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The Influence of Vegetation on the Spatial Distribution of Water Velocity in a Regulated Lowland River – Preliminary Results

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A b s t r a c t

The paper deals with the study of the influence of vegetation (*Sparganiaceae, Batrachium, Ceratophyllaceae, Elodea Michx.*) on the hydraulic conditions of water flow in a lowland river. The paper presents the results of measuring the spatial distribution of water table and water velocity in the Nida River. The studied section of the Nida is regulated, with a straight course however, the influence of regulation disappears. Banks and bed of the river are partially overgrown in summer seasons. Rigid vegetation grows on the banks of the Nida, but also covers the bottom with tufts of soft vegetation.

Measurements were taken in the summer period during low discharge in Nida (9.15 $m^3 s^{-1}$). Analyses of distribution in hydraulic parameters; water velocities in stream lines or in verticals and the depth variation as a preliminary analysis were presented.

1. DESCRIPTION OF THE OBJECT AND PURPOSE OF THE WORK

The research object is located in the Świętokrzyskie Province (Poland) (Fig. 1). The total length of the river euqals 153 km and a catchment area exceeds 3.8 thousand km^2. The Nida is a lowland river with sandy bottom. The measurements were carried out in the middle course of the Nida near the localities of Kije and Umianowice. Studied section has been regulated however river banks were not reinforced. The current of flowing water is so slow that both, banks and bed of the river during spring and summer are overgrown by aquatic vegetation which influences the distribution of flowing water (Bartnik et al. 2004; Dąbkowski and Pachuta 1996). On the banks, mainly stiff vegetation develops (mainly *Sparganiaceae*, sometimes *Batrachium*), growing vertically in compact habitats, while in the current, soft vegetation developing in clusters appear (*Ceratophyllaceae, Elodea Michx.*). The velocity profile of the water flowing

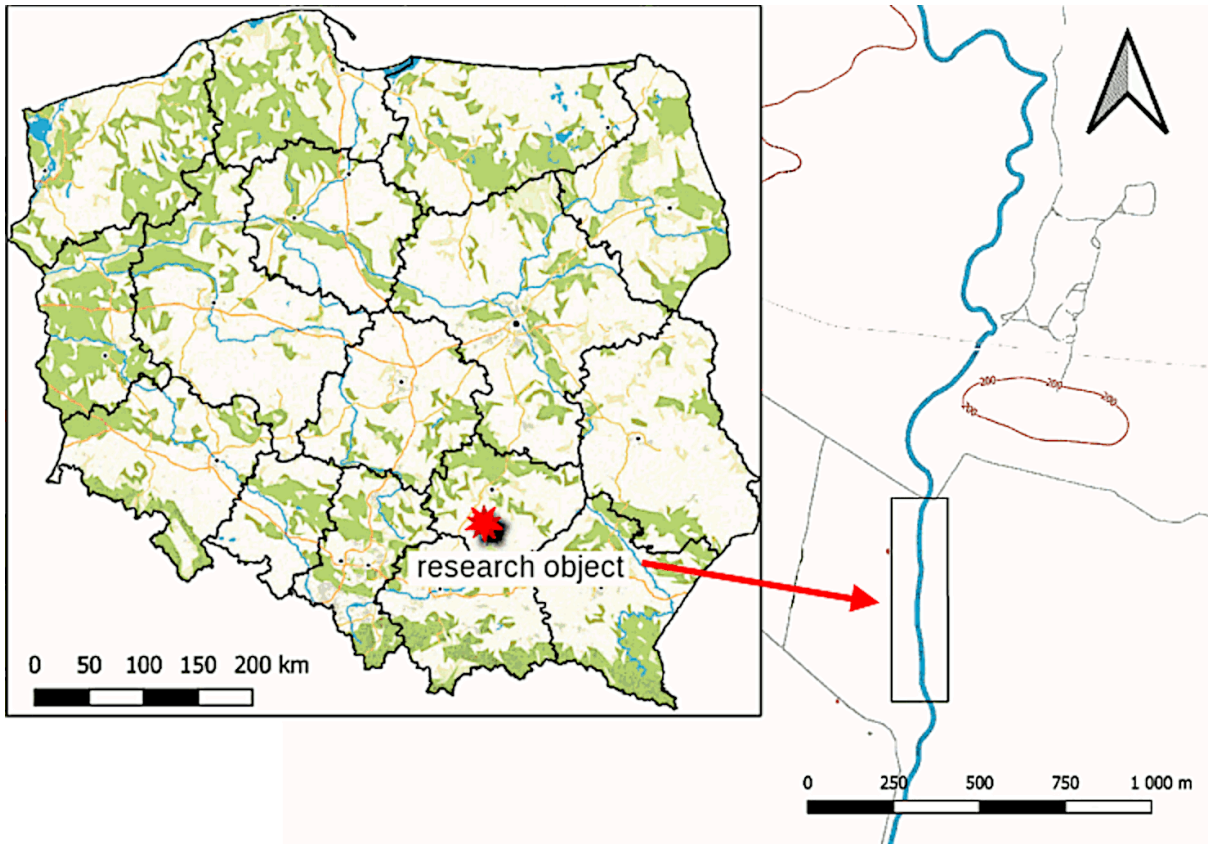

Fig. 1. Location of the study area in the map of Poland.

around and over these clusters is different from the logarithmic one (Chalfen et al. 2010, Kozioł et al. 2016). Its faster growth is favoured by low water levels that usually appear in the summer. The aim of the work is to compare water flow parameters in sections covered with and without vegetation.

2. RESEARCH METHODOLOGY, RESULTS, AND SUMMARY

Measurements of the depth and velocity of water flowing in the Nida River were carried out using the SONTEK S5 acoustic profiling probe (ADCP).

The water surface elevation was measured using the GPS-RTK TITAN TR7 device. ADCP measurements were taken on September 21, 2020 in the length of over 270 m. Obtained model of the riverbed was combined with a digital terrain model downloaded from the geoportal.gov.pl website. Additionally, an unmanned aerial plane equipped with an RGB Full HD camera was used to fly. Acquired photos of vegetated part of the reach were processed to obtain a georeferenced image in the PL1992 (EPSG 2180) system. The performed flight covers a section of the river over 70 m long.

These data were used, on the one hand, to create a longitudinal profile of the water surface in Nida and to create a model of the Nida channel, and on the other hand, a visualization of the average velocity and water table elevation in cross-sections. These measurements were made to describe the effects of slow overgrowing of the riverbed with vegetation during the growing season. On basis of the georeferenced images, polygons reflecting bed vegetation distribution were drawn (Fig. 2).

The velocity cross-sections presented at Fig. 2 indicate a close relationship between the distribution of the flowing water velocity and the growth vegetation. The lack of vegetation results in a uniform cross-sectional profile of the mean velocity in the riverbed. Also, soft vegetation

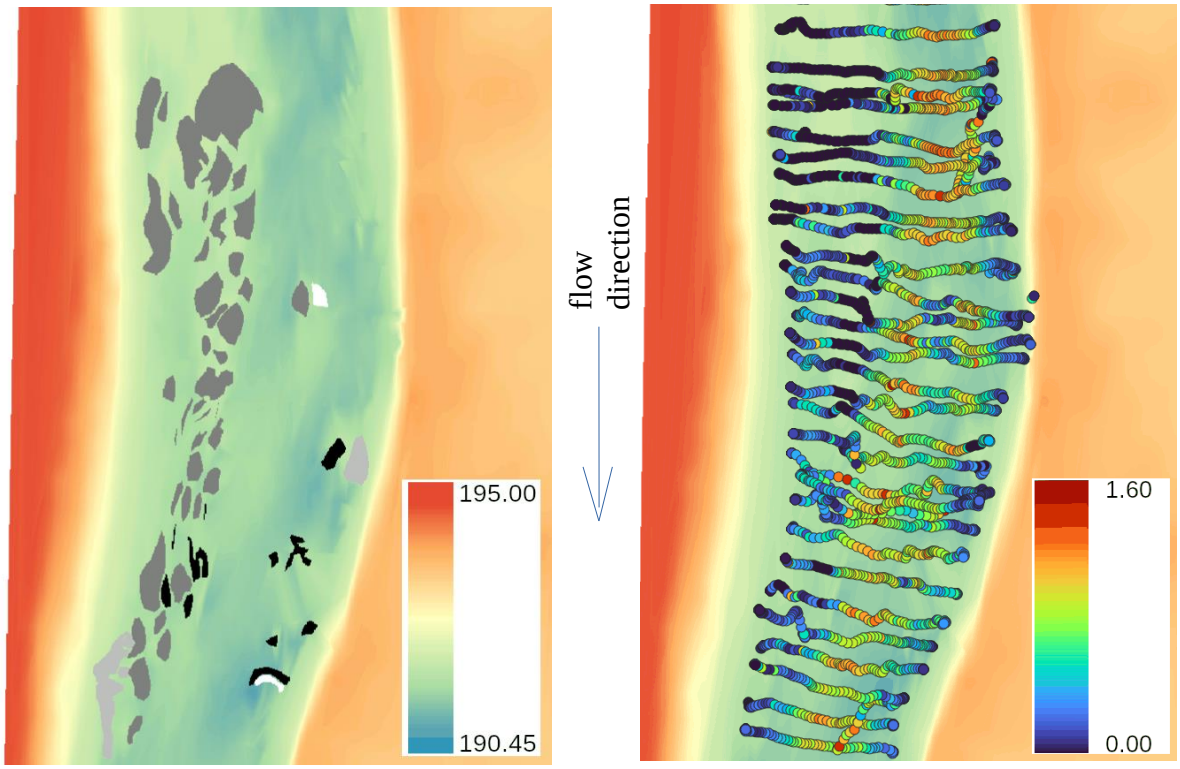

Fig. 2. The Nida River within the investigated reach. The left figure shows a sketch of the location of plants growing on the bottom (on the legend there is data presented elevations in the PL-KRON86-NH altitude system). The right figure shows measurement cross-sections with the value of the average velocity in the hydrometric verticals (on the legend there is data presented velocities in m s^{-1}).

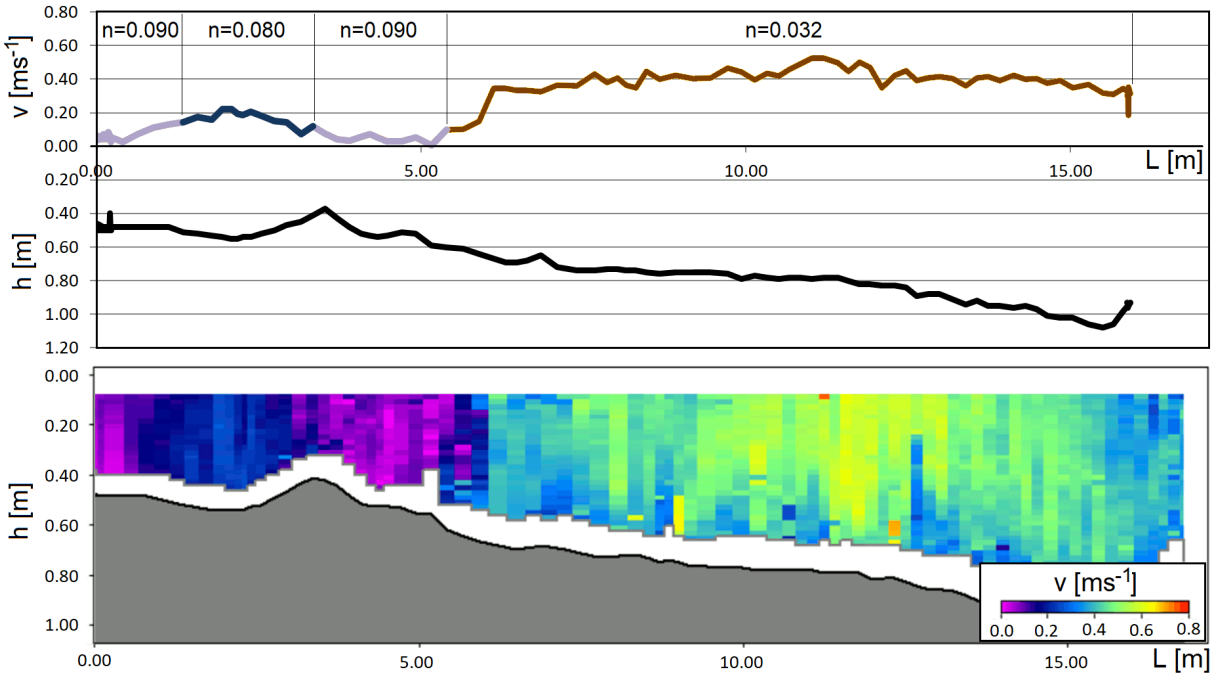

Fig. 3. Visualization of measurement data in chosen cross-section. The upper graph presents velocity averaged in verticals; in brown is an open channel flow marked, in grey and blue the vegetated regions are presented. The lower graph presents the typical picture prepared by ADCP dedicated software. The graph presents temporar velocities captured during measurement.

reaching the water surface can significantly reduce the capacity of the riverbed. Further analyses shell be conducted to determine the clogging effect of vegetation grow within variable flows conditions in the riverbed. At Fig. 3 presented is the chosen one of a cross-sections made in location covered with vegetation. The results are presented by a graph of the average velocity as well as assumed Manning roughness with marked locations of differentiated plant growth (Fig. 3, upper graph). The lower graph of Fig. 3 presents visualization of hydrometric verticals recorded by the ADCP device (Fig. 3, lower graph). There, the area of reduced water flow velocity is clearly marked in violet and blue colour zone.

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