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The vegetation of canal Novi Sad–Savino Selo

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Abstract: The canal Novi Sad-Savino Selo has the most rate of water flow and the most fresh water of all canals of the Main Canal Network Danube-Tisza-Danube hydrosystem (MCN DTD) in the Bačka. Vegetation growth in this canal is possible only in a narrow belt along the coast. Submerged vegetation of this canal is presented by plant communities *Ceratophylletum demersi* (Soó 27) Hild. 1956 and *Ceratophyllo demersi-Vallisnerietum spiralis* Lazić 2006. Floating belt is presented by plant communities: *Hydrocharitetum morsus-ranae* Van Langendonck 1935, *Trapetum natantis* Müller et Görs 1960, *Lemno-Spirodeletum* W. Koch 1954 and *Salvinio-Spirodeletum polyrrhizae* Slavnić 1956. Emerged vegetation is growth in a continuous belt along the canal and is presented with stands of plant communities *Scirpo-Phragmitetum* W. Koch 1926, *Typhetum angustifoliae* Pign. 1953, *Typhetum latifoliae* G. Lang 1973 and *Glycerietum maximae* Hueck 1931. The aim of this study was to appreciate the current status of the aquatic vegetation in the canal Novi Sad-Savino Selo for the first time.

Keywords: canal Novi Sad-Savino Selo, aquatic vegetation, submerged vegetation, floating vegetation, emerged vegetation.

Introduction

The overall length of the navigable canal Novi Sad-Savino Selo, a part of the canal network of Danube-Tisza-Danube Hydrosystem (DTD Hs), is 39.11 km. The canal consists of a pool (Novi Sad harbor zone), which stretches from the canal mouth into the Danube to Novi Sad hydro-junction, whose length is 4.5 km, and a section from Novi Sad hydro-junction to the T junction near the village of

Savino Selo, whose length is about 34 km. The latter junction joins the canal Novi Sad-Savino Selo with the section Bečej-Bogojevo. The infrastrucuture of the section Novi Sad-Savino Selo includes the Novi Sad and Despotovo weirs and the lock at Novi Sad. Width of the vegetation-free water surface is 50-70 m and water depth is 2.5-3 m. The canal is connected to the canal Bečej-Bogojevo (at the T junction near Savino Selo), Jegrička canal (at Despotovo weir), the canal Bački Petrovac-Karavukovo (at the mouth of the canal near Bački Petrovac) and the Danube River as the end recipient in Novi Sad. Regarding the traffic intensity, this is a major route connecting the Danube River with the central part of Bačka region. Due to canal location and purpose of Novi Sad weir, which is the most downstream weir of the canal network of DTD Hs in Bačka region, this canal has the steadiest water flow and it is most frequently replenished with fresh water of all canals in the region. Fresh water is supplied through the canal Bečej-Bogojevo (by gravity at the overflow weir at Bezdan and by the pump station at Bogojevo).

For the canal Novi Sad-Savino Selo, before these studies, there were no data about vegetation. The aim of this study was to appreciate the current status of the aquatic vegetation in the canal Novi Sad-Savino Selo for the first time.

Materials and methods

The phytocoenological studies were conducted (from 2003 to 2006) according to the principles of the Zürich-Montpellier School (BRAUN-BLANQUET, 1964). Most of the relevés have been taken from a plot size of 10-20 m^2. The syntaxonomic review of the studied vegetation was adjusted according to Soó (SOÓ, 1964-1980). Plant determination was done according to the publications “Flora of SR Serbia, I-IX” (JOSIFOVIĆ, ed. 1970-1977), “Flora Europeae, I-V” (TUTIN et al., 1964-1980 I-V), “Hínár határozó” (FELFÖLDY, 1990) and “Iconographie der Flora des Südostlichen Mitteleuropa” (JÁVORKA & CSAPODY, 1975). Results of phytocoenological research of the HS DTD published in “Vaskular flora and vegetation in the MCH of HS DTD on the territory of Bačka – current situation and management” (LAZIĆ, 2006) and “Flora and vegetation in main canal network of HS DTD in Bačka” (STOJANOVIĆ et al., 2007) were the basis for this research.

Canal Novi Sad-Savino Selo is located from the 45º29'34.44" and 45º16'05.59" north latitude to the 19º31'40.47" and 19º51'55.52" north longitude. This canal is channeled and it is about 30 years in exploitation. Water quality in this canal is mainly class II and occasionally it deteriorates to class II / III (“Regulation on the Classification of watercourses”). Because of a low water volume and sluggish water flow in the canal network, the self-purification capacity of the studied canal is limited. This explains why the canal section running through Novi Sad is polluted to a considerable degree and water quality deteriorates occasionally (STOJANOVIĆ et al., 1999; KILIBARDA & BUGARSKI, 2002).

Results and discussion

Long-term floristic and phytocoenological studies of the canal Novi Sad-Savino Selo have indicated the presence of 10 plant associations. Those are: submerged stands of the associations *Ceratophylletum demersi* and

Ceratophyllo demersi-Vallisnerietum spiralis, floating stands of the associations *Hydrocharitetum morsus-ranae*, *Trapetum natantis*, *Lemno-Spirodeletum* and *Salvinio-Spirodeletum polyrrhizae* and emergent stands of the associations *Scirpo-Phragmitetum*, *Typhetum angustifoliae*, *Typhetum latifoliae* and *Glycerietum maximae* (LAZIĆ, 2006; STOJANOVIĆ et al., 2007).

Ass. *Ceratophylletum demersi* (Soó 27) Hild. 1956 (Tab. 1, col. 1-3)

Submerged stands of this association were observed in the locations of Despotovo, Bački Petrovac, Rumenka and Novi Sad. The stands grow several meters away from canal banks, as the last vegetation belt towards the vegetation-free water surface of the canal. Going towards the banks, these stands are replaced, in an ecological sequence, with stands of the associations *Ceratophyllo demersi-Vallisnerietum spiralis* and *Hydrocharitetum morsus-ranae*.

In addition to *Ceratophyllum demersum*, which predominated in the submerged layer, we also found *Myriophyllum spicatum*, *Vallisneria spiralis* and *Elodea canadensis*, which were presented in small numbers and low cover percentages. The floating layer, in addition to *Spirodela polyrrhiza* and *Hydrocharis morsus-ranae*, the characteristic species of the order Hydrocharietalia, included also *Trapa natans, Salvinia natans* and *Lemna minor*.

Ass. *Ceratophyllo demersi-Vallisnerietum spiralis* Lazić 2006 (Tab. 2, col. 1-3)

Submerged stands of this community were observed in the locations of Despotovo, Kulpin, Bački Petrovac, Irmovo, Rumenka and Novi Sad. The investigated stands form dense “underwater meadows” along the canal´s banks. These “meadows” are several scores of meters long and 7-8 meters wide. In canal sections characterized by with steep and managed banks, the submerged stands of the association *Ceratophyllo demersi-Vallisnerietum spiralis* are the only representation of the vegetation. In other parts of the canal, going towards the deeper water, these stands are in contact with stands of the association *Ceratophylletum demersi*. In the location of Despotovo, they adjoin abundant populations of *Potamogeton pectinatus.* Going towards the shore, *Ceratophyllo demersi-Vallisnerietum spiralis* stands come in contact with floating stands of the communities of *Hydrocharitetum morsus-ranae* and *Lemno-Spirodeletum*.

In addition to *Vallisneria spiralis* and *Ceratophyllum demersum*, the characteristic species of the association, the submerged layer includes *Elodea canadensis*, the characteristic species of the alliance Potamion, *Myriophyllum spicatum,* the characteristic species of the order Potametalia, and *Najas marina* as a companion species. The floating layer comprising *Hydrocharis morsus-ranae*, *Trapa natans*, *Salvinia natans*, *Spirodela polyrrhiza* and *Lemna minor* is quite sparse.

Ass. *Hydrocharitetum morsus-ranae* Van Langendonck 1935 (Table 1, col. 10-12)

Floating stands of this community were noted in the locations of Despotovo, Bački Petrovac, Irmovo, Rumenka and Novi Sad. The observed stands grew

between submerged stands of the associations *Ceratophylletum demersi* and *Ceratophyllo demersi-Vallisnerietum spiralis*, floating stands of the associations *Trapetum natantis*, *Salvinio-Spirodeletum* and *Lemno-Spirodeletum*, or next to the emergent vegetation (in the location of Novi Sad).

The floating layer is formed by *Hydrocharis morsus-ranae*, the dominant species in the association, *Salvinia natans*, *Spirodela polyrrhiza* and *Lemna minor*, the characteristic species of the order Hydrocharietalia, and *Trapa natans*, the companion species. In spite of the density of floating layer, all stands form also a layer of submerged plants, which includes *Ceratophyllum demersum*, *Myriophyllum spicatum*, *Vallisneria spiralis, Elodea canadensis, Potamogeton pectinatus* and *Potamogeton crispus*.

Ass. *Lemno-Spirodeletum* W. Koch 1954 (Tab. 1, col. 7-9)

Floating stands of the association grow in the locations of Despotovo, Kulpin, Irmovo and Novi Sad. The free-floating species *Spirodela polyrrhiza* and *Lemna minor* that predominantly comprise these stands find optimum conditions for development in shallow and slow-flowing waters. The stands typically form small islands in the vicinity of hydromelioration facilities and next to the emergent vegetation. In the location of Novi Sad hydrojunction, because of blocked water flow, the entire water surface becomes periodically covered with the stands of this association.

Besides the major constituting species of the association, the floating layer comprises also *Salvinia natans,* the characteristic species of the alliance Lemnion minoris, *Hydrocharis morsus-ranae*, the characteristic species of the order Hydrocharietalia and *Trapa natans*, a companion species. The luxuriant submerged layer includes *Ceratophyllum demersum,* the characteristic species of the alliance Lemnion minoris, and the companion species *Vallisneria spiralis, Myriophyllum spicatum, Potamogeton pectinatus* and *Elodea canadensis*.

Ass. *Salvinio-Spirodeletum polyrrhizae* Slavnić 1956 (Tab. 1, col. 4-6)

Floating stands of this community were registered in the locations of Kulpin, Bački Petrovac and Irmovo. They grow next to or between the sparse reed stands. Abrupt changes of water level, due to controlled water regime, cause parts of the former stands to drift to the deeper parts of the canal. Furthermore, fragments of this association can be seen inside other floating communities, especially those whose constituting species have large leaves that slow down water movement, which is favorable for the development of the association *Salvinio-Spirodeletum polyrrhizae*.

The floating layer is formed by *Spirodela polyrriza* and *Salvinia natans*, the constituting species of the association, *Lemna minor,* the characteristic species of the alliance Lemnion minoris, *Hydrocharis morsus-ranae*, the characteristic species of the order Hydrocharietalia, and *Trapa natans*. The submerged layer includes *Ceratophyllum demersum, Vallisneria spiralis, Myriophyllum spicatum* and *Najas marina*.

Ass. *Trapetum natantis* Müller et Görs 1960 (Tab. 2, col. 4-6)

Floating stands of *Trapetum natantis*, which often form a luxuriant plant cover in the part of the MCN DTD Hs in Bačka region, were observed in the studied canal section at Despotovo and Novi Sad. These stands, together with stands of the communities *Hydrocharitetum morsus-ranae* and *Lemno-Spirodeletum,* form a floating vegetation belt or small islands that floated next to the emergent vegetation.

Among the luxuriant leaves of *Trapa natans,* a major constituting species, *Hydrocharis morsus-ranae*, *Lemna minor* and *Spirodela polyrrhiza* are the only other floating species that find the opportunity for growth. This dense floating cover prevents successful development of submergent plants. The submerged layer is formed by *Ceratophyllum demersum, Vallisneria spiralis* and *Myriophyllum spicatum* which are quite low in number and percent cover.

Ass. *Scirpo-Phragmitetum* W. Koch 1926 (Tab. 3, col. 1-3)

Emergent stands of the association *Scirpo-Phragmitetum* grow in the locations of Despotovo, Irmovo, Kulpin, Bački Petrovac, Rumenka and Novi Sad. Forming a wide or a narrow belt, they dominate the banks of the canal. They are occasionally interspersed with stands of the associations *Typhetum angustifoliae, Typhetum latifoliae* and *Glycerietum maximae,* forming a picturesque mosaic in the zone of the emergent vegetation.

Phragmites communis provides a major physiognomic feature to all stands of the association *Scirpo-Phragmitetum*. The floristic structure is made up by 20 plant species whose numbers and cover values are low. *Butomus umbellatus*, the characteristic species of the class Phragmitetea, is an exception. Its numbers and percentages of cover are quite high in several stands.

Ass. *Typhetum angustifoliae* Pign. 1953 (Tab. 3, col. 4)

Semiaquatic stands of the association *Typhetum angustifoliae* were observed in shallow waters along the canal banks, in the locations of Despotovo, Irmovo and Novi Sad. Going towards the middle of the canal, they are in contact with the previously described floating vegetation, and towards the banks they are in contact with stands of the association *Scirpo-Phragmitetum*.

The stands of this association are floristically poor. Besides *Typha angustifolia,* which is absolutely dominant, *Phragmites communis* and *Typha latifolia,* the characteristic species of the class Phragmitetea, and the companion species *Calystegia sepium* and *Solanum dulcamara* are present in small numbers and minimum percentages of cover.

Ass. *Typhetum latifoliae* G. Lang 1973 (Tab. 3, col. 5, 6)

Emergent stands of the association *Typhetum latifoliae* were found in the locations of Despotovo and Novi Sad. Their distribution is limited. They form small islands or narrow belts which, towards the banks, adjoin the stands of the association *Scirpo-Phragmitetum*.

These stands are floristically poor. In addition to the dominant species of the association, they include *Butomus umbellatus, Glyceria maxima* and *Rumex hydrolapathum*, the characteristic species of the class Phragmitetea, and the companion species *Carex pseudocyperus*.

Ass. *Glycerietum maximae* Hueck 1931 (Tab. 3, col. 7)

Emergent stands of the association *Glycerietum maximae* were observed only in the location of Despotovo, in the shallow waters near canal banks. Going towards the middle of the canal, these extensive stands come in contact with floating stands of the associations *Salvinio-Spirodeletum*, *Lemno-Spirodeletum*, *Hydrocharitetum morsus-ranae* and *Trapetum natantis* as well as with submerged stands of the association *Ceratophyllo demersi-Vallisnerietum spiralis*. Between these stands and the banks, there is a luxurious belt of stands of the association *Scirpo-Phragmitetum*.

The dominant species *Glyceria maxima* forms dense stands that permit a small number of other plant species to grow, i.e., those which start to grow and develop simultaneously with the dominant species. In this situation, *Butomus umbellatus, Iris pseudacorus* and *Rumex hydrolapathum*, the characteristic species of the class, and companion species *Carex pseudocyperus, Calystegia sepium, Solanum dulcamara* and *Epilobium adnatum*, are registered in small numbers and low cover percentages.

Conclusion

The vegetation of the canal Novi Sad-Savino Selo is comprised of stands of submerged, floating and emergent species. The submerged vegetation is formed by the stands of the associations *Ceratophylletum demersi* (Soó 27) Hild. 1956 and *Ceratophyllo demersi-Vallisnerietum spiralis* Lazić 2006. The floating vegetation is formed by the stands of the associations *Hydrocharitetum morsus-ranae* Van Langendonck 1935, *Trapetum natantis* Müller et Görs 1960, *Lemno-Spirodeletum* W. Koch 1954 and *Salvinio-Spirodeletum polyrrhizae* Slavnić 1956. The emergent vegetation is formed by the stands of the associations *Scirpo-Phragmitetum* W. Koch 1926, *Typhetum angustifoliae* Pign. 1953, *Typhetum latifoliae* G. Lang 1973 and *Glycerietum maximae* Hueck 1931.

After 30 years of exploitation, due to a relatively large width of the vegetation-free water surface and a relatively high water flow velocity, the canal Novi Sad-Savino Selo has a sparse vegetation, i.e., its aquatic and semi-aquatic vegetation develops mostly in a narrow zone along the banks. In the location of Novi Sad hydro-junction, the entire water surface is periodically covered with stands of the associations *Lemno-Spirodeletum* and *Hydrocharitetum morsus-ranae*.

Rational use, continual control of the physical, chemical and hydro-biological parameters of water, effective wastewater treatment before its release into the canal, and maintenance of an ecological minimum of water level are basic

prerequisites for the preservation of this anthropogenic ecosystem in accordance with the concept of sustainable development.

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References

ANONYMOUS (1968): “Regulation on the Classification of watercourses”. Official Gazette of Serbia, no. 5/68.

BRAUN-BLANQUET J. (1964): Pflanzensociologie. Wien-New York .

FELFÖLDY L. (1990): Hínár határozó. Vízügyi hidrobiológia 18. Kötet- Környezetvédelmi és Területfejlesztési Minisztérium, Budapest, 1-144.

JÁVORKA S. & CSAPODY V. (1975): Iconographie der Flora des Südostlichen Mitteleuropa. Akadémiai Kiadó, Budapest.

JOSIFOVIĆ, M. (ed.) (1970-1977): Flora of SR Serbia, I-IX, SANU, Beograd.

KILIBARDA P., BUGARSKI R. (2002): The receipt and disposal of water and their quality. Hydro system Danube-Tisa-Danube, 25 years later, “The Public Water Management Company Vode Vojvodine”, Novi Sad, 156-174.

LAZIĆ D. (2006): Vaskular flora and vegetation in the MCH of HS DTD on the territory of Bačka – current situation and management. Ph.D.thesis, PMF, University of Novi Sad, 1-198.

SOÓ R. (1964-1980): A Magyar Flóra és Vegetáció Rendszertani-növényföldrajzi Kézikönyve I-VI. Akadémiai kiadó, Budapest.

STOJANOVIĆ S., KILIBARDA P., ŽDERIĆ M., NIKOLIĆ LJ. & LAZIĆ D. (1999): The plant world of the Novi Sad-Savino Selo canal. Eko-Konferencija `99, Novi Sad, Monograph I, 137-142.

STOJANOVIĆ S., LAZIĆ D., KNEŽEVIĆ A., NIKOLIĆ LJ., ŠKORIĆ M. KILIBARDA P., MIŠKOVIĆ M. & BUGARSKI R. (2007): Flora and vegetation in main canal network of HS DTD in Bačka. University of Novi Sad, Faculty of Agriculture, “The Public Water Management Company Vode Vojvodine”, Novi Sad, 1-204.

TUTIN T. G., HEYWOOD V. H., BURGES N. A., VALENTINE D. H., WALTERS S. M. & WEBB D. A. eds. (1964-1980): Flora Europaea I-V.Cambridge University press, Cambridge.

Tab. 1. *Hydrochari-Lemnetea*

	1	2	3	4	5	6	7	8	9	10	11	12
Characteristic species of the association												
Ceratophyllum demersum L.	5.5	4.4	4.4	+.1	1.1	1.1	2.2	3.3	1.1	+.1	2.2	
Salvinia natans (L.) Allioni		+.1		1.1	2.2	4.4		+.1	1.1	+.1	+.1	
Spirodela polyrrhiza (L.) Schleid.	+.1	1.1	2.2	4.4	2.2	3.3	4.4	5.5	4.4	+.1	+.1	+.1
Lemna minor L.			+.1		1.1	+.1	1.1	+.1	2.2	+.1	+.1	+.1
Hydrocharis morsus-ranae L.	+.1	+.1	2.2	+.1		+.1	+.1	1.1	+.1	4.4	4.4	3.3
Accessory species												
Trapa natans L.	+.1	+.1		+.1	1.1	+.1	+.1	+.1		1.1		1.1
Myriophyllum spicatum L.	+.1		+.1		+.1	+.1	+.1	+.1			+.1	+.1
Vallisneria spiralis L.		+.1	+.1	+.1	+.1	1.1	1.1	+.1	1.1	+.1		+.1
Sagittaria sagittifolia L.												
Elodea canadensis Rich	+.1						+.1			1.1	+.1	+.1
Potamogeton pectinatus L.							1.1					+.1
Najas marina L.						+.1						
Potamogeton crispus L.											+.1	

Legend: 1, 2, 3 – *Ceratophylletum demersi;* 4, 5, 6 – *Salvinio-Spirodeletum polyrrhizae*; 7, 8, 9 – *Lemno-Spirodeletum;* 10, 11, 12 – *Hydrocharitetum morsus-ranae.*
Localities: 1 – Rumenka; 2, 8-Novi Sad; 3, 5, 11 – Bački Petrovac; 4, 10 – Irmovo; 6, 7, 12 – Despotovo; 9 – Kulpin

Tab. 2. *Potametea*

	1	2	3	4	5	6
Characteristic species of the association						
Ceratophyllum demersum L	1.1	1.1	3.3		+.1	+.1
Vallisneria spiralis L.	4.4	5.5	4.4	+.1	+.1	+.1
Trapa natans L.	+.1			4.4	4.4	3.3
Characteristic species of the alliances *Potamion* and *Nymphaeion*, the order *Potametalia* and the class *Potametea*						
Elodea canadensis Rich.	+.1	+.1	2.2			
Myriophyllum spicatum L.	+.1	+.1	+.1			+.1
Hydrocharis morsus-ranae L.		+.1		1.1		2.2
Accessory species						
Najas marina L.	+.1					
Salvinia natans	3.3					
Spirodela polyrrhiza	+.1	1.1	+.1	+.1	1.1	+.1
Lemna minor		+.1	+.1		+.1	

Legend: 1, 2, 3 – *Ceratophyllo demersi-Vallisnerietm spiralis*; 4, 5, 6 – *Trapetum natantis*
Localities: 1, 2, 4, 5, 6 – Despotovo; 3 – Irmovo

Tab. 3. *Phragmitetea*

	1	2	3	4	5	6	7
Characteristic species of the association							
Phragmites communis Trin.	3.3	4.4	4.4	+.1			
Typha angustifolia L.			+.1	5.5			
Typha latifolia L.				+.1	5.5	3.3	
Glyceria maxima (Hartm.) Holm.	+.1		+.1		+.1		4.4
Characteristic species of the alliances *Phragmition communis*, the order *Phragmitetalia* and the class *Phragmitetea*							
Butomus umbellatus L.	+.1	+.1	2.3		+.1	2.2	1.1
Iris pseudacorus L.	+.1	1.1	+.1				1.1
Lycopus europaeus L.	+.1		+.1				
Rumex hydrolapathum Huds.		+.1	+.1		+.1	+.1	+.1
Accessory species							
Calystegia sepium (L.) Br.	+.1	+.1	+.1	+.1			+.1
Carex pseudocyperus L.	+.1	+.1	+.1			+.1	1.1
Solanum dulcamara L.	+.1		+.1	+.1			+.1
Bidens tripartita L.	+.1						
Polygonum lapathifolium L.	+.1						
Sparganium ramosum Huds.	+.1						
Angelica palustris (Bess.) Hoffm.	+.1						
Galim palustre L.		+.1	+.1				
Lythrum salicaria L.		+.1					
Epilobium hirsutum L.		1.1					
Epilobium adnatum Gris.			+.1				+.1
Scutellaria galericulata L.			+.1				
Urtica dioica L.			+.1				

Legend: 1, 2, 3 – *Scirpo-Phragmitetum*; 4 – *Typhetum angustifoliae*; 5,6 – *Typhetum latifoliae*, 7 – *Glycerietum maximae*
Localities: 1, 5 – Novi Sad; 2, 3, 4, 6, 7 – Despotovo

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