Study of the mechanism of macroplastic litter transport in a stream with vegetation

Plastic pollution is one of the problems affecting reservoirs and waterways around the world. Rivers are the main route by which plastic waste ends up in the seas and oceans. After getting into the river system, these pollutants are deposited on the banks and they are retained by the vegetation. During floods, their mobilization takes place, i.e. the plastic is washed away and starts its journey to the mouth of the river again. A significant part of studies dealing with the issue of plastic pollution focuses on microplastic particles, i.e. with a diameter of less than 5 mm. However, most of the mass of plastic found in rivers is macroplastic, i.e. particles with a larger diameter. Scientists measure the amount and type of plastic they find; in European rivers the most common waste is food packaging. It is also known that different types of vegetation catch plastic rubbish to a different extent, which also gather in low velocity areas of the river. However, there is a lack of research to determine exactly how the presence of riparian vegetation affects the movement of plastic pieces. This is important because macroplastic are a threat to animals, and remaining in nature for a long time, decompose into microplastic, which is much more harmful to the environment, including humans. The knowledge so far indicates that this issue is important and complex, and measures are already underway in the European Union against plastic pollution.

This project has 3 goals: to determine the nature of plastic pollution on the example of an exposed stream with vegetation in an urbanized area and to describe its hydro and morphological conditions; real-scale simulation of a section of the stream with vegetation in laboratory conditions and recording videos of how various plastic elements move in such conditions; building a mathematical model describing such a phenomenon and using the collected data for calibration and evaluation of the computer simulation. The research results will be important in terms of water engineering and ecology. They can be used to design effective ways to remove plastic from rivers, install filtering devices or revitalize watercourses. Particularly in this respect, it will help to draw attention to vegetation during stream maintenance procedures. Moreover, effective implementation of a numerical model of plastic transport will help in identifying places sensitive to plastic accumulation both during low flows and during high water flows.

The project will be carried out by a consortium of three units: the Institute of Geophysics PAS, the Institute of Hydro-Engineering PAS and the Gdańsk University of Technology, combining the specialities and capabilities of young scientists and using the available infrastructure from both centres. A foreign expert from the world-famous Deltares research unit will act as a project consultant.

The examined site will be the Potok Służewiecki in Warsaw. The experiments will be carried out in the renovated Hydraulic Laboratory of the Institute of Hydro-Engineering PAS, the main element of which is a 60-meter-long flow channel. It will recreate natural flow conditions corresponding to the analyzed stream, including the cultivation of vegetation and types of plastic waste. High-resolution cameras placed above the canal will record the movement of prepared plastic particles thrown into the water, and then their trajectories will be described using software specially created for this purpose. Analysis of footage from various scenarios will allow us to identify the most important relationships between the transport of large plastic particles and the presence or absence of vegetation or artificial obstacles. Moreover, the results will be correlated with the flow velocity field, which will be measured with a Doppler velocimeter. Wind, plastic and plant parameters will also be taken into account in the research and used in the construction and verification of the mathematical model. An existing numerical model will be used for computer simulations and a new one will be created based on the ice transport model. The final task will be to integrate the collected information and compare the results, including computer model simulations, with other available data on the transport of macroplastics in watercourses.