ASSESSMENT OF WATER QUALITY FOR IRRIGATION IN THE AREA OF POMORAVLJE DISTRICT

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Abstract
The assessment of the quality of water for irrigation in the Republic of Serbia is carried out using the traditional classifications by Stebler, Neiggebauer and the classification of the US Laboratory for saline soils and by the more recent FAO and RSC classifications. In twenty selected locations in the area of Pomoravlje area in 2016, samples of irrigation water were sampled within the existing irrigation systems or at the locations of agricultural areas where the installation of irrigation systems is planned.
The following parameters were analyzed in the samples: pH value-potentiometric; EC-electroconductivity-electrochemical; dry residue-thermogravimetric; ionic balance: CO_3^{2-}; HCO_3^-; Cl^- -volumetric. The acid-available fraction of heavy metals and other microelements (As, B, Cd, Cr, Cu, Fe, Ni, Pb, Zn) and SO_4^{2-}; Ca^{2+}; Mg^{2+} preparation and reading on the ICP-OES method EPA 200.7; Content K^+, Na^+ -plamenephotometric; SAR (Sodium Adsorpcio Ratio)-calculating. The above analyzes were carried out to evaluate the above classifications. In all tested samples, the content of heavy metals and the tested microelements was within the limits of maximum permissible concentrations. Modern classifications require more detailed analysis of the chemical properties of the tested parameters than traditional ones, while they provide a more complex approach to the assessment of the usability of water and they should have priority in the application.

Key words: Irrigation, water, quality, classifications

Introduction

The sustainability of water resources depends to a large extent on the proper management and efficient use of available water resources. The testing of groundwater quality has become indispensable especially in developing countries where there is a growing shortage of surface waters [8]. In addition to the basic purpose, which allows the survival of life on earth, the use of water for agricultural purposes, primarily irrigation, is certainly invaluable. Irrigation aims to meet the ever-growing needs for food due to population growth [1]. Given that in many areas of the world [11] without irrigation, agricultural production would not be possible, it is necessary to pay special attention to the available water resources both on quantity and on their quality. Inadequate water quality for irrigation can significantly reduce the expected economic yield of agricultural production [4, 19]. Water quality is a element used to describe the physical, chemical and biological parameters of water characteristics and defines the suitability for a specific purpose and used in the decision-making process [7]. Water of inadequate quality can affect the salinization, alkalization and deterioration of water-physical soil properties. It is very important to estimate the risk of salinization of springs for irrigation of any agricultural area in order to maximize the yield of cultivated crops [18]. There are traditional and modern methods and classifications for assessing the quality of water for irrigation. None of them can be considered absolutely applicable to all conditions in plant production [16].

Description of the field of research and methodology of sampling

The Pomoravlje Administrative District, where research was conducted in 2016, ranges from 43°43'-44°19's north latitude and from 20° to 21°50's east longitude. The irrigation water sampling site coordinates are presented together with results of the analyzes in Table 1. At the sites where research was conducted, the drip irrigation system is applied at nine locations; in eight places plants are irrigated by artificial rain, and within the three parcels it is planned to use some of the irrigation methods in the following period. Water samples used for irrigation were taken from the well at eighteen locations, while from natural sources, river, water were sampled at two locations. Sampling was conducted in accordance with the procedure documented in the professional literature.

Research methods

In the irrigation water samples, the following parameters are determined: pH-potentiometric (SRPS H.Z1.111: 1987) [12], electrical conductivity (EC) - (SRPS EN 27888: 1993) - electrometric [5]; the total dissolved solids content (TDS) - gravimetric [9]; CO_3^{2-}; HCO_3^-; Cl- volumetric, K^+; Na^+ - plamenfotometric (APHA) [2]. The content of heavy metals and other toxic elements (As, B, Cd, Cr, Cu, Fe, Ni, Pb, Zn) and SO_4^{2-}; Ca^{2+}; Mg^{2+} are determined by EPA method 200.7, [13] on the ICAP 6300 ICP optical emission spectrometer (ICP-OES); (SAR) - calculating [17].

Results and discussion

In relation to the Stebler classification, based on the estimation of the irrigation coefficient detrmined by the content of Na^+, Cl^-, SO_4^{2-}, all the tested irrigation water samples are of good quality, which means that it can be used without special measures to prevent the accumulation of harmful salts in the soil. Based on the Neiggebauer classification [14], which takes into account the total amount of salt in irrigation water in interaction with the concentration of Na^+ with Ca^{2+} and Mg^{2+}, the tested samples, 88.5% belong to the Ia class, in which the dry residue is smaller of 700 mg l^{-1}, and the ratio (Ca+ Mg) : (Na+ K) is > 3 and 11.5%, Ib class, where the dry residue is less than 700 mg l^{-1}, and the ratio (Ca+Mg): >3. These are impeccable water with ameliorative characteristics of flushing salt marsh.

Experts from the University of Riverside, USA [6] made the largest contribution to the study of irrigation water quality and its classification as regards the benefits of irrigation of agricultural crops, and it is applied worldwide. The basis for assessing the method is EC and SAR. In the tested water samples for irrigation, the C1-S1 class belongs to 7.7% of the tested samples with characteristic that EC≤0.250 dS m^{-1}; SAR 0-10. These are waters where there is a small risk of dredging / alkalization, or water suitable for irrigation. 69.2% of the tested samples belong to the Class C2-S1 class of water, in which the EC values range from 0.250 to 0.750 dS m^{-1} and can be used for irrigation of plants with a mean salt tolerance. The remaining 23.1% of the tested samples belongs to the class C3-S1, in which the EC values range from 0.750 to 2.250 dS m^{-1}, and their use requires the application of special measures in the prevention of soil depletion.

Modified FAO classification [3], analyzes in detail the influence of dissolved salt in irrigation water and its impact on the water-physical properties of the soil, primarily on infiltration. It takes into account the risk of sedimentation, based on the amount of electrical conductivity (EC) and salt concentration in the test sample (TDS).

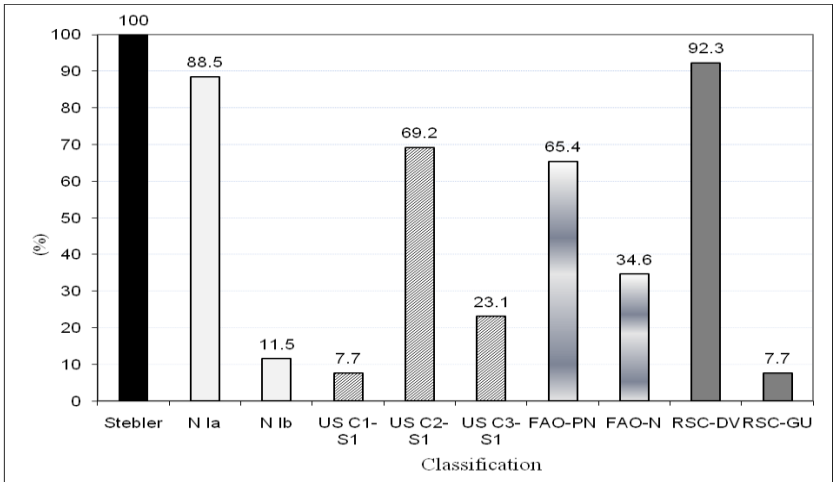
Table 1 shows the values of the parameters on the basis of which the irrigation water samples were estimated in relation to the above classification. It was found that 65.4% of the samples belong to the class of drinking water and irrigation (EC <0.7 dS m^{-1}, TDS <500 mg l^{-1}) and 34.6% water class for irrigation (EC: 0.7-2 dS m^{-1};TDS 500-1500 mg l^{-1}). An additional estimate using the possible influence of some elements dissolved in irrigation water,

analyzing Na^+ effects through different relationships with other tested substances (Na_2CO_3) was determined on the basis of the RSC-Residual Sodium Carbonate classification [10]. Based on this classification, 92.3% of the tested irrigation water samples belong to the class of good water (RSC <1.25) and 7.7% water class at the usability limit (RSC = 1.25-2.50).
The obtained values of the content of the studied microelements and heavy metals are presented in Table 1. The interpretation was prepared on the basis of the limit values in the Ordinance on the permitted quantities of hazardous and harmful substances in soil and irrigation water [15] and by the data from literature [3] (*).
The content of trace elements and heavy metals in irrigation water samples in all tested irrigation water samples was below the maximum permissible concentration (MAC).

Table 1. Chemical and physical properties of water samples for irrigation

N°	Coordinate		pH	EC (dSm^{-1})	TDS ($mg\,l^{-1}$)	SAR ($mg\,l^{-1}$)	As	B	Cd	Cr	Cu	Fe	Ni	Pb	Zn
	X	Y					($mg\,l^{-1}$)								
1	518133	4867123	7.00	0.99	850	0.58	bdl	0.0772	bdl	0.001	0.006	0.0544	0.0021	0.0013	0.0198
2	522588	4868034	7.10	0.72	550	0.37	bdl	bdl	bdl	0.0047	0.0068	bdl	0.0026	bdl	0.3372
3	507682	4855615	7.50	0.56	500	0.37	bdl	bdl	bdl	0.0013	0.0126	bdl	0.0001	0.0012	0.141
4	519887	4866458	7.30	0.85	640	0.42	bdl	bdl	bdl	0.0254	0.0599	bdl	bdl	0.0078	0.0544
5	510021	4854678	7.40	0.57	570	0.58	bdl	0.0128	bdl	0.0019	0.0058	bdl	0.009	0.0023	bdl
6	529462	4867180	8.10	0.63	480	0.52	bdl	0.0213	bdl	0.0008	0.0072	bdl	0.0007	bdl	bdl
7	509624	4856500	8.40	1.12	920	0.48	bdl	0.0939	bdl	0.0038	0.0101	bdl	0.0053	0.0047	0.0044
8	532709	4861037	7.20	0.68	450	0.47	bdl	bdl	bdl	0.0015	0.0052	bdl	bdl	0.0051	0.0269
9	533345	4868033	7.10	1.4	110	0.63	bdl	bdl	bdl	0.0017	0.0059	bdl	0.0003	0.0003	bdl
10	532788	4870253	7.10	1.12	120	0.45	bdl	bdl	bdl	0.0139	0.0311	bdl	0.0047	0.0038	0.0401
11	542816	4881028	7.25	0.54	360	0.65	bdl	bdl	bdl	0.0005	0.0204	bdl	0.0404	0.0022	0.5134
12	542482	4883901	7.15	0.42	330	0.69	bdl	bdl	bdl	0.001	0.0121	bdl	bdl	0.0059	0.017
13	530215	4887712	7.20	0.21	180	0.45	bdl	bdl	bdl	0.0013	0.0069	bdl	bdl	bdl	bdl
14	528908	4886074	7.50	0.52	410	0.95	bdl	bdl	bdl	0.0008	0.0073	bdl	bdl	0.0046	bdl
15	515990	4896413	7.20	0.47	400	0.4	bdl	bdl	bdl	0.0019	0.0084	bdl	0.0006	bdl	0.0117
16	531727	4852202	7.40	0.56	50	0.49	bdl	bdl	bdl	0.0006	0.0065	bdl	0.0081	0.0073	bdl
17	530419	4856321	7.40	0.36	310	0.36	bdl	bdl	bdl	0.0011	0.0418	0.0348	0.0001	0.0049	bdl
18	517732	4898714	7.60	0.39	330	0.37	bdl	bdl	bdl	0.0009	0.0306	bdl	0.001	bdl	bdl
19	515714	4896532	7.30	0.72	630	0.31	bdl	bdl	bdl	0.0021	0.0063	bdl	0.0001	bdl	0.0365
20	533811	4851397	7.40	0.62	570	0.36	bdl	bdl	bdl	0.0111	0.0067	bdl	0.0053	0.0057	bdl
						MAC	to	to	to	to	to	to	to	to	to
							0.05	1.00	0.01	0.50	0.10	5*	0.10	0.10	1.00

bdl-belov detection limit



N-Classification Neiggebauer [14]; US- Classification Laboratory for saline soil University Riverside[6]

Figure 3. Representation of tested samples according to the classifications of irrigation water

Conclusion

Based on the obtained and analyzed results of the quality study of irrigation water, it can be concluded that water from sampling sites can be used without restrictions to irrigate cultivated crops and there is no risk to have a negative impact on the structure of the soil on which it is applied. Nevertheless, the tests should be carried out periodically irrigation water and soil in order to prevent the creation of a rupture and breakdown of the structure.

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