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ASSESSMENT OF GROUNDWATER QUALITY FOR IRRIGATION IN NORTHERN VOJVODINA

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Abstract: Agriculture is one of the largest consumers of water and the importance of its quality need to be usable, because the consequences of applying water of unsuitable quality are permanent and far-reaching. Assessment of groundwater usability should be performed according to available parameters. For the needs of classifications, water parameters were analyzed all cations, anions, total dissolved salt and electrical conductivity. According to all the classifications, the analyzed groundwater can be a good source of water for irrigation in terms of its quality, but with control and appropriate measures.

Keywords: water quality, groundwater, irrigation, Vojvodina

Introduction

Under the influence of increasingly frequent extreme hydrometeorological phenomena such as droughts, more attention should be essentially taken into the full consideration to water resources, both from the aspect of quantity and from the aspect of quality. Agriculture is one of the largest consumers of water and the importance of its quality should be emphasized, because the consequences of applying water of unsuitable quality are permanent and far-reaching. It is known that the composition of irrigation water has a major impact on soil characteristics, on yield and quality of cultivated plants, and on irrigation equipment (Ayers and Westcot, 1976; Bortolini et al., 2018; Bauder et al., 2011; Fipps, 2003). Excess amount of some ions in irrigation water could causes salinity, sodicity and permeability problems in the root zone affects plant growth and crop yield. An increase in total salts, individual ions and their unfavorable ratio increases the risk of unwanted consequences. Striving for sustainable management and agricultural production,in order to avoid or at least reduce the negative effects of the use of potentially unsuitable water, it is

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precisely the analysis of these parameters from the aspect of agriculture that is necessary. The assessment of groundwater usability should be performed according to parameters that have a direct impact on the soil in terms of its productivity and in accordance with its characteristics. Irrigation equipment could be damaged by the usage of unsuitable irrigation water, which primarily refers to emitter congestion and this result in poor uniformity of watering, which leads to uneven plant development. Regarding the impact on the equipment of the irrigation system, suspended matter, bicarbonates, sulfides, manganese and iron are distinguished (Bortolini et al., 2018). In order to prevent the destructive impacts, water quality assessment should become a necessary measure for production under irrigation systems (Joshi et al., 2009). Numerous classifications have been developed to assess the quality of irrigation water under different conditions, however, the classifications known in Serbia, the Nejgebauer classification, and in the world such as the FAO classification (Ayers and Westcot, 1976) and the USSL classification (Richards, 1954) are commonly used. The aforementioned classifications were also applied in this paper and the assessment of groundwater quality was performed from the aspect of use for irrigation.

The aims of present study, which has been carried out during ten years monitoring period, were to determine characteristic of groundwater in a subjected area and its usability assessment for irrigation purposes using the most common classifications in Serbia and also common in the word.

Materials and methods

The quality of groundwater on the measuring points from which the analyzed samples were taken were Subotica-Mikićevo, Aleksa Šantić and Njegoševo. Those measuring points were obtained in the period from 2011. to 2020. and assessment of groundwater quality were done. Data on physical and chemical parameters of sample were taken from the Hydrological Yearbook of water quality from the Agency for the protection of the environment (SEPA, 2011-2020).

Statistical analysis of physical and chemical parameters of sampled water was performed on the basic parameters of water quality (total dissolved salts, electrical conductivity, as well as cations and anions). The analyzed quality parameters and their values of minimum, maximum, means and standard deviations (SD) are given in Table 1. A detailed analysis of the parameters required for the application of the three water classification classes for irrigation

has been carried out. First used classification is categorization of water according to Nejgebauer which is adapted to the natural conditions of Vojvodina (Belić et al., 2011), second is FAO classification (Ayers and Westcot, 1976) and US Salinity Laboratory classification (USSL) (Richards, 1954). The basis of these classifications is the analysis of potential problems of salinization and alkalization, i.e. analysis of the concentration of total salt in water and of sodium, or its relation to divalent cations ($Ca^{2+}$and Mg^{2+}), and FAO classification provides more detailed analyses.

Table 1. Analyzed parameters on the measuring points in period 2011-2020

	Subotica-Mikićevo				Aleksa Šantić				Njegoševo			
Parameter	**Min**	**Max**	**Mean**	**SD**	**Min**	**Max**	**Mean**	**SD**	**Min**	**Max**	**Mean**	**SD**
Ca^{2+} (mg/l)	157.2	87	121.97	27.06	107	90.9	95.55	4.73	121.2	75	92.52	12.93
Mg^{2+} (mg/l)	84	41.8	59.46	15.20	33	18	26.17	3.70	49	8.8	30.6	10.32
Na^{+} (mg/l)	72.5	54	63.4	6.18	59.5	41.5	49.39	5.98	193.5	48.8	71.09	43.52
K^{+} (mg/l)	2.6	1	1.78	0.51	2	1	1.64	0.35	1.8	0.9	1.49	0.27
HCO_3^{-} (mg/l)	608	511	556.6	40.44	508	479	490.9	9.87	705	391	437.7	95.04
Cl^{-} (mg/l)	162	33	91.19	52.21	31.9	18	23.11	4.87	71.8	48.3	60	8.16
SO_4^{2-} (mg/l)	150	53	95.4	30.75	33	10	23.2	8.01	72	38	52.1	12.06
NO_3-N (mg/l)	0.5	0.03	0.128	0.14	0.31	0.02	0.097	0.09	23.65	0.08	3.036	7.29
EC (□S/cm)	1586	880	1188.2	275.63	828	708	776.5	31.25	1407	787	895.4	185.22
TDS (mg/l)	990	588	759.4	160.51	525	451	484.2	24.80	895	484	560.9	118.61
pH value	7.5	7.1	7.34	0.11	7.5	7.1	7.272	0.13	7.67	7.04	7.409	0.20

Results and discussion

The obtained results indicate that, according to the Nejgebauer classification, on the measuring point Subotica-Mikićevo, there was fluctuation in the water quality from first to third class of water for irrigation.

Graph 1. Percentile representation of individual water classes on the measuring points according to Nejgebauer classification, 2011-2020

On measuring point Aleksa Šantić water quality were uniform through entire analyzed period, while on the measuring point Njegoševo, the second and fourth class of irrigation water appears. The percentage representation of certain classes during the analyzed period according to Nejgebauer's classification is shown in the Graph 1.

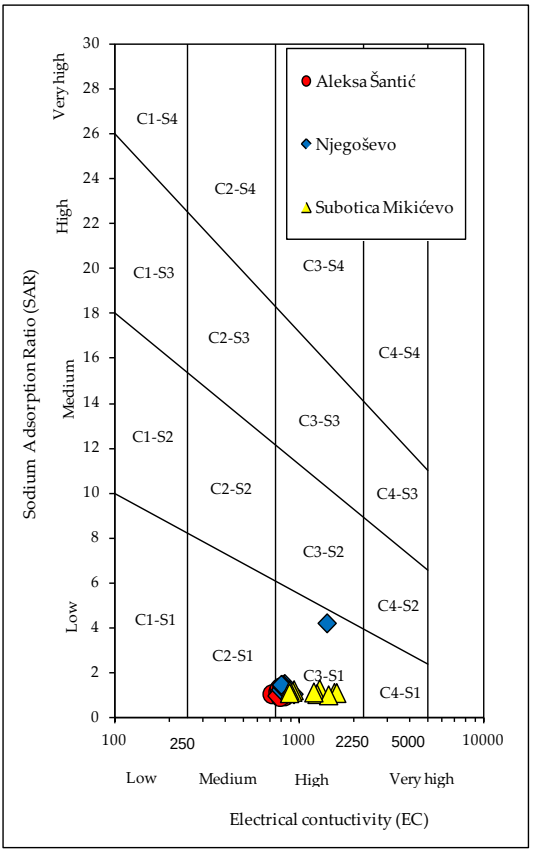
According to the FAO classification criteria results during the observed period are presented in Table 2. On all measuring points water quality in terms of salinization not changed from first class, which has no limitations. According to the influence of water on infiltration, the quality condition is similar in sense of changing on all measuring points, but it is it is characterized by belonging to class II, moderate use restriction. Special attention should be paid to the possible effects concentrations of Na^+ on measuring point Subotica-Mikićevo and Njegoševo.

Table 2. Percentile representation of individual water classes on the measuring points according to the FAO classification, period 2011-2020

	Subotica-Mikićevo		**Aleksa Šantić**		**Njegoševo**	
Potential problems	Class (%)		Class (%)		Class (%)	
Salinity	**II**	100	**II**	100	**II**	100
Infiltration	**I**	100	**I**	100	**I**	100
Toxicity of Na^+	**I**	70	**I**	100	**I**	90
	II	30			**II**	10
Toxicity of Cl^-	**I**	60	**I**	100	**I**	100
	II	40				

Measuring point Subotica-Mikićevo concentration was within the first class of no limitations in using water for irrigation in 70% of analyzed samples, with occasional occurrences of the need for moderate use restriction (II class) in 30% of analyzed samples. Similar occasions were on measuring point Njegoševo but in other percentage. Concentration was within the first class of no limitations in using water for irrigation in 90% of analyzed samples, with occasional occurrences of the need for moderate use restriction (II class) in 10% of analyzed samples. On measuring point Aleksa Šantić concentrations of Na^+ are within the limits in which they do not exhibit toxic effects on plants. Another specificity of FAO classification is the influence of chloride ions. On measuring point Subotica-Mikićevo concentration was within the first class of no limitations in using water for irrigation in 60% of analyzed samples, with

occasional occurrences of the need for moderate use restriction (II class) in 40% of analyzed samples. On measuring point Aleksa Šantić and Njegoševo concentrations of Cl^- are within the limits in which they do not exhibit toxic effects on plants.



Graph 2. Water classes according to USSL classification all measuring points, 2011-2020

USSL classification, based on the value of electrical conductivity and the Sodium Adsorption Ratio, water samples on measuring point Aleksa Šantić were classified mainly in the C3-S1 class, more precisely about 90% of the samples, and about 10% in the C2-S1 class. On other two measuring point all samples were classified in C3-S1 class. Graph 2 shows that the EC values varied from lower to upper limit of the class, while all SAR values are closer to the lower limit value of the class. USSL classification classifies water the most of

samples in class C3-S1, i.e. "Salty" water without a significant risk of the effect of adsorbing harmful sodium in terms of alkalization. In terms of total salt therefore measures such as choice of cultures resistant to salt, and the inability to use this water on naturally poorly drained soils are necessary. Due to the appearance of class C3 in the irrigation season, regular controls and measures must be in line with assessment of groundwater quality.

Conclusion

Assessment of groundwater qualityaccording to all water classifications, the analyzed groundwater samples are usable for irrigation. The results according to the Nejgebauer classification adapted to the conditions of Vojvodina are most favorable for use. According to this classification, the quality of Subotica-Mikićevo and Aleksa Šantić is in I and II class about 80% to 100% of the samples, the remaining samples were "unsuitable" quality (III and IVclass). All three measuring points require control over the content of total salt, due to the impact on soil and plants, as well as the ratio of sodium concentration to calcium and magnesium (SAR value), due to a moderate usage of water to the salinity properties of the soil. Special control is needed on the concentration of Na^+ and Cl^-, from which there is a risk of occurrence of various adverse effects on the soil, irrigated plants and irrigation equipment. USSL classification classified water mainly to C3-S1 class which means that the water can be used for irrigation with mandatory control during the irrigation season. These results of research can contribute to a better understanding of the selection of sources for irrigation in accordance with its quality and indicate the usability of irrigation water.

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