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ASSESSMENT OF INVASIBILITY OF THE DANUBE SECTION IN SERBIA

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OCENA INVAZIBILNOSTI PODRUČJA NA DELU TOKA DUNAVA KROZ SRBIJU

Apstrakt

Popis alohtonih vrsta određene teritorije i procena stepena njihove invazivnosti predstavljaju polazni korak na osnovu koga se može pratiti efikasnost sprovedenih mera borbe protiv invazivnih vrsta. Važan aspekt metodologije predstavlja i definisanje potencijalno osetljivih teritorija sa aspekta bioloških invazija, odnosno procena stepena invazibilnosti područja. U ovom radu data je procena invazibilnosti dela toka Dunava kroz Srbiju na osnovu parametara za koje pretpostavljamo da imaju najveći uticaj na osetljivost vodenih ekosistema prema bioinvazijama. To su: nadmorska visina, razuđenost reljefa, broj stanovnika, nivo hidroloških promena i intenzitet rečnog saobraćaja. Na osnovu ukupne ocene koja je dobijena kao srednja vrednost pojedinačne ocene za svaki od navedenih parametara, možemo zaključiti da je sektor od Beograda do brane „Đerdap I" najosetljiviji na biološko zagađenje, kao i deo toka nizvodno od Novog Sada. Na sektor od Beograda do brane „Đerdap I" najveći uticaj na visoku klasu invazibilnosti ima prvenstveno intezivan rečni saobraćaj, kao i nivo hidromorfoloških promena.

Ključne reči: *Dunav, Srbija, biološke invazije, invazibilnost područja.*
Keywords: *Danube river, Serbia, biological invasions, section invasibility*

INTRODUCTION

The ecological status of surface waters is one of the two main determinants of the Water Framework Directive (WFD, 2000). In addition to the ecological status, it is envisaged that all signatory countries identify significant hydromorphological changes on water bodies.

Although hydrological and morphological data in many countries are part of the standard procedure, the mutual dependence of hydromorphological changes and ecological status of the river is poorly known (Babić Mladenović and Kolarov, 2010). Only a few countries have developed a system to integrate hydromorphological changes into ecological assessments. For the Danube River Basin, this was done within the International Commission for the Protection of the Danube River (ICPDR).

In this paper, an estimation of the invasibility of the Danube in Serbia is given based on parameters which we presume to have the greatest impact on the sensitivity of aquatic ecosystems to bioinvasions.

MATERIAL AND METHODS

Assessment of the invasibility of the Danube was done on data collected during the International expedition Joint Danube Survey 3 supported by International Commission for the Protection of the Danube River (ICPDR). Macroinvertebrate samples were collected in August and September 2007. In total, 22 localities along the 588 km of main course of the Danube in Serbia were examined: Batina (JDS40), upstream from the Drava confluence (JDS41), Bogojevo (JDS43), Dalj (JDS44), Bačka Palanka (JDS45), Novi Sad (upstream, JDS46 and downstream, JDS47), Stari Slankamen (JDS48), Belegiš (JDS50), Pančevo (upstream, JDS52 and downstream, JDS53), Grocka (JDS54), Velika Morava confluence (upstream, JDS55 and downstream, JDS57), Stara Palanka (JDS58), Banatska Palanka (JDS59), Golubac (JDS60), Donji Milanovac (JDS61), Tekija (JDS62), Iron Gate II (JDS63), Vrbica (JDS64) and locality upstream from the Timok confluence (JDS65). Benthic samples were taken by benthological hand net (mesh size 500 μm and 1000 μm).

The assessment of the invasibility of the area was obtained by assessing the impact of the selected parameters that supposedly have the greatest impact on the sensitivity of aquatic ecosystems to bioinvasions. These are: elevation, relief characteristics, number of inhabitants, level of hydromorphological changes and intensity of river transport. Scales of rated classes by parameters are given in Table 1.

Parameters are divided into five classes, except for relief characterization and intensity of river transport. The final value of the impact is calculated as the mean value of the classes of all presented parameters. As the values of the two parameters are evaluated in three classes, final values are multiplied by the factor 5/3.

Classes for the assessment of the level of hydromorphological changes were given by Schwarz and Kraier (2008), and taken over Babić Mladenović and Kolarov (2010).

The estimation of the number of inhabitants was based on the number of inhabitants of the municipalities located along the Danube bank, in order to assess the water load of various types of pollution, urban and industrial wastewater, as well as water from the agricultural area. The number of inhabitants is given according to the 2011 census of the Republic of Serbia from Statistical Office of the Republic of Serbia (www.popis2011.stat.rs).

The impact of river transport intensity was estimated by traffic density in t/km according to the data of the Statistical Office of the Republic of Serbia 2007 (2009).

Table 1. Classes of selected parameters. 1 – very low risk, 2 – low risk, 3 – moderate risk, 4 – high risk, 5 – very high risk.

parameter/ class	1	2	3	4	5
elevation (m)	>801	501-800	201-500	101-200	1-100
relief characteristics	very diverse	moderately diverse	unique	/	/
number of inhabitants	below 10.000	10.000-49.999	50.000-99.999	100.000-999.999	over 1.000.000
hydro-morphological changes	nearly natural	sligthly modified	moderately modified	severely modified	totally modified
water transport (t/km)	below 5.000	5.000-10.000	over 10.000	/	/

RESULTS AND DISCUSSION

The results of the hydromorphological assessment show slightly to moderately modified channel in upper stretch of the river, upstream from Pančevo (JDS52). The backwater effect of power plants "Iron Gate I" and "Iron Gate II" is felt on downstream sections characterized by fluctuating flow regime. Twenty kilometres of flow downstream from the "Iron Gate II" (JDS63) is characterized as moderately altered. High level of hydromorphological changes along the Iron Gate reservoirs are also contributed by fully coated shore as a protection against high water levels.

The parameter estimation of the number of inhabitants was based on the municipalities located along the Danube bank. Belgrade (JDS53) is the only town with more than one million inhabitants (class 5). The largest number of cities along the Danube belongs to the second class with a population between 10,000 and 49,999. From this aspect, the most affected part of the Danube represents 150 km of river flow from Novi Sad to Smederevo (JDS47-JDS57). Downstream of the dam "Iron Gate I" (JDS60) the number of inhabitants is decreasing.

Regarding the intensity of river transport, it is noticeable that it is increasing downstream along the river. Sectors with the highest intensity of transport have a traffic density over 10,000 t/km (JDS52-JDS59), while the smallest density is only about 3,500 t/km (JDS40-JDS41).

In its major part, Danube is typical lowland river with a slope of 0.05-0.04 per thousand (Paunović et al., 2007). Sector from the state border (JDS40) to the site of Banatska Palanka (JDS59) has highly variable characteristics of the river channel (class 3). Due to its relatively uniform morphological characteristics, the next sector, namely the Iron Gate Gorge (JDS60-JDS62) has assigned to the class 1. Danube sector downstream of the "Iron Gate II" dam (JDS63-JDS66), has typical characteristics of the lowland river with higher river terraces (class 2).

Based on the overall analyses of selected parameters considered to be important for intensity of biological invasions, we concluded that part of the Danube stretch between Belgrade and Iron Gate I dam, as well as locality downstream Novi Sad are most affected (Figure 1). High class of invasibility was determined due to high intensity of water transport, as well as the level of hydromorphological changes.

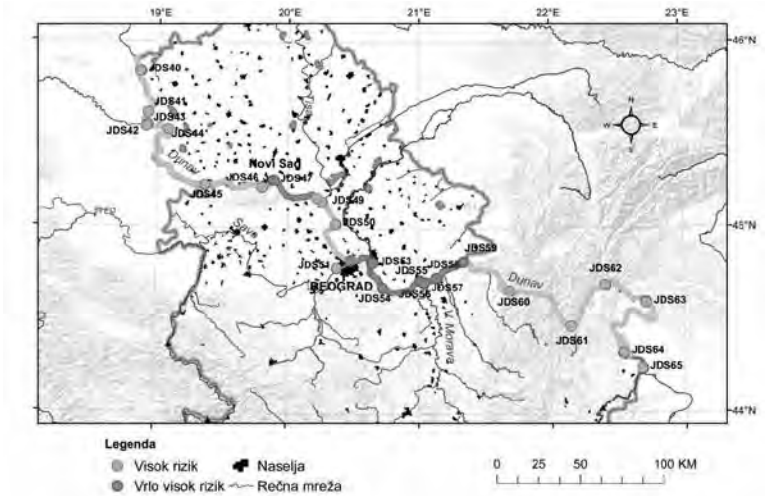

Figure 1. Assessed invasibility of the Danube River in Serbia

In future, research a larger number of environmental parameters should also be included in the analysis, primarily physico-chemical parameters of water and sediment.

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REFERENCES

Babić Mladenović, M., Kolarov, V. (2010): Hydromoorphology. In: Danube in Serbia – Joint Danube Survey 2 (eds. Paunović, M., Simonović, P., Simić, S., Simić, V.). Directorate for Water Management. Belgrade. 97-110 p

European Community (2000): Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy. Official Journal of the European Communities, 327: 1-72.

Paunović, M.M., Jakovcev-Todorović, D.G., Simić, V.M., Stojanović, B.D., Cakić, P.D. (2007): Macroinvertebrates along the Serbian section of the Danube River (stream km 1429–925). Biologia, 62: 214-221.

Statistical Office of the Republic of Serbia (2009): Saobraćaj, skladištenje i veze 2007. Beograd. 167 pp

Statistical Office of the Republic of Serbia (2015): Popis 2011. Available at http://popis2011.stat.rs/ (assessed November 11th, 2017)

Schwartz, U., Kraier, W. (2008): Hydromorphology. In: Joint Danube Survey, 2: Final Scientific Report (eds. Liška I., Wagner, F., Slobodnok, J.). International Commission for the Protection of the Danube River. Vienna. 32-40 p.