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Environmental diagnosis of the aquifer free of the north zone of Aracaju - Sergipe through metal, ions and BTEX concentrations

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INTRODUCTION

Groundwater generally has good quality for human consumption, requiring less treatment costs than surface water, which makes it more accessible to the public (LAVOIE et al, 2015). Although a significant portion of Brazilian municipalities use groundwater to supply, there are few studies about the resource, its water potential and quality, and most of these are focused on specific issues in the characterization of contaminated sites

According to data published, only 26 municipalities in Sergipe have sewage, and, out of these, only 07 perform some kind of treatment. The lack of an efficient environmental sanitation system requires the use of tank-filter-sink, contributing to groundwater contamination, naturally high in sandy soils. Were identified contaminated areas in the greater Aracaju associated with domestic and industrial effluents untreated, from trace metals analysis in sediments of rivers, potential contamination of the aquifer.

The aim of this study was to evaluate the contamination of the unconfined aquifer in the North Zone of the municipality of Aracaju / SE, through the analysis of metals, ions and BTEX compounds in water samples from shallow wells, relating to human activities and potential sources contamination, comparing the results to the limits of potability of Decree No. 2,914 / 2011 of the Ministry of Health.

METHODOLOGICAL PROCEDURES

Study area

The study area is located the north of the city of Aracaju and in the east of Sergipe, being part of the basin of the Sergipe and Vaza Barris Rivers, Figure 1.

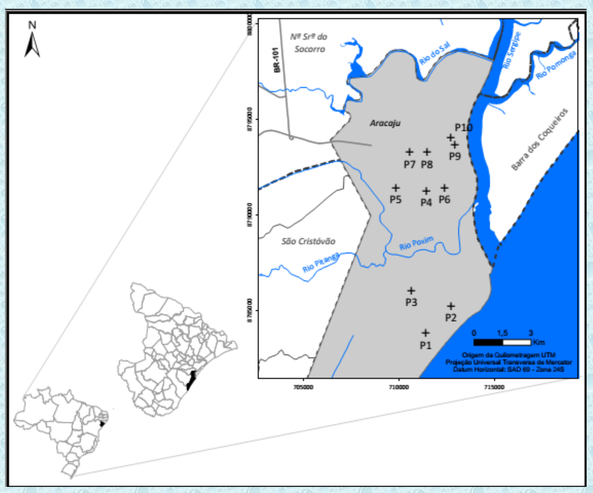

Figure 1. Study area and location of sampling points.

Sampling

Samples were taken with a sampler bailer manual of double valve, disposable, and immediately transferred to containers appropriate for each analysis, properly identified with tags, and preserved in ice. The valve in the bailer allows the sample to be transferred to sample containers with less loss of volatiles compounds. The collection forms were filled with the data on the collected sample and the static level of the well.

For this work, 10 shallows monitoring wells (up to 8 m deep) were selected to collect, all of them already existing, manually drilled with auger and located in the unconfined aquifer in the North Zone of Aracaju. The sample size was established at the cost of analysis and the twells available for collection. The samplings were carried out in May (rainy season) and in November and December 2015 (dry season), evaluating the seasonal effect for the concentrations of metals (Al, As, Ba, B, Cd, Co, Cr, Cu, Fe, Li, Mn, Ni, Sr, Zn) ions (calcium, magnesium, potassium, sodium, sulphate , chloride, fluoride) and BTEX (benzene, toluene, ethylbenzene and xylenes), and when appropriate, compared to the maximum permissible values of Decree n° 2,914/2011 of the Ministry of Health, CONAMA 420/2009 and CONAMA 396/2008 to characterize the quality of groundwater for potable purposes.

RESULTS AND DISCUSSIONS

The presence of high levels of metals in groundwater may be related to the release of industrial effluents or leaching of industrial waste, particularly heavy metals such as As, Cr, Cu, Pb, which, in addition to being toxic, have a cumulative effect in the body. Among metals which have limits of potability (Al, As, Ba, Cd, Cr, Cu, Fe, Mn, Ni and Zn), only Cd and Mn extrapolated the boundaries (Table 1). Co and Cr were not detected in any of the studied points.

Table 1 - Total concentration of metals in groundwater

Site	Al	As	B	Ba	Cd	Co	Cr	Cu	Fe	Li	Mn	Ni	Sr	Zn
	mg.L^{-1}	mg.L^{-1}	mg.L^{-1}	mg.L^{-1}	mg.L^{-1}	mg.L^{-1}	mg.L^{-1}	mg.L^{-1}	mg.L^{-1}	mg.L^{-1}	mg.L^{-1}	mg.L^{-1}	mg.L^{-1}	mg.L^{-1}
P01	0,0328 ±0,0032	0,0091 ±0,0032	0,0281 ±0,0003	n.d.	0,0041 ±0,0005	n.d.	n.d.	n.d.	0,0005 ±0,0003	0,0163 ±0,0011	0,3824 ±0,0057	n.d.	0,5356 ±0,0040	0,0367 ±0,0056
P02	0,0041 ±0,0010	0,0104 ±0,0039	n.d.	n.d.	0,0040 ±0,0004	n.d.	n.d.	n.d.	0,0025 ±0,0004	0,0227 ±0,0020	0,4069 ±0,0028	n.d.	0,1635 ±0,0023	0,0454 ±0,0020
P03	0,0444 ±0,0092	0,0221 ±0,0019	n.d.	n.d.	0,0034 ±0,0003	n.d.	n.d.	n.d.	0,0392 ±0,0039	0,0162 ±0,0018	0,0429 ±0,0024	n.d.	0,1196 ±0,0047	0,0457 ±0,0058
P04	0,0206 ±0,0071	n.d.	0,0094 ±0,0056	n.d.	0,0049 ±0,0002	n.d.	n.d.	n.d.	n.d.	0,0167 ±0,0017	0,0262 ±0,0038	0,0014 ±0,0002	0,2372 ±0,0039	0,0335 ±0,0022
P05	0,0555 ±0,0037	0,0254 ±0,0038	0,0192 ±0,0037	n.d.	0,0033 ±0,0005	n.d.	n.d.	n.d.	0,0132 ±0,0012	0,0164 ±0,0020	0,0213 ±0,0025	n.d.	0,1040 ±0,0050	0,1706 ±0,0066
P06	0,0262 ±0,0061	0,0078 ±0,0025	0,0280 ±0,0054	n.d.	0,0035 ±0,0006	n.d.	n.d.	n.d.	0,0132 ±0,0003	0,0164 ±0,0019	0,0167 ±0,0030	0,0011 ±0,0004	0,4619 ±0,0062	0,0331 ±0,0014
P07	n.d.	0,0186 ±0,0047	n.d.	n.d.	0,0035 ±0,0004	n.d.	n.d.	n.d.	n.d.	0,0167 ±0,0018	n.d.	n.d.	0,1403 ±0,0032	n.d.
P08	n.d.	0,0279 ±0,0042	0,0015 ±0,0003	n.d.	0,0033 ±0,0002	n.d.	n.d.	n.d.	0,0086 ±0,0002	0,0167 ±0,0018	0,1447 ±0,0038	n.d.	0,1950 ±0,0028	0,0138 ±0,0053
P09	0,0968 ±0,0083	0,0146 ±0,0019	n.d.	n.d.	0,0045 ±0,0005	n.d.	n.d.	n.d.	0,0512 ±0,0004	0,0169 ±0,0015	n.d.	n.d.	0,0493 ±0,0027	n.d.
P10	n.d.	0,0071 ±0,0065	0,0090 ±0,0004	n.d.	0,0036 ±0,0003	n.d.	n.d.	n.d.	0,0430 ±0,0003	0,0163 ±0,0018	0,0042 ±0,0007	n.d.	0,3759 ±0,0019	n.d.

The As was found at all points, exceeding in 9 of them a concentration of 0.01 mg L^{-1} defined by Decree No. 2,914/11, in at least one of the campaigns. This compound is related to industrial waste, burning coal, mineral smelting activities and insecticide. The highest value was found in P10, equal to 0.0436 mg L^{-1} in the dry season.

Table 2 - Total concentration of ions in groundwater

Site	Ca	Mg	Na	K	SO_4	Cl	F
	mg.L^{-1}	mg.L^{-1}	mg.L^{-1}	mg.L^{-1}	mg.L^{-1}	mg.L^{-1}	mg.L^{-1}
P01	143,61 ±0,17	7,816 ±0,011	24,847 ±0,190	11,821 ±0,012	32,888 ±0,204	54,61 ±0,14	0,280 ±0,025
P02	60,20 ±0,10	2,544 ±0,011	26,881 ±0,143	8,564 ±0,012	1,793 ±0,111	58,90 ±0,08	0,462 ±0,035
P03	37,81 ±0,06	2,985 ±0,006	8,602 ±0,187	3,323 ±0,019	12,431 ±0,121	14,33 ±0,07	0,047 ±0,003
P04	57,52 ±0,15	2,429 ±0,019	19,145 ±0,179	5,938 ±0,006	25,311 ±0,163	26,95 ±0,15	0,237 ±0,035
P05	33,85 ±0,13	1,234 ±0,013	9,918 ±0,173	2,770 ±0,019	7,071 ±0,135	15,65 ±0,10	0,042 ±0,003
P06	111,81 ±0,16	7,963 ±0,012	45,588 ±0,197	16,885 ±0,009	40,179 ±0,154	72,77 ±0,09	0,156 ±0,028
P07	25,85 ±0,11	0,674 ±0,020	3,970 ±0,060	3,374 ±0,006	5,356 ±0,200	5,30 ±0,06	0,076 ±0,009
P08	54,84 ±0,15	3,726 ±0,009	27,364 ±0,182	10,448 ±0,017	33,584 ±0,156	47,18 ±0,19	0,250 ±0,039
P09	14,06 ±0,08	0,758 ±0,014	5,170 ±0,088	4,589 ±0,006	5,253 ±0,204	8,27 ±0,05	0,023 ±0,005
P10	92,30 ±0,19	5,843 ±0,006	35,292 ±0,095	15,233 ±0,007	12,608 ±0,182	55,05 ±0,10	0,146 ±0,036

The presence of chlorides in groundwater is very common, and may be the result of the dissolution of salts, saline intrusion and also the release of domestic and industrial effluents. Chloride concentrations were detected in all samples and none of them exceeded the limit of 250 mg L^{-1} of Decree No. 2,914/11. The samples collected in the dry season showed higher concentrations, as a result of lower water demand period, and therefore less dilution.

Table 3 - Total concentrations of BTEX in groundwater

Site	Rainy				Dry			
	Benzene	Toluene	Ethylbenzene	Total xylene	Benzene	Toluene	Ethylbenzene	Total xylene
	mg.L^{-1}	mg.L^{-1}	mg.L^{-1}	mg.L^{-1}	mg.L^{-1}	mg.L^{-1}	mg.L^{-1}	mg.L^{-1}
P01	23,940 ± 1,077	0,460 ±0,058	7,690 ±0,988	1,330 ±0,037	17,569 ±0,957	n.d.	20,120 ±1,089	3,238 ±0,088
P02	6,990 ±0,997	0,260 ±0,038	5,170 ±0,769	1,420 ±0,076	15,753 ±0,927	n.d.	7,349 ±0,781	4,219 ±0,091
P03	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
P04	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
P05	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	0,212 ±0,038	1,246 ±0,087
P06	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
P07	n.d.	n.d.	n.d.	n.d.	n.d.	0,232 ±0,072	n.d.	0,874 ±0,024
P08	n.d.	0,160 ±0,034	n.d.	n.d.	n.d.	0,350 ±0,029	n.d.	n.d.
P09	n.d.	0,200 ±0,026	n.d.	n.d.	n.d.	0,548 ±0,082	0,127 ±0,035	n.d.
P10	n.d.	0,280 ±0,019	0,110 ±0,076	n.d.	2,173 ±0,027	0,658 ±0,106	0,343 ±0,035	0,342 ±0,039

The highest values in the dry season may represent a new contamination between periods, but may also be a result of the lower volume of water in the dry season. Additionally, the presence of dissolved oxygen and nitrate in the water may have contributed to the biodegradation of BTEX compounds in the analyzed.

Among the results, the concentrations of BTEX compounds diagnosed a serious situation for contamination by fuel, out of 10 points analyzed, 7 exceeded the limits of potability for any of these parameters in at least one of the campaigns. The limits of the turbidity, nitrite, sodium, sulfate, fluoride, chloride, aluminum, barium, copper, iron, nickel and zinc parameters are not exceeded in any of the samples performed.

CONCLUSION

Aracaju has vulnerabilities which allow us to infer a poor quality of the unconfined aquifer, because besides the existence of the various impacts inherent to urban areas, the predominance of sandy soils provides conditions favorable for contamination. The results diagnosed that water is unfit for human consumption in 09 of 10 analyzed points, in at least one of the campaigns..

The detection of BTEX compounds show greater concern for these toxicity at high concentrations, even it is highly volatile, suggesting greater attention to these parameters in potability assessments.

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