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IRRIGATION WATER QUALITY IN THE SALINAS-MG REGION, BRAZIL

QUALIDADE DA ÁGUA DE IRRIGAÇÃO NA REGIÃO DE SALINAS-MG

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ABSTRACT: This study aimed to evaluate the risk of salinity and sodicity of surface and underground water used for irrigation purposes on rural properties in the municipality of Salinas/MG, Brazil. The water samples were collected at a catchment point used by irrigators, and the physical-chemical parameters evaluated were: pH, sodium (Na) content, calcium (Ca) content, magnesium (Mg) content, electrical conductivity (CE), and sodium adsorption ratio (SAR). The latter was calculated to classify water as a function of risk of salinity and soil sodification. Groundwater was rated as class C3 (high salinity) while surface water as C1 (low salinity). As for soil sodification risk, groundwater was moderate, while the other samples were severe.

Keywords: Electrical conductivity, Salinity, Sodicity.

RESUMO: objetivo desse estudo foi avaliar o risco de salinidade e sodicidade das águas superficiais e subterrâneas utilizadas para fins de irrigação nas propriedades rurais no município de Salinas, MG. Foram avaliados os parâmetros de qualidade físico-química da água, como: pH, sódio (Na), cálcio (Ca), magnésio (Mg) e condutividade elétrica (CE) e a razão adsorção de sódio (RAS), com posterior classificação das águas de estudo, de acordo com o risco de salinidade e sodificação do solo. Os resultados permitiram classificar as águas subterrâneas em classe C3 (Água de alta salinidade, apresentando riscos de salinização dos solos) e as superficiais em C1 (Água de baixa salinidade, apresentando baixo risco de causar salinização dos solos). Quanto ao risco de sodificação, as águas subterrâneas apresentam risco moderado, enquanto as demais amostras, apresentam alta severidade quanto ao risco de causar sodificação nos solos.

Palavras-chave: Condutividade elétrica, Salinidade, Sodicidade.

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INTRODUCTION

The Brazilian semiarid region undergoes severe droughts that affect socioeconomic development and agricultural activities (PATRÍCIO; ARAÚJO, 2016). Irrigated agriculture, as the main user, should be limited to the use of qualitatively inferior waters(ZAMBERLAN et al., 2013). With the scarcity of water resources that meet quality criteria, high-salt waters have been increasingly used, which has made essential to analyze water intended for irrigation(GOMES et al., 2015).

Salinity has an influence on plant development. This is due to specific ion toxicity and increased osmotic pressure. These factors negatively interfere with physiological processes and reduce water absorption by roots, thus inhibiting meristematic activity and cell elongation (TAIZ et al., 2017; LIMA et al., 2015).

Among the physical-chemical parameters of water, electrical conductivity is an indication of its potential to salinize soil (ALMEIDA, 2010). On the other hand, sodicity, which is the sodium adsorption ratio (SAR) of irrigation water, refers to the effect of sodium on water ability to infiltrate the soil, as exchangeable sodium percentage in the soil tends to rise (PIZARRO, 1985).

Based on the above, this study aimed to evaluate the risks of salinity and sodicity problems associated with the use of surface and groundwater for irrigation purposes on rural properties in the municipality of Salinas-MG, Brazil.

MATERIAL AND METHODS

The study was carried out in the municipality of Salinas-MG, which is in the northern mesoregion of Minas Gerais State (Brazil). According to the Köppen classification, the local climate is predominantly of the Aw type, which stands for a tropical climate with a dry winter season (MARTINS et al., 2018).

Surface and groundwater samples were collected in December 2020, in the Salinas River Basin and in the Bananal and Ribeirão River sub-basins (Figure 1). Collections followed the method proposed by Holanda et al. (2016). One sample was collected per sampling point.

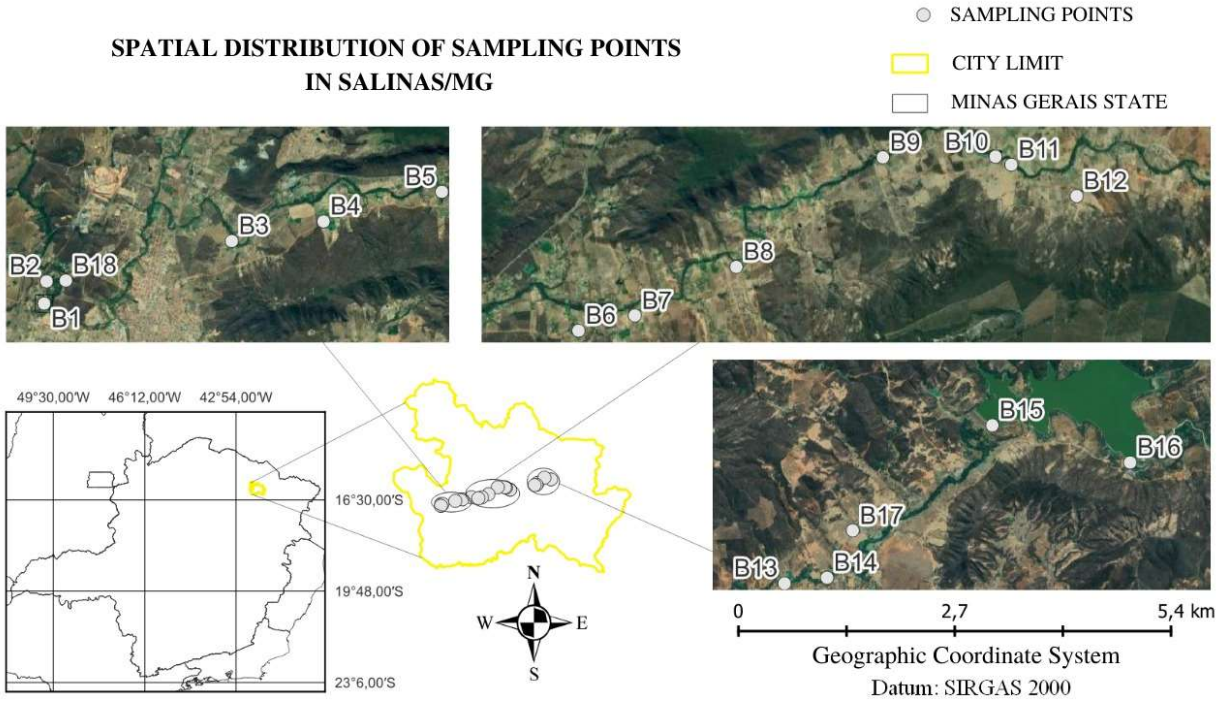

Figure 1. Location of sample collection points in the municipality of Salinas/MG (Brazil).

Physicochemical analyzes were carried out in the soil laboratory of the *Instituto Federal do Norte de Minas Gerais* (IFNMG), Salinas campus.

The parameters hydrogenic potential (pH), sodium (Na) content, calcium (Ca) content, magnesium (Mg) content, and electrical conductivity (EC) were analyzed according to Almeida (2010), in addition to sodium adsorption ratio (SAR) as in Equation 1.

$$SAR = \frac{Na^{+}}{\sqrt{\frac{Ca^{2+}+Mg^{2+}}{2}}} \quad (1)$$

Wherein:

Na^{+} - sodium concentration in water, in mEq L^{-1}

Ca^{2+} - calcium concentration in water, in mEq L^{-1}

Mg^{2+} - magnesiumconcentration in water, in mEq L^{-1}

The classifications proposed by the United States Department of Agriculture – USDA (Table 1; RICHARDS, 1954) and the University of California Committee of Consultants – UCCC (Table 2; AYERS; WESTCOT, 1985) were used to determine water use restriction for irrigation in terms of risks to plant toxicity and soil salinity and sodicity

Table1. Criteria for classification of water use restriction for irrigation according to the United States Department of Agriculture - USDA (RICHARDS, 1954)

SalinityEC (dS m^{-1})		
Class	Degree of Restriction	Threshold
C1	Low	<0.25
C2	Intermediate	0.25 – 0.75
C3	High	0.75 – 2.25
C4	Very high	>2.25

Source: Adapted from theUnited States Department of Agriculture (RICHARDS, 1954)

Table 2. Criteria for classification of water use restriction for irrigation according to the University of California Committee of Consultants – UCCC (AYERS;WESTCOT, 1985)

Potential Problem	Unit	Degree of Use Restriction		
		None	Moderate	Severe
Salinity				
EC	dS m^{-1}	<0.7	0.7 – 3.0	>3.0
Sodicity - Infiltration				
SAR = 0 - 3 and EC =		>0.7	0.7 – 0.2	<0.2
SAR = 3 - 6 and EC =		>1.2	1.2 – 0.3	<0.3
SAR = 6 - 12 and EC =	dS m^{-1}	>1.9	1.9 – 0.5	<0.5
SAR = 12 - 20 and EC =		>2.9	2.9 – 1.3	<1.3
SAR = 20 - 40 and EC =		>5.0	5.0 – 2.9	<2.9

Source: Adapted from theUniversity of California Committee of Consultants (AYERS; WESTCOT, 1985)

RESULTS AND DISCUSSION

Table 3 shows the results for each physical-chemical parameter of surface and groundwater, in addition to the risk of infiltration, according to Ayers and Westcot (1985). Regarding pH, all samples were within the range between 6.06 and 7.60, thus classified as neutral/ basic. This result falls within the range considered normal for use in irrigation (AYERS; WESTCOT, 1985). In addition, our findings were like those from other studies in the northern region of the state of Minas Gerais (SOUZA et al., 2014; SANTOS et al., 2015).

Table3. Water quality analyses for the region of Salinas-MG (Brazil).

Sample	Na (mEq L^{-1})	pH	EC (dSm^{-1})	(Ca + Mg) mEq L^{-1}	SAR	Infiltration Risks*
B1[1]	1.1	7.60	0.149	0.5	2.2	Severe
B2[1]	1.1	7.58	0.15	0.3	2.8	Severe
B3[2]	1.6	7.06	0.16	0.3	4.1	Severe
B4[3]	11.8	7.57	1.13	3.2	9.3	Moderate
B5[2]	1.8	7.14	0.172	0.4	4	Severe
B6[2]	1.6	7.26	0.172	0.4	3.6	Severe
B7[2]	2.2	6.56	0.211	0.4	4.9	Severe
B8[2]	2	7.45	0.17	0.3	5.2	Severe
B9[2]	2.4	7.23	0.19	0.4	5.4	Severe
B10[2]	2.5	7.62	0.206	0.6	4.6	Severe
B11[2]	2.5	6.97	0.206	0.7	4.2	Severe
B12[3]	13.5	7.32	1.096	1.9	13.9	Moderate
B13[2]	1.6	7.19	0.143	0.4	3.6	Severe
B14[2]	1.3	7.06	0.138	0.5	2.6	Severe
B15[4]	0.4	7.17	0.051	0.2	1.3	Severe
B16[4]	0.4	7.12	0.05	0.3	1	Severe
B17[2]	1.6	6.73	0.227	0.5	3.2	Severe
B18[5]	0.2	6.60	0.035	0.3	0.5	Severe

* Infiltration risks according to Ayers and Westcot (1985); 1 Salinas River; 2 Bananal River; 3 Artesian Well; 4 Curralinho Dam; and 5 Ribeirão River

Sodium contents ranged from 0.2 to 13.5 mEq L^{-1}. Except for B4 and B12, all samples are within the recommended threshold for use in sprinkler irrigation, in terms of sodium toxicity risks (< 3.0 mEq L^{-1}), as proposed by Ayers and Westcot (1985). The highest sodium contents were observed in samples B4 and B12, with values of 11.8 and 13.5 mEq L^{-1}, respectively. Both samples came from artesian wells. Such high sodium amounts can cause severe toxicity to crops irrigated by sprinklers (AYERS; WESTCOT, 1985). Moreover, our findings were higher than those found by Ribeiro et al. (2010) in the North of Minas Gerais State. These authors evaluated water quality at different tubular wells and observed sodium contents below 3.0 mEq L^{-1}.

Regarding electrical conductivity (EC), samples B4 and B12 had a "mild to moderate" risk for soil salinization (Ayers and Westcot, 1985). These samples were thus classified as class C3, i.e., high-salinity water (RICHARDS, 1954). The other samples showed no degree of restriction to use (AYERS; WESTCOT, 1985) and were classified as C1, i.e., low salinity water (RICHARDS, 1954). Souza et al. (2016) found the same trend when analyzing surface and groundwater in the semi-arid region of Ceará State (Brazil).

As for the risk of infiltration problems, samples B4 and B12 had moderate risk, and the others severe risk, according to the classification of Ayers and Westcot (1985) (Figure 2). For Pizarro (1996), when the salinity in irrigation water is very low, the risk of sodicity is high, even with very low SAR values. In the case of water for irrigation purposes, when the EC is lower than 0.2 dS m^{-1}, it tends to cause sodicity problems, regardless of the SAR value (AYERS; WESTCOT1985; ALMEIDA, 2010).

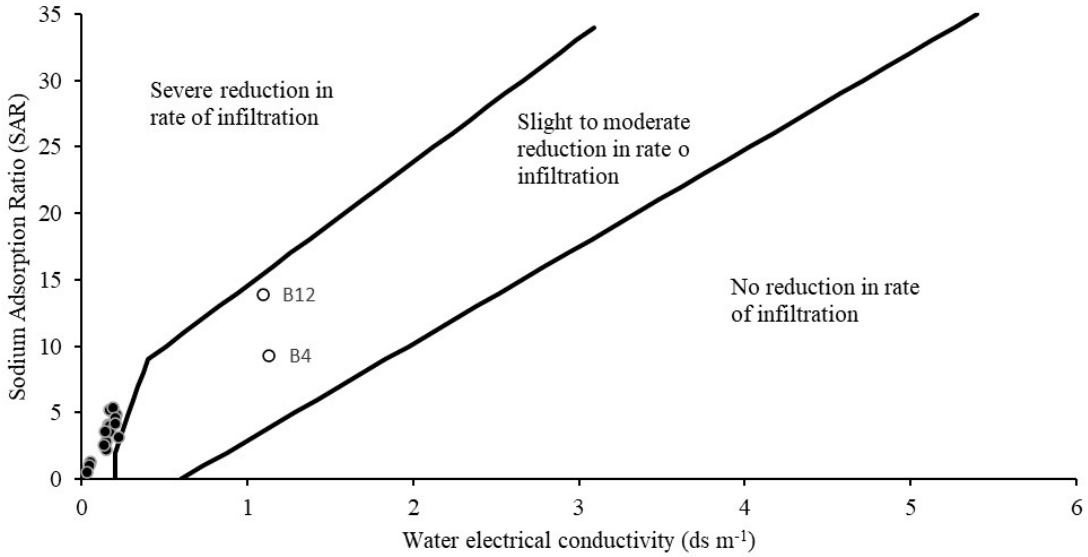

Figure 2. Classification regarding the risk of sodicity for the region of Salinas-MG (Brazil).
Source: AdaptedfromRhoades(1977) and Oster&Schroer (1979).

CONCLUSIONS

The region of Salinas, in Minas Gerais State (Brazil), requires care in terms of water use since the lack of a proper management can cause serious damage to the soil and, in some cases, toxicity to irrigated crops. Therefore, producers must perform analyses in the waters intended for irrigation.

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REFERENCES

ALMEIDA, O. A. de. **Qualidade da água de irrigação**. Cruz das Almas: Embrapa Mandioca e Fruticultura, 2010. 234 p.

AYERS, R. S.; WESTCOT, D. W. **Water quality for agriculture** (Revised). Rome: FAO, 1985. 174 p. (Irrigation and Drainage, Paper n. 29)

GOMES, K. R.; SOUSA, G. G. de; LIMA, F. A.; VIANA, T. V. de A.; AZEVEDO, B. M. de; SILVA, G. L. da. Irrigação com água salina nacultura do girassol (*Helianthus annuus* L.) em solo com biofertilizantebovino. **Irriga**, v. 20, n. 4, p. 680–693, 2015.

HOLANDA, J. S.; AMORIM, J. R. A.; FERREIRA NETO, M., HOLANDA, A. C.; SÁ, F. V. S. Qualidade da água para irrigação. In: GHEYI, H. R.; DIAS, N. S.; LACERDA, C. F. (Eds). **Manejo da Salinidadena Agricultura**: Estudos Básicos e Aplicados. Fortaleza: INCT Sal, 2016, p. 35-47.

LIMA, L. A.; OLIVEIRA, F. A.; ALVES, R. C.; LINHARES, P. S. F.; MEDEIROS, A. M. A; BEZERRA, F. M. S. Tolerância da

berinjela à salinidade da água de irrigação. **RevistaAgro@mbiente On-line**, v. 9, n. 1, p. 27-34, 2015.

MARTINS, F. B. GONZAGA, G.; SANTOS, D. F. dos; REBOITA, M. S. Classificação climática de Köppen e de Thornthwaite para Minas Gerais: cenárioatual e projeçõesfuturas. **Revista Brasileira de Climatologia**, v.1, p. 129-156, 2018.

OSTER, J. D.; SCHROER. F. W. Infiltration as influenced by irrigation water quality. **Soil Sc. Soc. Amer. Jour.** n.43, p.444-447, 1979.

PIZARRO, F. **Drenajeagrícola y recuperación de suelossalinos**. 2. ed. Madrid: Editorial Española S.A., 1985. 542p

PIZARRO, F. **Riegoslocalizados de altafrecuencia (RLAF)**. goteo, microaspersión y exudación. 3. Ed. Rev. y amp. Madrid: Mundi-Prensa. 1996. 513p

RHOADES. J. D. Potential for using saline agricultural drainage waters for irrigation. **Proc. Water management for irrigation and drainage**. Reno: ASCE. 1977. P.85-116.

RIBEIRO, M. S.; LIMA, L. A.; FARIA, F. H. S.; SANTOS, S. R.; KOBAYASHI, M. K. Classificação da água de poços tubulares do norte do estado de Minas Gerais para irrigação. **Revista Engenhariana Agricultura-Reveng**, Viçosa, v. 18, n. 3, p. 208-218, maio/jun. 2010.

RICHARDS, L. A. **Diagnosis and improvement of saline and alkali soils**. [S.l.]: Soil Science, v. 8, n. 2., 1954. p 154.

SANTOS, C. P.; FONSECA, S. F.; SANTOS, D. C.; TRINDADE, W. M. Avaliação da qualidade da água superficial da Lagoa do Bairro Nossa senhora Aparecida–Pirapora/MG a partir de parâmetro sfísico-químicos. **Revista da Casa da Geografia de Sobral**, v. 17, n. 2, p. 36-53, 2015.

SOUZA, C. A.; ARAUJO, Y. R.; ARAÚJO NETO, J. R.; PALÁCIO, H. A. Q.; BARROS, B. E. A.; Análise comparativa da qualidade de água para irrigação em três sistemas hídricos conectados no semiárido. **Revista Brasileira de Agricultura Irrigada**, Fortaleza, v. 10, n. 6, 2016.

SOUZA, M. C. F. B.; OLIVEIRA, S. M. A. C.; PAIXÃO. M. M. O M.; HAUSSMANN, M. G. Aspectos hidrodinâmicos e qualidade das águas subterrâneas do Aquífero Bambuí no Norte de Minas Gerais. **Revista Brasileira de RecursosHídricos**, v. 19, n. 1, p. 119-129, 2014.

PATRÍCIO, M. C. M.; ARAÚJO, S. M. S. Indicadores socioambientais dos municípios de Cabaceiras e Barra de São Miguel - PB - Brasil: fragilidades e vulnerabilidades à Seca e à Desertificação. **Espacios**. v. 37, n.24, p. 4, 2016.

TAIZ, L.; ZEIGER, E.; MOLLER, I.; MURPHY, A. **Fisiologia e desenvolvimento vegetal.** 6.ed. Porto Alegre: Artmed, 2017. 888 p.

ZAMBERLAN, J. F.; ROBAINA, A. D.; PEITER, M. X.; FERRAZ, R. C.; PINTO, L. M. Índices sazonais de qualidade da água de irrigação via análise multivariada na região central do Rio Grande do Sul. **Irriga**, v. 18, n. 3, p. 376-386, 2013.