Riparian vegetation surveys for roughness estimation – creation of bed roughness maps of the Vistula River

Riparian vegetation is an integral part of river ecosystems. The presence of vegetation increases the roughness by impeding the movement of water, leading to the reduction of flow velocity and the rise of water level in channels. However, the vegetation is both dynamic, since its distribution changes seasonally, or affected by sudden changes due to natural hazards like floods. The bed roughness influenced by vegetation is, thus, dynamic, meaning that the hydrodynamic process represented by numerical models simulated by constant roughness might be not fully accurate. To make numerical simulations a more proper representation of reality and produce accurate results that are basic and crucial references for flood management, it is necessary to monitor the dynamic vegetation roughness and apply it to hydrodynamic simulations. Unfortunately, the challenge of accessing long-term and large-scale monitoring of riparian and aquatic vegetation makes it difficult, making very challenging the quantification of dynamic roughness.

The introduction of remote sensing technology (satellites and uncrewed aerial vehicles-UAVs) simplifies access to vegetation and its monitoring at large scales over a long period. With the help of multispectral vegetation indexes (MVIs), vegetation coverage conditions can be described in detail, while vegetation height and diameter are still difficult to extract from satellite images due to their low spatial resolution. On the other hand, UAVs data generally covers short-term investigations, given the high costs connected with repeated surveys covering large regions. It is, therefore, challenging to obtain long-term and large-scale information from UAV field measurements. The combination of satellite and UAVs images enables the vegetation conditions (VCs) to be acquired easily. Namely, the relationship between MVIs and VCs obtained from high spatial resolution drone imagery can be established, thereby enabling the representation of long-term and large-scale vegetation conditions using satellite-based MVIs.

With the aim of estimating dynamic roughness directly from satellite-based MVIs for supporting flood risk management, three reaches of the Vistula River are selected as the study areas. As the longest river and one of the most important water sources in Poland, the Vistula River is frequently subject to extreme events like floods. By analyzing MVIs and VCs obtained from UAVs' images taken in different seasons, the relationship between them will be established. Long-term dynamic roughness maps, therefore, can be drawn according to such a relationship and satellite images. The project's results will enable vegetation conditions and roughness to be estimated whenever and wherever satellite images are available to calculate MVIs. This project will help to have a better understanding of the role and mechanisms of vegetation roughness in hydrodynamic processes, improve the accuracy of hydrodynamic model simulations, and provide more reliable scientific support for watershed management, flood forecasting, and ecological conservation.