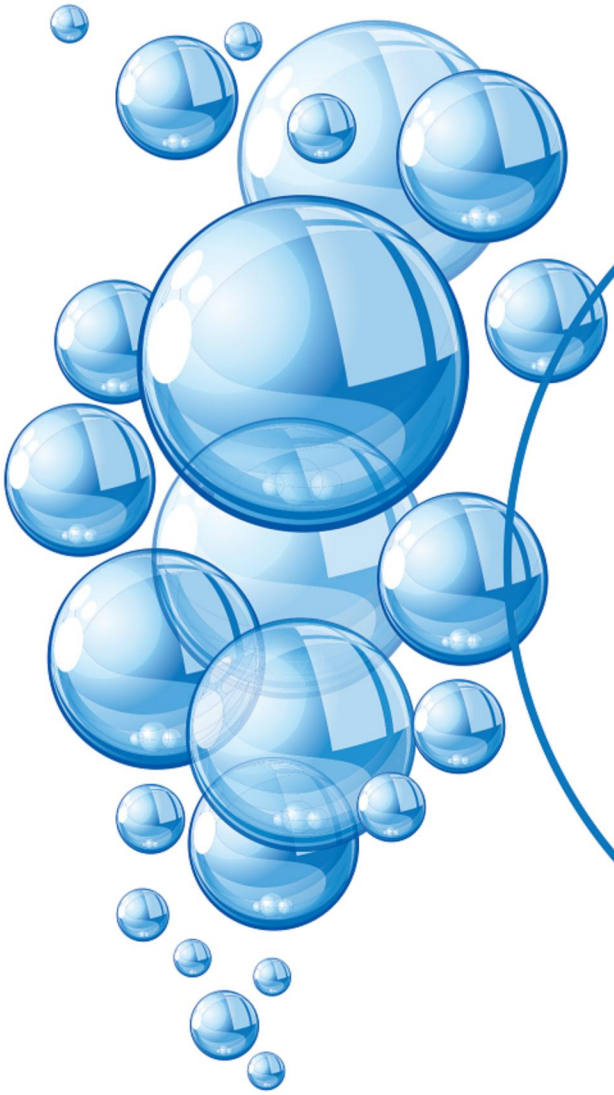
International Symposium



Water Resources Management: New Perspectives and Innovative Practices

PROCEEDINGS BOOK

http://www.swarm.ni.ac.rs/symposium

September 23rd – 24th, 2021
Novi Sad, Serbia

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Water Resources Management:
New Perspectives and Innovative Practices

Symposium Proceedings

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PREFACE

The University of Novi Sad, Faculty of Technical Sciences hosted the **International Symposium "Water Resources Management: New Perspectives and Innovative Practices"** from 23rd-24th September 2021. The Symposium was a part of the activities realized under the CBHE KA2 project SWARM "Strengthening of master curricula in water resources management for the Western Balkans higher education institutions (HEIs) and stakeholders" co-funded by the Erasmus+ Programme of the European Union. SWARM project is implemented by a consortium made up of seven HEIs from the Western Balkan Region and six HEIs from Program Countries: University of Niš, University of Novi Sad, University of Priština in Kosovska Mitrovica, University of Montenegro, University of Sarajevo, Džemal Bijedić University of Mostar, Academy of Applied Sciences of Kosovo and Metohija, University of Natural Resources and Life Sciences from Vienna, Norwegian University of Life Sciences, Aristotle University of Thessaloniki, University of Architecture, Civil Engineering and Geodesy from Sofia, University of Rijeka, Faculty of Civil Engineering, Universidade de Lisboa, and Public Water Management Company "Vode Vojvodine".

The main objective of the SWARM project is the education of water management experts in the Western Balkan Region in accordance with the national and European Union policies. This objective is further broken down into the following specific objectives:

- To improve the level of competencies and skills in higher education institutions by developing new and innovative master programmes in the field of water resources management in line with the Bologna requirements and national accreditation standards.
- To design and implement new laboratories in Western Balkan HEIs, in cooperation with project partners from Program Countries.
- to develop and implement LLL courses for professionals in water sector in line with EU Water Framework Directive.

The International Symposium was an interdisciplinary forum where the research results and best practices in the field of Water Resources Management were shared with all SWARM fellows and stakeholders from the entire world. At the same time, the event was the place for the promotion of the SWARM results to a wider audience.

We would like to express our sincere thanks to all session chairs, keynote speakers, presenters, Organizing and Scientific committees, as well as to many others who contributed to the success of this Symposium.

We are confident that the solid foundation created by the SWARM project will continue to build up and strengthen our unique international network.

In Novi Sad, September 2021

Symposium Chairs

Maja Petrović

Milan Gocić

CONTENTS

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WATER QUALITY EVALUATION IN BOVAN RESERVOIR FOR IRRIGATION PURPOSE

Milica Marković[*], *Mladen Milanović*[*] *and Slaviša Trajković*[*]

[*]University of Niš, Faculty of Civil Engineering and Architecture, Aleksandra Medvedeva 14, 18000 Niš

Abstract: Aleksinac field, with a total area of about 5660 ha, is located in the fertile valley of the Južna Morava River in the municipality of Aleksinac. The area planned for irrigation is within the cadastral municipalities of Aleksinac, Bobovište, Ćićuna, Rutevac, Vukašinovac, Deligrad, Jasenje, Brodarevac, Mozgovo, Bovan, Subotinanac, Kraljevo. The feasibility study from year 1994, envisages irrigation of the Aleksinac field from the multi-purpose reservoir Bovan. More than 30 years have passed since. The Bovan reservoir have been used for water supply, which was not the main purpose of this reservoir. The dead volume has decreased and the water quality has changed. In this paper, the water quality for irrigation in the Bovan reservoir was assessed on three profiles in the reservoir and recommendations are given for the future research.

Keywords: irrigation, reservoir "Bovan", water quality

INTRODUCTION

Water is the most important natural resource. The importance of this resource is especially highlighted when we consider the increase the world population, the accelerated development of industry, the construction of new settlements and especially climate change. Lack of food emphasizes the importance of irrigation systems developing and finding appropriate sources of surface water and groundwater. Water resources and soil quality across globe decreased due to anthropogenic contamination (Dash & Kalamdhad, 2021). Surface waters are a particularly sensitive resource. Many studies assessed water quality of rivers (Merouche et al., 2019; Safari et al., 2021; Elsayed et al., 2020; Sharma et al., 2020), ground waters (Abbasnia et al., 2018; Samtio et al., 2021), channels (Abdel-Fattah et al., 2020) for irrigation purposes, with special reference to the requirements of individual plant species (Allende & Monaghan, 2015). Artificial lakes are usually multi-purpose sources of water (AbuDalo et al., 2020; Jovanic, 2015) and achieving the water quality of such a water source is to harmonize the requirements of a larger number of users.

MATERIALS AND METHODS

Bovan reservoir

Aleksinac field, with a total area of about 5660 ha, is located in the fertile valley of the Južna Morava River in the municipality of Aleksinac. The area planned for irrigation is within the cadastral municipalities of Aleksinac, Bobovište, Ćićuna, Rutevac, Vukašinovac, Deligrad, Jasenje, Brodarevac, Mozgovo, Bovan, Subotinanac, Kraljevo.

The soil is compacted and the average plot area is 60.91 a. Each plot has an access road. The plots are in the private property.

The feasibility study from year 1994 envisages irrigation of the Aleksinac field from the multi-purpose reservoir Bovan. The total net irrigated area is about 4 500 ha (about 7 000 plots), and the system envisages water supply of each plot. According to this study, two irrigation subsystems are planned on areas of about 2250 ha:

- I subsystem which is gravity-fed water supplied system from Bovan reservoir (below elevation 225 MASL)
- II subsystem which is water distribution system supplied by pumping water from the Bovan reservoir and covering high irrigation zones (above 225 MASL).

The multipurpose reservoir Bovan is located on the river Moravica near the village Bovan, 14 km upstream from the mouth of the river Moravica and Južna Morava River.

The main purpose of the reservoir Bovan is water supply, flood protection, protection against sedimentation within the HPS "Iron Gate", increasing of low water level in the river, hydro power and irrigation.

Table 1. The main characteristics of the reservoir

Watercourse	Moravica
Nearest settlement	Aleksinac
Total reservoir volume	60 000 000 m^3
Minimal water level	243.00 MASL
Normal water level	252.00 MASL
Maximal water level	261.50 MASL

The main project of the dam and reservoir Bovan was done in 1974 and envisages about $15*10^6$ m^3 of water for irrigation. More than 30 years have passed since and in the meantime the Bovan reservoir has been used for water supply, which was not the main purpose of this reservoir. The quantities of water have been reduced, socio-economic changes have taken place (privatization of socially owned enterprises has been carried out, the construction zone of Aleksinac has been expanded, a new Law on Planning and Construction is being implemented), it is necessary to revise the available quantities and quality of water for irrigation from the Bovan reservoir. In this paper USSL classification was used in order to define suitability of water quality in Bovan reservoir for irrigation purpose.

USSL Classification

The US Salinity Laboratory (USSL) classification represents the method for evaluation of irrigation water quality, based on the hazards of salinization and alkalization of irrigated soils (Wilcox, 1955). Using this classification irrigated water can be classified into 16 categories (Figure 1). The concentration of salt in irrigated water can be very harmful for the crops, i.e. it will reduce the growth and fertility of crops. In order to define the water salinity, the electrical conductivity (EC) is used. EC measure the amount of total dissolved solids (TDS) in water at 25°C. Alkalization of irrigated water can be defined using the SAR (Sodium adsorption ratio) value, which represents the risk of sodium in water. The high value of SAR leads that soil becomes hard and compact, which reduces the infiltration rates of air and water into the soil.

SAR value is based on the comparative concentrations of sodium (Na) and calcium (Ca) and magnesium (Mg) in a water sample (high contents of Ca and Mg reduces the soil permeability), and is expressed as (Wilcox, 1955; Richards, 1954):

$$SAR = \frac{Na}{\sqrt{\frac{Ca+Mg}{2}}} \tag{1}$$

The lack of springs with quality water for irrigation leads to the modification of the basic SAR formula into SARcorr (Ayers & Westcot, 1976):

$$SAR_{corr} = SAR\left[1+\left(8.4-pHc\right)\right] \tag{2}$$

$$pHc = \left(pk_2 - pk_c\right) + p\left(Ca+Mg\right) + p\left(Alk\right) \tag{3}$$

where p represents the negative logarithm, k_2 is the second dissociation equilibrium constant of carbonic and k_c is the solubility equilibrium constant for calcite.

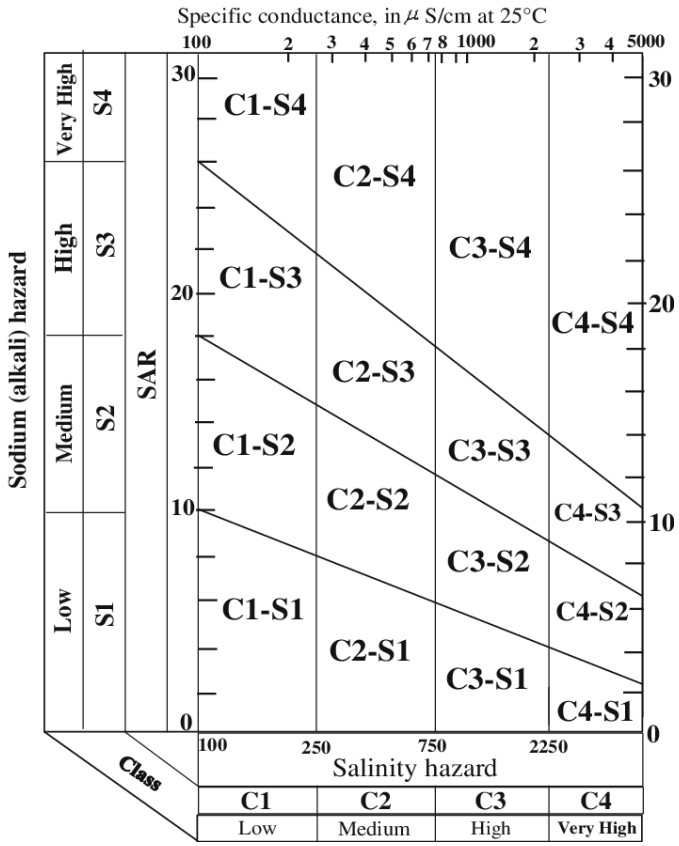

Figure 1. USSL classification of irrigation water (Wilcox, 1955)

RESULTS AND DISCUSSION

In this paper, the water quality for irrigation in the Bovan reservoir was assessed on three profiles in the reservoir and recommendations are given for the future research. The profiles are presented in Figure 2 and results are given in Table 2.

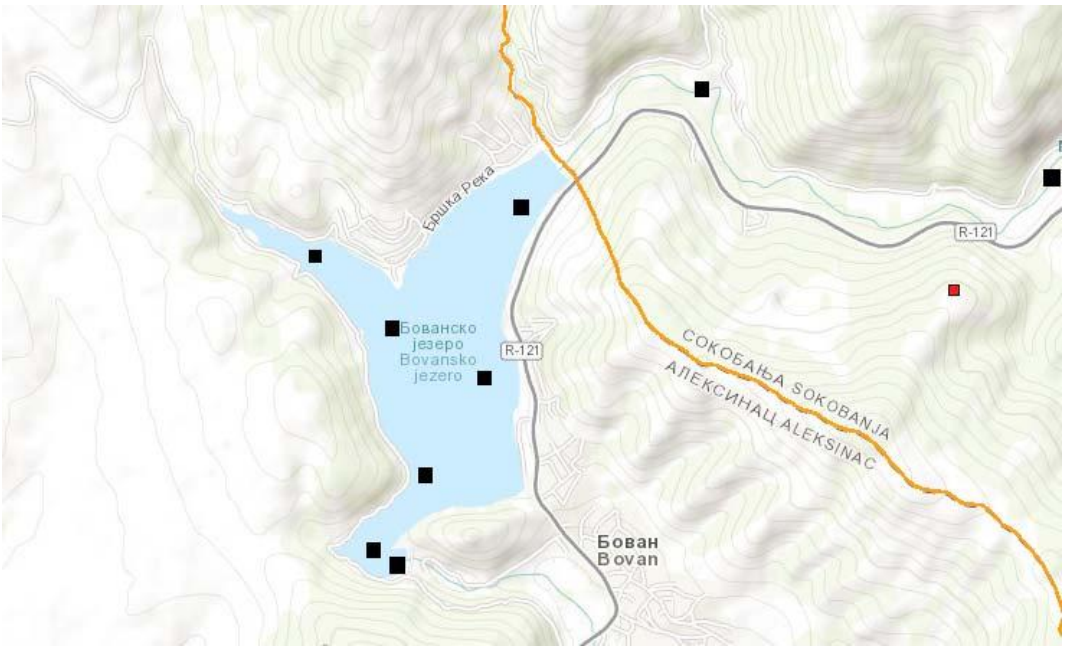

Figure 2. Bovan Reservoir-sampling locations

Table 2: USSL classification of Bovan reservoir water

	A1	A2	A3	B1	B2	B3	V1	V2	V3
Depth (m)	0.5	15	30	0.5	11	22	0.5	4.5	9
EC	382	413	447	387	430	457	418	424	462
S.O. (mg/l)	254	264	291	249	279	288	267	273	301
Na (mg/l)	7.2	7.1	7.2	6.9	7.3	7.4	7.4	7.7	7.9
K (mg/l)	1.8	1.9	3	1.1	2	2.2	1.9	2	1.9
Ca (mg/l)	62	64	71	63	75	75	72	72	83
Mg (mg/l)	17	17	20	15	9	20	11	11	7
CO_3 (mg/l)	7.2	0	0	7.2	0	0	7.2	6	5.4
HCO_3 (mg/l)	196	232	255	200	242	256	218	225	250
SAR corr	0.439	0.436	0.436	0.424	0.456	0.443	0.457	0.474	0.492
Class	C2S1	C2S1	C2S1	C2S1	C2S1	C2S1	C2S1	C2S1	C2S1

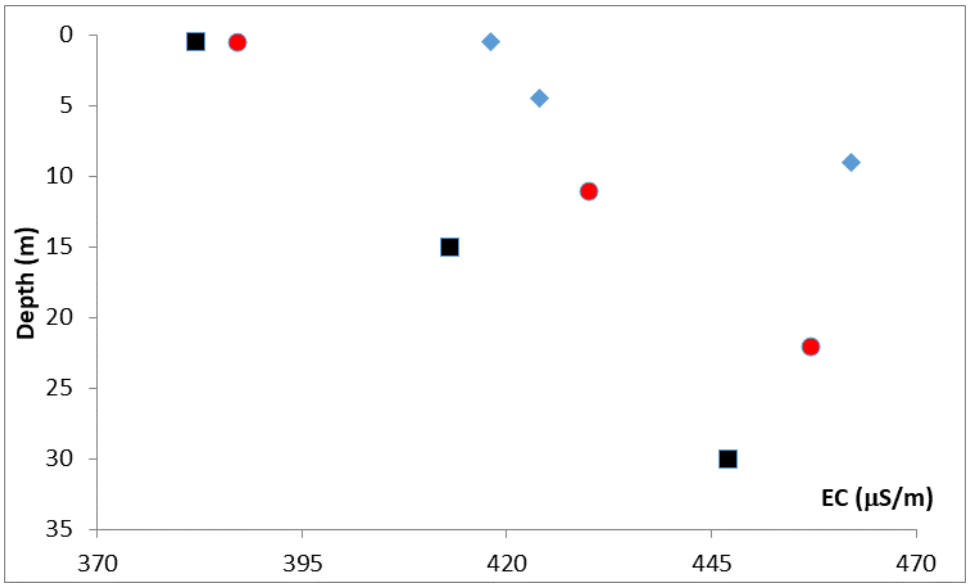

Figure 3. EC versus sampling depth

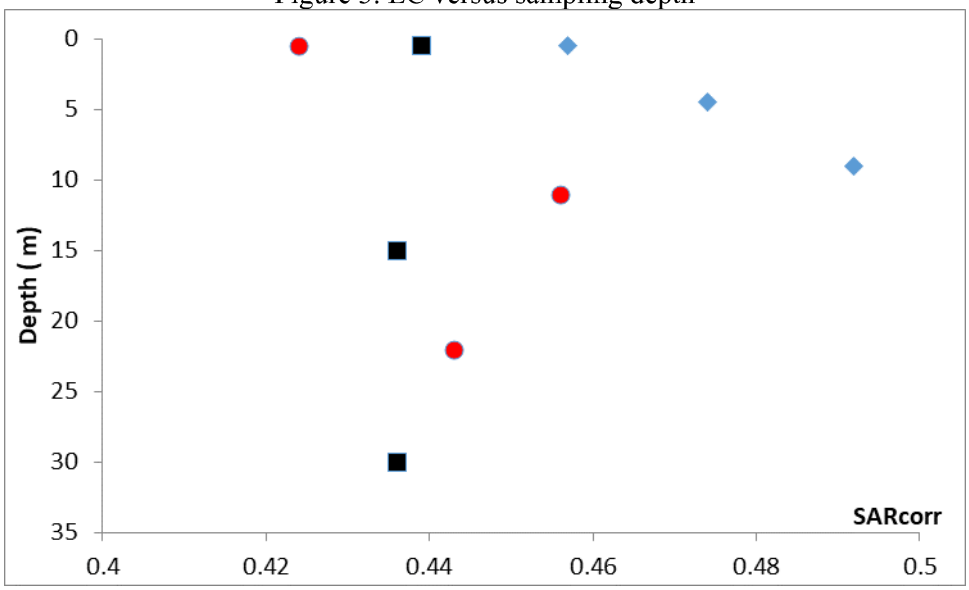

Figure 4. SARcorr versus sampling depth

On the Figure 3, electric conductivity values are given regarding sampling depth. On each profile we can see that electric conductivity increases with depth. On the Figure 4 corrected SAR values are presented regarding sampling depth. These values do not differ significantly so we can conclude that sampling depth has no greater significance.

Results indicate the same water quality class:

- Medium to good quality irrigation water
- Low risk of alkalization
- Medium risk of salting.

CONCLUSIONS

In this paper we tried to evaluate the usability of water from the Bovan reservoir for irrigation purpose, by evaluating the EC (dS/m) of the water and the amount of sodium (mg/l) and consequently the risk of salinity and risk of alkalization respectively. For all three locations where the samples of water were taken, measured values are within the moderate risk of salinization and low risk of alkalization, which indicates that reservoir water can be used for irrigation of crops that are moderately tolerant to the presence of salt in the water. It is recommended that some measures should be taken in terms of reservoir management in order to improve the quality of irrigation water and consequently to increase number of crops to be threated. The main measure would be following the dispatch plan, which would prevent the process of eutrophication of the reservoir. Reservoir silting is a main water quality problem generally, but according to recent studies it does not affect the total dissolved solid and thus to EC of the irrigated water.

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