

## CONCLUSION

In general, groundwater presented low to medium restriction for irrigation use. Data showed a trend in finding higher salt concentration in groundwater from coast zone to inland of the State. Sodicyty had an inverse trend when compared to the salinity.

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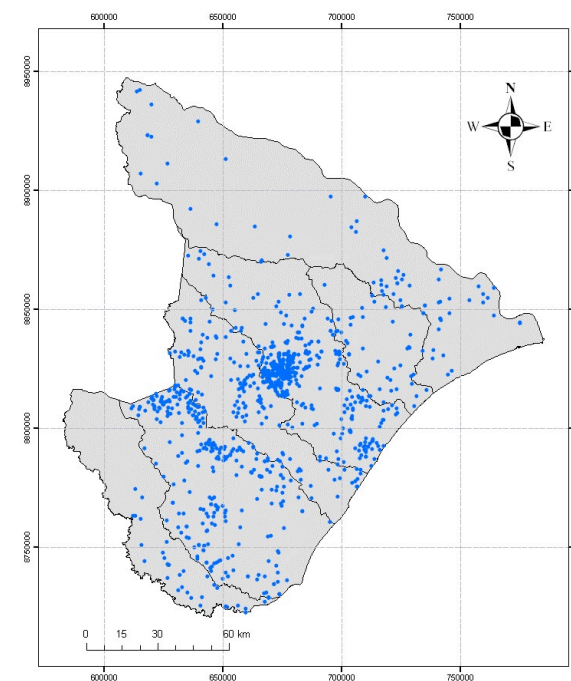
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## GROUNDWATER QUALITY FOR IRRIGATION PURPOSES IN SERGIPE STATE, BRAZIL



**Embrapa**

# ABSTRACT

This study aim to organize water quality information from all six main watersheds of Sergipe State in a single georeferenced database, using data from two different preexistent databases that comprehend 1,200 physical-chemistry analyses of water from deep wells. Diagnoses of groundwater quality for irrigation purposes were elaborated using parameters such as pH, electrical conductivity (EC), sodium adsorption ratio (SAR), and ion content of sodium, chloride, and total iron as water quality indicators of potential irrigation problems. In general, groundwater presented low to medium restriction for irrigation use.

# INTRODUCTION

Sergipe State is located in the Northeast Region of Brazil and is partially inserted in the so called Polygon of Droughts, which is characterized by an extreme irregularity in the rainfall distribution, causing restrictions on water availability for several uses. In this scenario of water scarcity, the demand for groundwater sources is intensified and in most of the time these sources have poor management due to lack of information on amount and quality of used resources (Cruz et al., 2007). Groundwater use for crop irrigation is presented as a great alternative for economic sustainability of the agricultural activities in the region. A diagnosis of the potential risks associated with water quality would allow detecting potential problems of degradation of soil by salinization and clogging of components of localized irrigation systems and planning corrective or mitigating measures to be adopted (Ayers & Westcot, 1994; Resende et al., 2006). The objective of this study was to consolidate the data of two different databases into a single and consistent georeferenced database, organizing the information on water quality to allow for better planning the groundwater management in Sergipe State, taking in account the resolutions of the National Policy for Water Resources.

# METHODOLOGY

Data of two different preexistent databases with 1,200 physical-chemistry analyses of the deep wells water were used. The databases belong to the Company for Development of Water Resources and Irrigation – COHIDRO and the State Secretary of the Environment and Water Resources – SEMARH. The wells are spread

out along the six main river basins of the Sergipe State: São Francisco, Japarutuba, Sergipe, Piauí, Vaza-Barris, and Real (Figure 1). For consolidating a single and consistent georeferenced database from the two databases, a critical data analysis was performed to standardize the variables information and correct duplicate, divergent, and mistaken data, mainly concerning to the wells identification code, geographic localization, measurement units, and typing errors. Diagnoses of groundwater quality for irrigation purposes were elaborated using parameters such as: pH, electrical conductivity (EC), in  $\text{dS m}^{-1}$  at  $25^\circ\text{C}$ , sodium adsorption ratio (SAR), in  $(\text{mmol}_e \text{L}^{-1})^{1/2}$ , and ion content of sodium, in  $\text{mmol}_e \text{L}^{-1}$ , chloride, in  $\text{mmol}_e \text{L}^{-1}$ , and total iron, in  $\text{mg L}^{-1}$ , as water quality indicators of potential irrigation problems. The guidelines for interpretations of water quality for irrigation are presented in Table 1 (Ayers & Westcot, 1994). The database manager module of the Spring GIS (version 4.3.2) was used for classifying waters, according to potential hazards of salinity, sodicity, toxicity of ions sodium and chloride for sprinkler-irrigated plants, and clogging in localized irrigation systems, as well as plotting georeferenced images (Câmara et al., 1996).

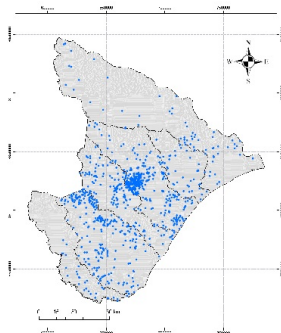


Figure 1. Spatial distribution of deep wells in the six watersheds of Sergipe State, Brazil.

Table 1. Guidelines for interpretations of water quality for irrigation<sup>1</sup>.

Parameters	Degree of restriction on use		
	None	Slight to Moderate	Severe
pH	< 7,0	7,0 – 8,0	> 8,0
Total iron ( $\text{mg L}^{-1}$ )	< 0,1	0,1 – 1,5	> 1,5
EC ( $\text{dS m}^{-1}$ )	< 0,7	0,7 – 3,0	> 3,0
Sodium ( $\text{mmol}_e \text{L}^{-1/2}$ )	< 3,0	> 3,0	
Chloride ( $\text{mmol}_e \text{L}^{-1/2}$ )	< 3,0	> 3,0	
SAR = $0 - 3$ vs. EC =	> 0,7	0,7 – 0,2	< 0,2
= $3 - 6$	= > 1,2	1,2 – 0,3	< 0,3
= $6 - 12$	= > 1,9	1,9 – 0,5	< 0,5
= $12 - 20$	= > 2,9	2,9 – 1,3	< 1,3
= $20 - 40$	= > 5,0	5,0 – 2,9	< 2,9

<sup>1</sup> Adapted from Ayers & Westcot (1994).  
<sup>2</sup> Toxicity of ions sodium and chloride for sprinkler-irrigated plants.

# RESULTS AND DISCUSSION

Table 2 presents frequency distribution of groundwater quality indicators by class of degree of restriction on use for irrigation purposes. With frequencies ranging between 51% and 61%, the most of well water analyses showed no irrigation restriction for salinity and total iron, which is associated with clogging problems in localized irrigation systems. As for the indicators associated with pH, sodicity, and toxicity of ions sodium and chloride for sprinkler-irrigated plants, higher frequency values

occurred in the slight to moderate restriction class. The frequency of severe restriction class reached at most 21%, meaning, in general, that groundwater presents low to medium restriction on use, mainly by localized irrigation systems.

Table 2. Frequency distribution (%) by class of degree of restriction on use for water quality indicators of groundwater for irrigation purposes in Sergipe State, Brazil.

Class of degree of restriction on use	Water quality indicator					
	pH	Total iron	Salinity	Sodicity	Sodium	Chloride
None	26	61	51	35	45	47
Slight to moderate	52	30	37	49	55	53
Severe	21	09	12	16		

Spatial distribution of restriction classes of groundwater quality for irrigation purposes is presented in Figure 2. Data showed a trend of increase in salt concentration of groundwater from the coast to inland indicating more evident restrictions for irrigation in part of the central and the hinterland regions of Sergipe (Figure 2.a), corresponding to higher parts of the watersheds, where the demand for irrigation is higher. The opposite occurs with sodicity potential risk since restriction on groundwater use for irrigation is more evident in coastal zone (Figure 2.b). It is observed that groundwater with no restriction on use for irrigation, related to potential hazards of salinity and toxicity of ions sodium and chloride, predominates in middle and lower parts of the six watersheds, corresponding to the central and coastal zone regions of Sergipe State (Figures 2.a, 2.c, and 2.d). The pH values presented a uniform spatial distribution all over the six watersheds (Figure 2.e). Apparently, there was no spatial distribution pattern related to total iron (Figure 2.f).

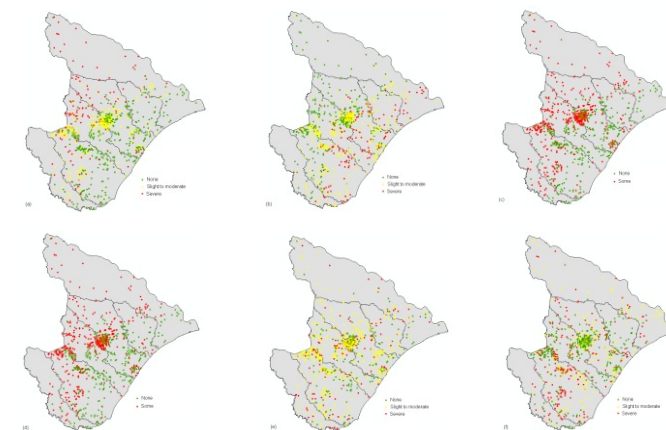


Figure 2. Spatialization of groundwater quality restriction classes for irrigation purposes in Sergipe State, Brazil, in relation to salinity (a), sodicity (b), sodium toxicity (c), chloride toxicity (d), and clogging problems in localized irrigation systems associated with pH (e) and total iron (f)..