Methods for measuring plastic transport in large rivers and downstream of hydropower plants

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Introduction: Plastic waste in our environment is a matter of increasing concern due to the largely unknown long-term effects on biota [1]. Although freshwater systems are known to be the transport paths of plastic debris to the ocean, almost no freshwater studies existed. Over the recent years, such studies are advancing, but they rarely address the spatial distribution of plastic debris in the water column. Hence a methodology for measuring microplastic transport at various depths that is applicable to medium and large rivers was needed, offering the possibility of measuring microplastic transport at different depths of verticals distributed within a profile. First measurements within the project "PlasticFreeDanube" addressing larger plastic particles also showed that high quantities of macro plastics are retained at hydropower plants. Hence a device was needed to measure the transport right after the power plant and it is aimed to quantify the material retained at the inlet grate of a power plant.

Methods: A robust, net-based device was developed which can be applied at high flow velocities and discharges [2]. The device consists of a strong and stable equipment carrier enabling a stable positioning within a river. Three frames can be equipped with 1-2 nets each, having different mesh sizes (Fig. 1).

Fig. 1: Final device configuration used for measurements in the Austrian Danube River

The uppermost frame is carrying buoyant bodies to sample the surface-near layer of the river, the stopper of the middle net is adjusted to the correct depth after measuring the water depth in the field. One net can be attached to the equipment carrier to address the bottom-near layer. The equipment carrier was then adapted to have a device to measure plastic transport downstream of a hydropower plant. A waste analysis was conducted, in order to quantify the material retained in the inlet grate of the power plant.

Results: The methodology was tested in the Austrian Danube River, showing a high heterogeneity of microplastic concentrations within one cross-section [2]. As plastic transport cannot be limited to the surface layer (turbulence, different densities, growth of biofilms) of a river, it must be examined within the whole water column like suspended sediments. Hence multi-point measurements are necessary for obtaining the spatial distribution of plastic concentration and are a prerequisite for calculating the transport that is occurring. The 500 µm mesh sizes are recommended for a partly turbid stream.

Discussion: A new device was introduced that is the first to address plastic transport at various depths and multiple vertical profiles in medium and large streams. We propose, that the presented methodology can serve as a standard to address plastic transport in freshwater systems.

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