Numerical modelling of plastic transport and accumulation at the Austrian Danube River

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Introduction: Rivers nowadays are known to be the main contributors for plastic debris to the ocean. Due to the longevity and unknown long-term effects on biota, these contaminations pose a risk to our environment [2]. Although more than 80 % of marine plastics is related to land-based sources, studies in freshwater systems are rare [1].
Waste collecting activities in the Nationalpark Donau-Auen – a part of the Austrian Danube River in the East of Vienna – indicate that increasing quantities of plastic waste can also be found near the banks and within the inundation areas of our rivers.
To face this challenging pollution problem the EU financed project "PlasticFreeDanube" was launched. The goal of the project is to investigate macro plastic waste (plastic particles > 5 mm) in and along the Danube, in particular its sources, environmental impacts, transported amounts and paths, compositions and possible plastic accumulation zones. New methods have been developed to hydraulically characterize accumulation zones and possibly use them as plastic traps in future.

Methods: Three-dimensional numerical simulations were performed to calculate hydrodynamics for different flow conditions and river sections using the software RSim-3D [3]. The main objective of these high resolution models was to characterize flow fields near river engineering structures such as groynes and guiding walls in areas known as plastic accumulation zones. In addition a particle tracing tool was implemented in RSim-3D. This tool was adapted and further developed, accounting for the floating properties of macro plastic and to describe the flow paths especially in bank near regions. To gain experience on a larger scale a 2D model was set up, predicting potential accumulation zones in the Danubian inundation areas.

Results: The results show that known macro plastic accumulations located in river engineering structures can be explained using 3D models. The particle tracing tool depicts the interaction of particles coming from the main channel and e.g. a groyne field, indicating accumulation and remobilization processes at different discharge levels (Fig. 1).

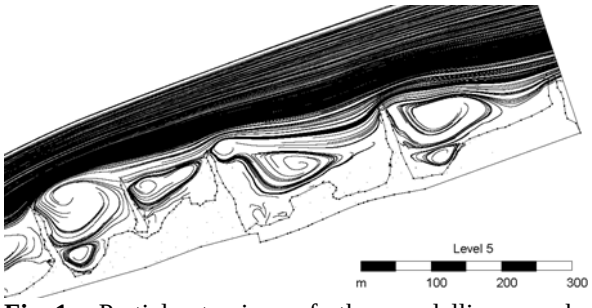

Fig. 1: Particle tracing of the modelling reach Witzelsdorf at low flow conditions (980 m^3s^{-1})

However, the model shows its limitations at banks where other phenomena - such as vegetation - contribute to those accumulations. Furthermore, 2D-modeling turned out to be a suitable method for finding further potential accumulation zones at e.g. anabranches in the inundation area.

Discussion: The results of this study could lead to a reduction of future collection efforts for macro plastics in riverine environments. Information about potential accumulation zones can be provided and by drawing a reverse conclusion recommendations for creating “artificial” accumulation zones can be given.

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