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Abstract Book

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Keynote Lectures

RLR Rivers, Lakes and Reservoirs

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ECS Estuaries, Coasts and Seas

UHH Urban Hydrology and Hydraulics

FDCC Floods, Droughts and Climate Change

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TCEM Theoretical, Computational and Experimental Methods

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WREM Water Resources and Energy Management

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POSTER PRESENTATIONS

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Relation of the observed water level decrease and morphological changes of the river channel in the middle Danube

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ABSTRACT

This work is a continuation of works by Goda et al. (2007) and Tamás et al. (2021) that were prompted by the drying of floodplains and problems in the water supply of irrigation and drainage canal networks in the whole middle Danube region. Previous works focused on hydrology and showed a constant lowering of water levels, which indicated the deepening of the riverbed. In the present study, the relationship between indicators of morphological changes and the decrease in low water levels at Gauging Stations (GS) is sought. At this stage, results confirm a continuous deepening of the riverbed. Despite small correlation coefficient values between low water levels (Z_{min}) and percentage increase in the cross-sectional areas in the sand bed part of the investigated reach, the linear decreasing trend in Z_{min} is evident.

1. Morphological data

The datasets for this study were provided by the Directorate for Inland Waterways in Serbia and the Lower Danube-valley Water Authority in Hungary. These include cross-sectional data either of the regularly surveyed, inventory cross-sections of the two authorities or at GSs' locations along the 300 km long reach from river km (rkm) 1560 (Dunaföldvár, Hungary) to rkm 1255 (Novi Sad, Serbia). In 60 years, there are seven comparable bathymetric surveys for both countries. The data from older surveys were available only in the paper as either depth maps or cross-sections, so they were digitized. In the case of depth maps, cross-sections were extracted after the digitization of the map. In newer surveys, cross-sections were recorded digitally, using an echo sounder synchronized in operation with an RTK GPS.

After the conformance of the datums in the two countries, the cross-sections were plotted in AutoCAD software. To provide a common ground for comparisons along the investigated reach, a reference water level was adopted. *Étiage Navigable* (EN), defined by the Danube Commission in 2012 for each GS, was increased by 2 m. Such a choice of the reference water level is based on visual observations of each cross-section, and it is justified by the fact that this water level (EN + 2 m) is close to bank full level but remains within the main channel. A cross-sectional area below EN + 2 m was then chosen as a starting point for the analysis of the riverbed incision.

2. Results

The evolution of the two chosen cross-sections is presented in Fig.1. The incision may be due to a negative sediment balance caused by river regulation works with cutoffs at the end of the 19th century, extensive dredging in the 20th century and the construction of several Hydro Power Plants in the upstream reaches (Habersack et al. 2019).

Figure 2 shows the percentages of cross-sectional area changes and the correlation between these changes and the minimum water levels at GSs along the Middle Danube River reach. It is readily noticeable that the cross-sectional areas are constantly increasing (Figs. 2a, b). This increase correlates to the decrease in minimum water levels at each GS (Figs. 2c, d). The percentage increase in the cross-sectional area, when compared to the first survey, changes at the rate of 1.6% yearly at the upstream end of the reach to 0.16% yearly at the downstream end (Table 1). The linear decreasing trend in Z_{min} is evident from Figs. 2c, d.

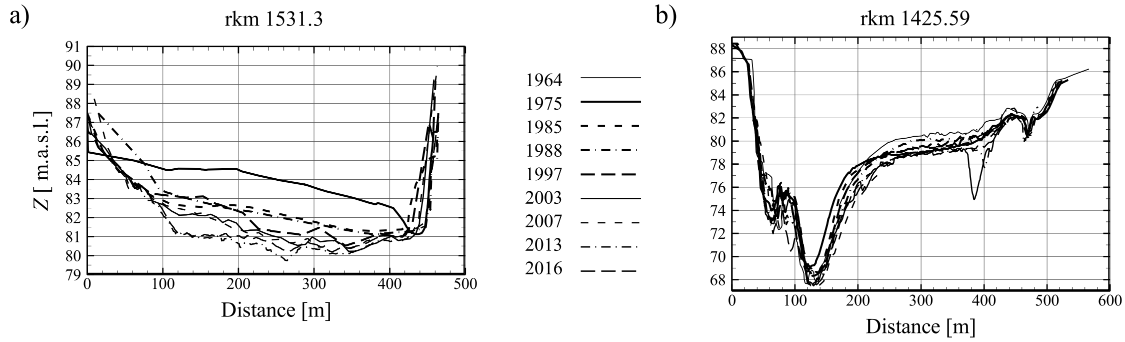

Fig. 1. *Cross-sections evolution at a) GS Paks and b) GS Bezdan; at GS Paks bathymetric data are available from 1975 and for GS Bezdan from 1964.*

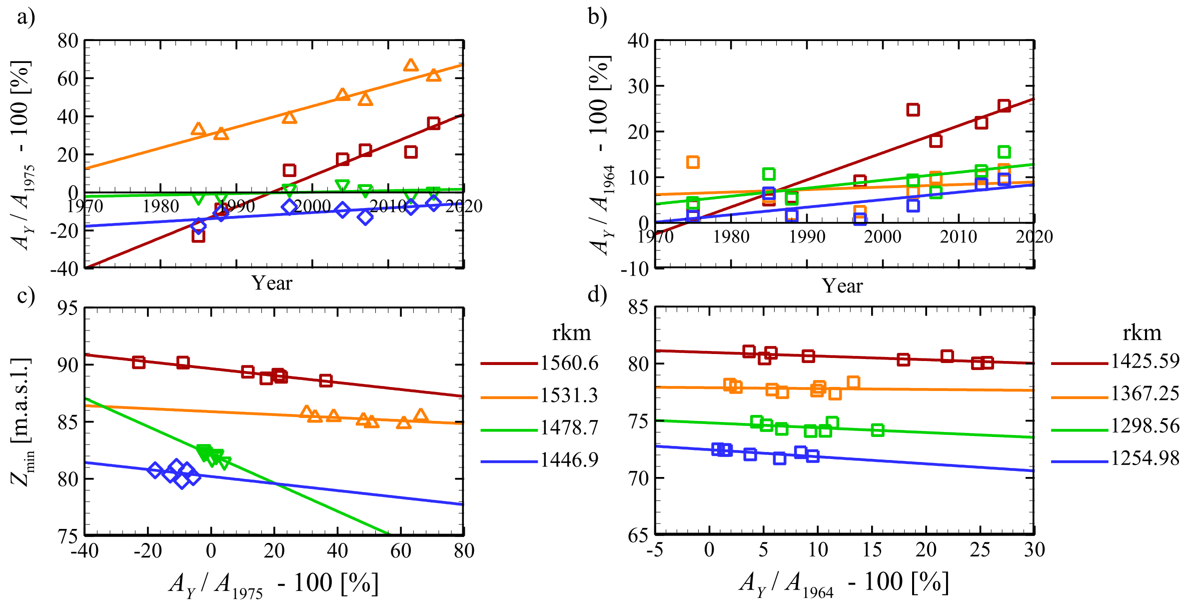

Fig. 2. *Percentages of cross-sectional area changes a) and b) with reference to the initial survey (A_Y/A_{ref} – 100) and the correlation of minimum water levels and percentages of cross-sectional area changes c) and d) at gauging stations in the Middle Danube River reach. A_Y is the cross-sectional area in any year, A_{1975} and A_{1964} are reference cross-sectional areas (A_{ref}) for the first survey in Hungary and Serbia, respectively.*

Table 1. Rates of increase in the cross-sectional area with reference to the first survey $A_Y / A_{ref} - 100 = a\text{Year} - b$, reference years (ref) are 1975 for GSs in Hungary and 1964 for GSs in Serbia

Name of GS and river km	*a*	*b*	Name of GS and river km	*a*	*b*
Dunaföldvár, rkm 1560.60	1.62	3239.6	Bezdan, rkm 1425.59	0.59	1172.1
Paks, rkm 1531.30	1.10	2149.8	Bogojevo, rkm 1367.25	0.27	526.51
Baja, rkm 1478.70	0.08	152.36	Bačka Palanka, rkm 1298.56	0.17	339.07
Mohács, rkm 1446.90	0.24	489.29	Novi Sad, rkm 1254.98	0.16	323.13

3. Conclusions

With the present study of the morphological changes in the middle Danube, the incision along the entire reach is proven by the increase in cross-section areas. The rate of change of the cross-sectional area decreases going downstream, which corresponds to the findings for the water level decrease in Tamás et al. (2021).

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References

Goda L, Kalocsa B, Tamás EA (2007) River Bed Erosion On The Hungarian Section Of The Danube, Journal of Environmental Science for Sustainable Society, 1, 47-54
Habersack H, Haimann M, Gmeiner P, Baranya S, Holubova K, Vartolomei F (2019) Sediment (dis)balance – A significant river management issue, E-proceedings of the 38th IAHR World Congress.
Tamás EA, Đorđević D, Kalocsa B, Vujanović A (2021) Hydrological indicators of the riverbed incision along the free-flowing Danube River reach from Budapest to Slankamen relevant for the lateral connectivity between the river channel and floodplains, Extended Abstracts of the IAD Conference.