

Vulnerability potential analysis of aquifers aiming the implementation of sanitary landfills; case study: municipality of Descalvado (Brazil)

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Abstract: This study tries to diagnose the geoenvironment characteristics related to aquifers contamination by inadequate disposal of solid residues, using de municipal district of Descalvado (Brazil) as a case study, with the objective of producing a chart of the vulnerability potential of aquifers in view of the production of a chart of vulnerability potential of aquifers aiming the implantation of sanitary landfills, in a 1:50,000 scale.

Key Words: sedimentary aquifer, vulnerability, sanitary landfills, geoenvironment, groundwater.

INTRODUCTION

The studied area sits in the southeast region in Brazil, about 250 km far from the city of Sao Paulo, comprising the city of Descalvado, with an approximate area of 756 km², within the following coordinates: UTM time zone 23: $X_{\min} = 210000$; $x_{\max} = 242000$; $y_{\min} = 7558000$ and $y_{\max} = 7598000$.

The climate in the studied region is classified as type Cwa, according to the Köppen system, which means it is mesothermic humid undertropical of dry winter, in which the average temperature during the coldest month is inferior to 18 °C and, during the hottest month, it reaches temperatures above 22 °C. In relation to its rainfall, the annual precipitation is around 1,442 mm, within a period from October to April.

The surface geological formations in the area of study present the following percentage distribution: recent Quaternary deposits (5,51 %); Pirassununga Formation (4,41 %); Itaqueri Formation (1,75 %); Basalts of the Serra Geral Formation (7,65 %); Diabase Intrusive in Serra Geral Formation (16,72 %); Botucatu Formation (3,97 %); Pirambóia Formation (2,14 %); Corumbataí Formation (0,66 %) emphasizing the Santa Rita do Passa Quatro Formation occupying (57,18 % of the area of study), respectively with approximately 432.22 km². The Santa Rita do Passa Quatro Formation, with its larger portion inside the area of study, presents unconsolidated materials with typical sand texture, which indicates the probable fragility of the area of study as for the aquifer vulnerability.

In the studied area, the most important rocks for aquifers are those, which present porosity for storage and permeability to enable water movement within those rocks. Therefore, the

sandstones form regional aquifers with large amounts of drinkable water. The Botucatu and Piramboia aquifers create one of the largest underground drinkable water reservoirs on Earth, and are called Guarani aquifer.

To select adequate areas to implement sanitary landfills, it is important to consider, among other issues, the creation of a cartographic product to evaluate the aquifers natural vulnerability to contamination. This document can be obtained by elaborating a map of aquifer natural vulnerability. In order to do so, it is necessary to individualize the terrain characteristics, which condition the vulnerability evaluation, i.e., geological outline of deep wells, soil outline and lithology; morphology and morphometry of the relief, and surface drainage.

RESULTS AND DISCUSSION

The Chart of the Potential of Aquifer Natural Vulnerability for the Implementation of Sanitary Landfills (Figure 1), presents 5 classes, based on the adopted criteria, with the vulnerability potential increasing from class 1 to class 5. Therefore, the higher the vulnerability potential, the less adequate the area is to implant sanitary landfills

Figure 2 presents the frequency distribution of vulnerability classes, where it was found the predominance of class 5, with 67,47 % of the area of study, class 2 with 8,95 %, class 3 with 8,93 %, class 4 with 8,45 % and class 1 with 6,20 %. Class 5 is predominant in the area because the higher percentage of unconsolidated material is of a sand texture (approximately 73 %), followed by a smaller quantity of soils with clay texture (approximately 27 %), which confirms the fragility potential of the area of study in view of the aquifer vulnerability.

In the most parts of the area of study, the Cenozoic cover layer is original from the Santa Rita do Passa Quatro Formation, being constituted of sand-clay material, sobrejacente to the Botucatu Formation, which in turn, is constituted almost entirely of fine to medium grain sand, uniform, with a good selection of grains. Below the Botucatu Formation is the Pirambóia Formation, constituted of fine to medium grain sand, with a larger fraction of clay in the inferior part than that in the superior part of the formation, where conglomeratic thick sandstones are found. In the outline base, there is the Serra Geral Formation, constituted of basalt igneous rock (basalt and diabase).

CONCLUSION

The methodology, in view of the physiographic analysis of the area of study, allows different evaluations of the area, making it possible to correlate information about vulnerability with other potentialities of the environment, of great importance to environmental management.

Analyzing the obtained results, we notice that the chosen method demonstrates that the use

of advanced analysis tools available in software like the IDRISI32, allows the introduction of knowledge and facilitate the analysis of complex questions, like the groundwater contamination, which needs, besides the balance of involved attributes, the knowledge of aspects related to the contaminant nature and of the hydraulic geology of the region. Therefore, the SIGs are an important tool in helping the decision, making it less subjective than by using analogical tools.

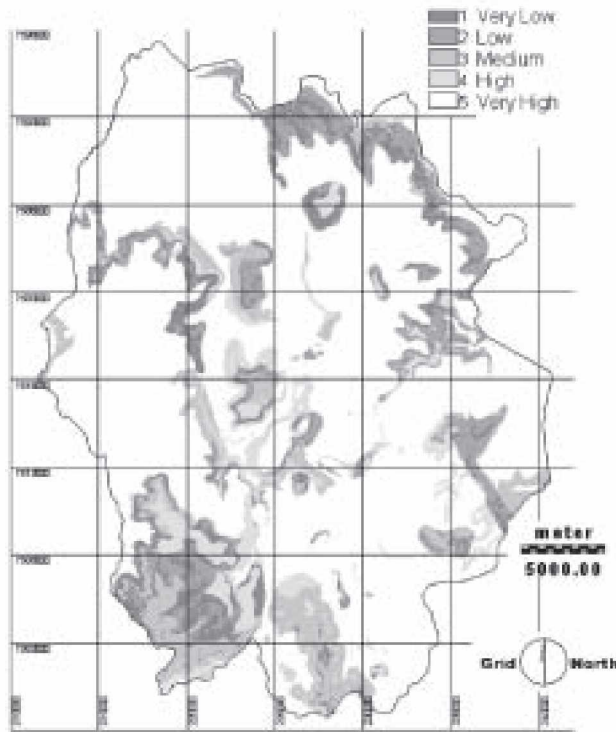


Figure 1. Chart of the Vulnerability Potential of Aquifers

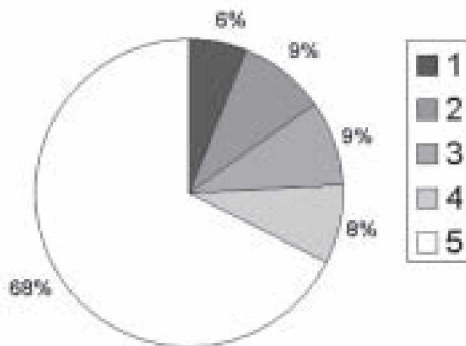


Figure 2. Frequency distribution of vulnerability classes

The more vulnerable city areas are represented by fields in which the Santa Rita do Passa Quatro Formation (sands) is found overlaid to the Botucatu (sandstone) and the Pirambóia (sandstone) Formations, both belonging to the Guarani aquifer.

Environmental studies are very complex because there are a considerable number of variables to analyze which concern several knowledge areas. To carry out this type of study the most adequate procedure should be accomplished by a team of specialists. Therefore, the performed study shows that physical analysis of the attributes allowed the area division in homogenous units that present environmental significance. This information can contribute to the management of the region.

REFERENCES

- MOREIRA, M. A. A. (2002): Aplicação de técnicas de geoprocessamento para seleção de áreas para disposição de resíduos sólidos em aterro sanitário no município de Descalvado (SP). Dissertação de mestrado. São Carlos: Universidade Federal de São Carlos ; 165p.