

SOME ASPECTS OF WATER REGIME MANAGEMENT  
OF THE DONJE POLJE SOIL AT SURČIN

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**Abstract:** Drainage system Galovica is situated in southeast Srem. It occupies the area of about 100,000 ha, it has a dense channel network of 30-40 m/ha, 2,575 constructed facilities and 11 pump stations. The main channel - Galovica is 40 km long and it is one of the basic receiving channels of the surplus internal waters from the area of southeast Srem. In addition to its basic purpose, this channel has recently also become the receiving channel of the municipal waste water, agro-industrial and processing waste water, discharged without purification and causing significant pollution of the water in the channel. The aim of this paper is to study the water in the Galovica channel and the possibility of its purification in the aim of its multipurpose utilisation, especially from the aspect of soil water regime management in the conditions of water deficit in the soil. The study area is the locality Donje Polje – PIK “7. juli”. The study of water quality for irrigation shows that water quality is in harmony with the prescribed standards, pursuant to the Regulation on the admissible concentrations of hazardous and harmful substances in the soil and water for irrigation and the methods of their analysis. The water of the Galovica channel was subjected to the purification by the equipment of the Army of Serbia and the testing of chemical and microbiological characteristics of purified water shows that this equipment can purify the water of the third and fourth classes and make it sanitary safe, so that it can be used as drinking water, especially in emergency situations.

**Key words:** drainage, channel, water, irrigation.

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## **I n t r o d u c t i o n**

The drainage system Galovica is situated in southeast Srem. It occupies the area of about 100,000 ha, it has a dense channel network of 30-40 m/ha. The main channel - Galovica is 40 km long and, together with Mihaljevački, Golubovački and Progarski channels, it is the basic receiving channel of the surplus internal waters from the area of southeast Srem. In addition to the basic purpose, these channels have recently also become the receiving channels of the municipal waste water, agro-industrial and processing waste water, discharged without purification and causing significant pollution of the water in the channel (Manojlović 1993, Djukić 1993, Brajković, 1994).

The reserves of pure water are increasingly lower, mainly due to continuous pollution and, simultaneously, water consumption is increasing thanks to the growing population numbers and the capacities of industry, agriculture and energy.

The drainage system Galovica has a high effect on soil water regime management of Donje Polje (Rudić 1979, 1983, Stojićević, 1956). The aim of this paper is to study the possibility of using the water from this channel for other forms of soil water regime management, primarily for irrigation in the conditions of water deficit in the soil. It was also investigated to which extent the water from the channel can be purified to the drinking water quality, particularly in emergency circumstances. Water purification, i.e. the improvement of water quality, is performed by the formation equipment of the Army units and institutions, and exceptionally also by some auxiliary equipment from the municipalities. Water purification is organised and carried out by the hydrotechnical units of the supply services, by using manual and motor filters for conventional and complex (RHB) water purification.

### **Characteristics of the study area**

The drainage pattern of the Galovica catchment is characterised by the absence of permanent natural watercourses, as well as by the presence of deep main channels and temporary marshes. The deep main channels (Galovica, Mihaljevački, Ašanjski, Stranjski, Ugrinovački, etc.) have changed considerably the original hydrographic situation which prevailed in this area. Before these channels were constructed and the levees along the Sava, the entire area was under a strong effect of surface and ground water flooding. Floodwaters moved by permanent and temporary watercourses and flooded the lower terrains and in this way they directly influenced both the soil salinisation and alkalinisation.

Today the entire area can be divided in two parts, depending on the ground water behaviour: north of the Galovica channel, in the stretches Selište and Majur,

with very high ground water level, and south of the Galovica channel, where ground water is considerably deeper.

The analysis of meteorological and climate characteristics of the area is based on the measured data at the weather station Surčin. Mean annual air temperature at the WS Surčin is 12°C, which is higher than the multiannual mean for Belgrade – 11.8°C. The warmest month is August, with air temperature 22.6°C, and the coldest month is January with 0.9°C. Mean maximal temperature is the highest in August, 26.2°C, and minimal in December, -3°C.

Average annual precipitation at Surčin is 628.7 mm. The maximal precipitation was recorded in June, 77 mm, and the minimal in February, 24.7 mm. Mean maximal precipitation was recorded in July, 209.5 mm, and in August, 206.4 mm, and mean minimal - in October, 0 mm.

Relative air humidity is rather high throughout the year, particularly in winter. Mean annual relative air humidity is 74%. The minimal values of relative air humidity were recorded in August, 50%, when air temperatures are the highest, and the maximal values were recorded in January, 94%. The most frequent winds are from the west (W) direction, 123‰, southeast (SE), 89‰ and east-southeast (ESE), 87‰. The channel network density in the Galovica basin is about 30-40 m/ha. The main channels which drain water from the basin into the Sava are: the Galovica channel, length 51 km, with the catchment area 74,100 ha, channel Petrac, which drains the area of 17,800 ha, length 93 km, Progarska Jarčina which drains the area of 17,800 ha, length 33.6 km, channels of the basin Zidina, total length 50 km, drain the area of 2,150 ha, watercourse Vranj, total length of the channel network 310 km, channel Veliki Begej - length 27.7 km with the basin area of 270 km<sup>2</sup>, channel Jaračka Jarčina drains the area of 22,400 ha, channel Patka, length 50 km, and channel Krivaja, with the area of 6,330 ha, total 77 km of which the main channel amounts to 12 km.

The Galovica basin, in addition to the above channel network, also has 2,575 constructed facilities and 11 pump stations.

Irrigation in the Galovica basin is very inadequately developed. In addition to the attempts of several minor individual farmers to irrigate the vegetables, one of the rare localities with significant irrigation is Donje Polje PIK “7. juli” at Surčin and, for this reason, it has been selected as the study area.

#### **Location, size, soil and topography of Donje Polje**

The area of Donje Polje in the vicinity of Surčin belongs to PIK “7. juli”. It occupies about 700 ha between the Bežanijska Kosa in the north, the river Sava in the east and southeast, and the railroad Batajnica-Ostružnica in the west and southwest. In the topographic sense, the area is predominantly flat, and the altitude is between 71.0 and 74.0 m. The soil types in the study area are chernozem, semigley, humogley and alluvium (Moskovičević, 1975, 1979).

Soil type chernozem is formed on loess, it has very favourable water-air and physical properties and it is rich in nutrients. Its particle-size distribution is sandy-clay loam, with total soil porosity 48% in the topsoil horizon and 45% in the deeper horizons.

Semigleys and humogleys are heavier textured soils. The soil texture of the surface layer of these soils is heavier than the deeper horizons, which is reflected in the low infiltration and wetting by surplus surface water. They are characterised by the absence of  $\text{CaCO}_3$  throughout the profile and by acid reaction. The content of humus decreases sharply with depth, and the supplies of readily available forms of nitrogen and potassium are low.

Alluvial soils cover the riparian part along the Sava. They are characterised by marked bedding. The surface layer is clay loam, lighter in colour, 20 cm thick, poorly alkalisied, with humus content less than 3%. The deeper layers are clay loam and loam, more alkalisied.

#### **Irrigation methods at the locality Donje Polje**

Soil characteristics of the study area, as well as the hydrologic conditions indicate that all irrigation methods applied in modern agriculture are possible. The drainage system was constructed in a part of the area, because the vicinity of the river Sava affects the ground water level, and because a part of the area is covered by the heavier textured soil which is also endangered by surface waters.

Water for irrigation is taken from the river Sava by a reversible pump station, which was erected in the village Boljevci. The capacity of the pump station is  $3\text{m}^3/\text{s}$ ; it is driven by electric motor. Water is pumped to the channel Petrac, the tributary of the Galovica channel, which supplies the water to the hydro-system "Donje Polje".

Irrigation is performed by rain wings and tifons. The stationary part of the system is in the ground at the depth of 3 m, and there is a hydrant at each 108 m. The length of rain wings is 400 m and the distance between them depends on the type of the sprinkler.

#### **Material and Methods**

Water samples from the Galovica channel were taken in the area of Donje Polje. The analyses of channel water quality, as well as of the samples of purified water for irrigation purposes were performed in the specialised institutions: the Military Medical Academy and the Republic Institute for the Protection of Health "Dr Milan Jovanović Batut" in Belgrade. Chemical composition was determined by standard methods applied in water analysis. The deviations of some physico-chemical or chemical parameters were determined in the maximal admissible concentrations of the substances in water which are prescribed by the Regulations on the sanitary safety of drinking water (Official Gazette SRY, no. 42/98 and

44/99) i.e. Regulations on the admissible concentrations of hazardous and harmful substances in the soil and water for irrigation and methods of their analysis (Official Gazette RS, no. 23/94)

The complete purification of the channel water by the manual filter 300/150 l/hour was performed at the pump station Donje Polje, PKB "7. juli", Surčin.

The manual filter for conventional and complex water purification, capacity FR-300/150 l/h, is used for the conventional and complex purification of spring water, river, lacustrine and marsh water. The filter is not suitable for the purification of sea water, or water polluted with oil and oil derivatives.

There are two steps in water purification: the first step is the primary treatment, and the second step is the complex purification. The filter operates by the principle of primary treatment (coagulation and hyper-chlorination and by water deposition in the tanks for primary treatment – settling) and the successive continuous flow of water filtering through two columns in conventional purification, i.e. through four columns in the complex purification.

Unpurified water is pumped from the channel to the reservoirs for the primary treatment: The settling is supported by aluminium sulphate, 150 mg/l. Powdered activated carbon is added at the rate of 100 mg/l. This is followed by hyper-chlorination by adding 50 mg/l of caporite. The final phase of primary treatment is water settling, coagulation and flocculation during 70 minutes. The reservoirs (settling tanks) for primary treatment of unpurified water by coagulation, hyper-chlorination and settling are made of synthetic rubber-lined cloth. The set of filter consists of three identical reservoirs, total volume 165 litres.

Unpurified water is pumped to the settling tank and the treated water is pumped out of the settling tank and pushed through the filter by manual pumps. The pumps are winged, capacity 1200 l/h, suction pumps height to 3 m.

After the primary treatment, water is filtered through four columns under the maximal water discharge of 150 l/h. Purification technology is based on water filtering through four filter columns:

The first filter column is for the mechanical filtering of primarily treated water. The column is filled with ten litres of sintered mass, granulation 0.25–1mm. The filter is of cylindrical form, internal diameter 200 mm and height 550 mm. It is made of stainless steel, thickness 1 mm. At the bottom of the filter vessel, there is a drainage plate with steel mesh which retains the filtered material.

The second column is dechlorination column, intended for the removal of the retained chlorine from the water after hyper-chlorination in the settling tanks, as well as for the removal of colour, taste, odour and fine mechanical impurities from the water. The column is filled with 10 to 11 litres of activated carbon granulation 0.25 to 1 mm. Along with chlorine, activated carbon is used for water decolourisation and deodorisation, and it retains very fine particles which pass the filter in the column.

The third column is cation column intended for the removal of negatively charged particles of radioactive substances (anions) from the water. It is filled with 10–11 l of cation ion-exchange resins "amberlit IR-120" immersed in water.

The last, anion column is intended for the removal of positively charged particles of radioactive substance (cations) from the water polluted with these substances. It is filled with 10–11 l of anion-ion-exchange resin "amberlit IRA-410" immersed in water.

The reservoir for clean water is the storage of clean water after purification, before the distribution to the consumers. The volume of the reservoir is 75 litres. At the bottom of the reservoir, at two sides, there are hose connections for the drinking water distribution hoses.

After filtering, water samples were taken for the analysis at the laboratory of the Institute for municipal hygiene of the Military medical Academy.

### Results and Discussion

Water in the Galovica channel at first sight seems very turbid and with a great number of different admixtures. In the samples of the surface there were no floating hazardous substances, but occasionally there was hydrogen sulphide. Water transparency is low and ranges from 0.45 – 0.70 m.

The analysed water was yellowish in colour, transparent, without strong odour. The content of ammonia (1.18 mg/l) exceeded considerably the admissible value. Water reaction was mild alkaline, which was expected, although the exceedance of pH value (pH 8.6) is not always the sign of pollution. The contents of chlorides, nitrites and nitrates did not exceed the maximal admissible concentrations.

The analyses performed with the samples of unpurified water of PKB "7 juli" Donje Polje show that water, pursuant to the Decree on the categorisation of watercourses (Official Gazette RS number 5/68) and the Decree on the classification of watercourses (Official Gazette RS number 5/68) can be classified in the third quality class. As such, it cannot be used for water supply or in food industry.

Although the values of some water parameters (nitrites, nitrates, chlorides) do not exceed the maximal admissible concentrations, some of the parameters (ammonia, consumption of  $\text{KMnO}_4$ ) exceed the maximal admissible concentrations and classify the water in the third class. The analyses of the purified water (Table 1) show that by purification with manual filters, regarding the chemical composition, it can be purified to the state prescribed by the standards of drinking water quality, i.e. that the contents of individual elements do not exceed the critical values prescribed by the Regulations on the sanitary safety of drinking water (Official Gazette of SRY, numbers 42/98 and 44/99). The bacteriological analysis which was also performed at the Military Medical Academy shows that the purified water is bacteriologically safe. There were no

faecal kaliforme, streptococcus of faecal origin, or proteus species. Total number of all living bacteria in 1 ml of water amounted to 160, which is the first class water category.

The analysis of chemical and microbiological characteristics of the purified water shows that manual filters FR-300/150 l/h can purify water of the third and fourth classes, and change it to a sanitary safe status, so that it can be used as drinking water, especially in emergency situations. This agrees with the data reported in similar researches (Nikolić, 1990).

T a b. 1. – Analysis of unpurified and purified water from the Galovica channel at the pump station Donje Polje

Parameters	Results of purified filtered water samples		MAC
Colour	Yellowish	Colourless	
Turbidity	Clear	Clear	
Odour	Odourless	Odourless	
Deposit	a large amount	No deposit	
Ammonia	1.18 mg/l	0.06 mg/l	0.17
pH	8.2	7.7	7.7
Consumption of KMnO <sub>4</sub>	26 mg/l	1.0 mg/l	12
Nitrates	33.3 mg/l	1.7 mg/l	75
Electr.conduct.	1126.0 µs/cm	550.7 µs/cm	600
Nitrites	0.040 mg/l	<0.002 mg/l	0.05
Hardness	36.7 <sup>0</sup> dH	11.5 <sup>0</sup> dH	12 <sup>0</sup> dH
Chlorides	45.2 mg/l	11.5 mg/l	200

The results of the analyses of trace elements and maximal admissible concentrations in irrigation water, pursuant to the Regulations on the admissible concentrations of hazardous and harmful substances in the soil and water for irrigation and the methods of their analysis (Official Gazette RS, no. 23/94), are presented in Table 2. The inadequate water quality for irrigation can decrease the yield of the crops and decrease the quality of the end products.

T a b. 2. – Study of trace elements in irrigation water

Trace elements	Content mg/l	MAC in irrigation water
Fe	0.21	5
Mn	0.08	0.2
Pb	<0.01	5
Cd	<0.001	0.01
Hg	<0.001	0.001
Zn	0.01	2
Cu	<0.01	0.2
As	<0.004	0.1
Ni	<0.01	0.2

The results show that all the analysed trace elements are within the admissible concentrations and that the study water can be used for irrigation according to the Regulations. The analyses of unpurified water show that, pursuant to the Regulations on water quality, it is classified in the third class and can be used for irrigation. Because of the higher consumption of  $\text{KMnO}_4$  in unpurified water, the irrigation of seasonal vegetables (lettuce, spring onion, etc.) should be avoided without previous water treatment. After purification, water can be used for irrigation without limits.

### Conclusion

The Galovica channel, in addition to its main function of drainage, can also be used for irrigation, which is enabled first of all by the developed channel network of 30-40 m/ha, and the sufficient water discharge in the channels.

The study of water quality for irrigation in the specialised institutions: Military Medical Academy and Republic Institute for the Protection of Health "Dr Milan Jovanović Batut" in Belgrade, show that water quality for irrigation is according to the prescribed standards, according to the Regulations on admissible concentrations of hazardous and harmful substances in the soil and water for irrigation and the methods of their analysis.

The equipment for water purification which is used by the Army of Serbia and Montenegro can purify water of the third and fourth classes, and make it sanitary safe, so that it can be used as drinking water, especially in emergency situations.

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NEKI ASPEKTI UREDJENJA VODNOG REŽIMA ZEMLJIŠTA DONJEG  
POLJA U SURČINU

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R e z i m e

Sistem za odvodnjavanje Galovica nalazi se u jugoistočnom Sremu. Zauzima površinu od oko 100000 ha, sa velikom gustinom kanalske mreže od 30-40 m/ha, 2575 izgrađenih objekata i 11 crpnih stanica. Glavni kanal Galovica prostire se dužinom od 40 km i predstavlja jedan od osnovnih recipijenata suvišnih unutrašnjih voda područja jugoistočnog Srema. Pored osnovne namene, u novije vreme, ovaj kanal je i recipijent komunalnih otpadnih voda, otpadnih voda agroindustrije i preradjivačkog kompleksa, koje se ispuštaju bez prečišćavanja i dovode do značajnih zagađenja vode u kanalu. Cilj ovog rada je da se ispita voda iz kanala Galovica i mogućnost njenog prečišćavanja u cilju njenog višenamenskog korišćenja, posebno sa aspekta uređenja vodnog režima zemljišta u uslovima deficita vode u zemljištu.

Za ispitivanja je odabran lokalitet Donje polje – PIK “7. juli”. Ispitivanja kvaliteta vode za potrebe navodnjavanja pokazala su da kvalitet vode odgovara propisanim normama, prema Pravilniku o dozvoljenim količinama opasnih i štetnih materija u zemljištu i vodi za navodnjavanje i metodama njihovog ispitivanja. Voda iz kanala Galovica podvrgnuta je procesu prečišćavanja uređajima kojima raspolaže Vojska R Srbije i posle ispitivanja hemijskih i mikrobioloških osobina prečišćene vode utvrđeno je da oni mogu da prečiste vodu treće i četvrte klase, dovedu u higijenski ispravno stanje te se ona može koristiti i kao voda za piće, posebno u vanrednim prilikama.

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