed plastic parts together in one category (foamed plastics). Trials are currently being carried out for further subdivision.

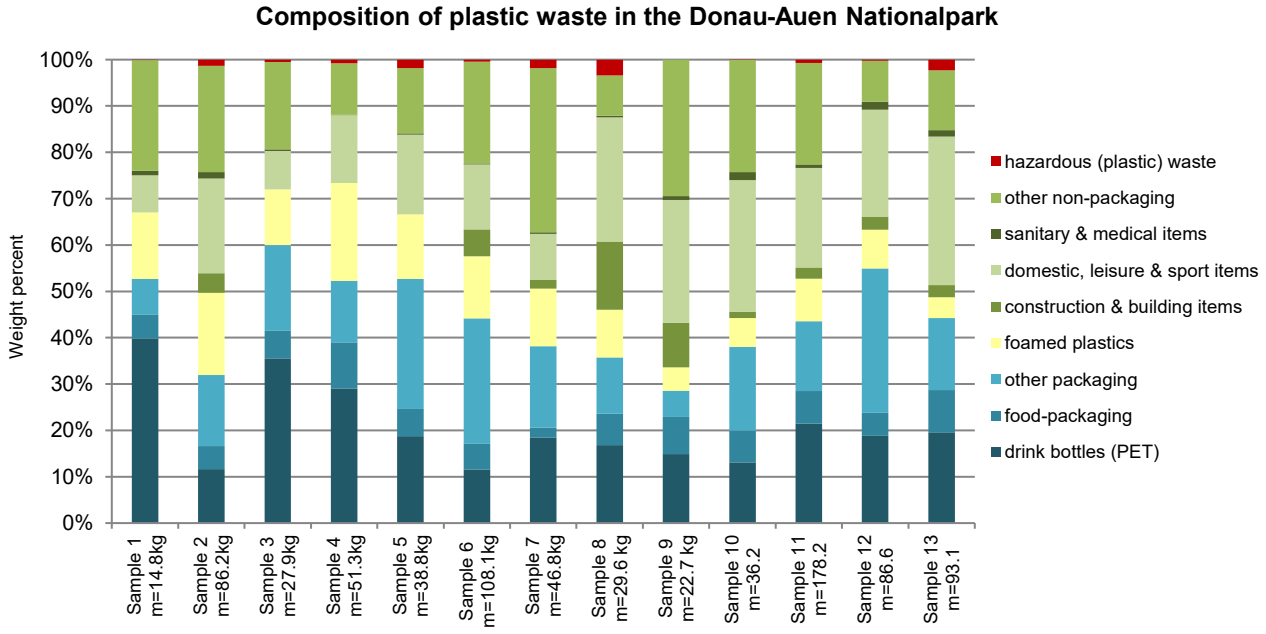

Figure 2: Composition of plastic waste from volunteer's collection campaigns in the Donau-Auen Nationalpark

With regard to the main groups, packaging and non-packaging are on average balanced, whereby the proportion of foamed plastics are not included here.

For the time being, no correlations could be established with regard to the site or collection area. The waste composition is also not subject to seasonal fluctuations (collection autumn/early winter vs. spring/early summer), only the category "leisure and sport items" is on average 6 percentage points higher in summer. This could be due to increased use of such articles in the summer months.

The comparison with studies on running waters in Germany shows the significant influence of a deposit system on the littering of plastic beverage bottles. For example, deposit-free plastic bottles in the Saale river amounts 0.8 % by weight and 0.2 % by item, whereby 90% of all bottles found were deposit free. Measurements in the rivers Fulda, Rhine and Haune showed similar results (Breitbarth, 2017). Conversly, in the Austrian project area of the Donau-Auen National Park PET-beverage bottles are the greatest fraction (mass 12 % to 40%, but also volume) in almost all collections. According to Breitbart, the existing deposit system in Germany can already be regarded as an effective measure to avoid littering of beverage packaging.

5. CONCLUSIONS

On the basis of the composition of the plastic waste collected and sorted as well as the experience of the National Park Rangers, following prelimary conclusions can be made: (i) the majority of the collected macro plastic waste can be attributed to direct or indirect littering and (ii) the bulk of the waste - coming from Vienna as flotsam - is discharged from the Danube into the surrounding area. Regular inspections and controls in the National Park have shown that visitors leave little or no waste in the recreation area. Targeted awareness-raising measures in recent years, such as the reduction of the existing number of waste bins along popular routes and leisure space or recreation areas, have led to a significant reduction of waste generated. The visitors were successfully sensitized to take along their waste.

As mentioned above, measures such as the introduction of a mandatory deposit on disposable PET beverage bottles have a positive impact on waste and litter generation. This is currently being discussed in Austria anyway in connection with the EU's Single-Use Plastics Directive: by 2025, exactly 77 percent of PET bottles will have to be collected, 90 percent by 2029 (European Commission, 2019). Currently, only 73 percent of the bottles issued are collected in Austria (ARA, 2019). Many experts agree that the higher quota of 90 percent demanded by the EU can only be achieved with a deposit.

The general increase in EU recycling quotas for plastic in the framework of the European Circular Economy Package also gives reason to hope in future that the litter situation will improve and that less plastic waste will end up in rivers.

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