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Assessment of Ground water Vulnerability using GOD Method

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Abstract

Both the quantity and quality of ground water are subject to anthropogenic influence. Use of fertilizer, sewage, and domestic waste dumps are a few human-made activities that can pollute. Analyzing the groundwater's susceptibility is one way to protect it. This study was carried out to evaluate the Guelma plain's ground water's susceptibility. In fact, the method GOD type of aquifer, general lithology of the aquifer, and depth of ground water was used to assess the vulnerability of ground water in this study. Three factors, including aquifer type, lithology or rock type, and depth to water table, will be used to determine the vulnerability class of groundwater using this method. The results of this study can be applied as a decision-support tool for the management and preservation of the Guelma plain's water resources Quality.

Key words: Vulnerability, Aquifer, GOD, Groundwater, Plain.

INTRODUCTION

Ground water is one of the major sources of replenishable water on the earth and constitutes approximately 30% of fresh water from the total water of which only 0.86% is fresh water and total available water is 0.022% [10]. The groundwater is comparatively safe and reliable source as compared to surface water. Though not easily polluted, but once it is polluted it's exhaustively expensive, time consuming and extremely difficult to remediate this precious source of the contaminants it has been polluted with and replenish the lost integrity and sometimes it's impossible to restore. Due to increasing population, other anthropogenic activity (like agriculture, industrial, domestic waste etc.) changes in topography and relief, and land use land cover deteriorated it and its been over exploited and stressed due to ever increasing water demand and less availability of surface water. The socioeconomic development of a region depends on the availability of good quality water. Recent decades have seen a global increase in demand for freshwater, mainly satisfied by ground water abstracted from aquifers via numerous wells and boreholes. Ground water is under intense anthropogenic pressure in the Mediterranean basin, from sources such as changes in land use, urbanization, a lack of proper sewerage, intensive agriculture and a general increase demand.

There are several vulnerability assessment methods available. The most widely applied techniques include: the DRASTIC system [1], the SI [12], the GLA[12], the SINTACS method [4], the GOD method [7], the KAVI [2], the AVI ranting system AVI system [14], the PI [5]. as well as EPIK [6].

In Algeria several study of groundwater vulnerability to contamination by | 11;10; 13;3] this study was undertaken with the aim of identifying area of high risk of contamination regardless of the type of pollutant by GOD (vulnerability) method.

The goal of this study was to determine the vulnerability of the Guelma alluvial plain to groundwater pollution using the general GOD [7] approach and GIS. Map of groundwater pollution sensitivity created using GOD approach help to better pinpoint the location of polluted areas, which is necessary to establish measures to conserve these resources and prevent the loss of this wealth.

Presentation of the Study Area

The studied area Guelma-Boumahra belongs to the alluvial aquifer of Guelma, integral part of the Oued Seybouse basin which is part of the middle Seybouse. It is located in the heart of a large region with intense agricultural activity at 227 m average altitude. The alluvial layer of Guelma covers an area of about 122 km^2 with about 25 km from East to West and between 3 and 10 km wide. The plain is limited:

- to the North by the massif of Houara and Djebel Bousbaa;
- to the South by the Mahouna and Beni marmis massif;
- in the West by the Djebel Arar and;
- to the East by the massif of Nador[8].

Three main sets make up the geology of the Guelma region: pre-aquifer, Mio-Pliocene (continental, from Guelma basin), and recent set (Pliocene and Quaternary). Djebel Debagh Neritic domain, Heliopolis, and Guelma South are all parts of the Guelma region. This Jurassic-Cretaceous carbonate number of thrust layers and has undergone important tectonic events. The Seybouse wadi has left behind alluvium [15] along its path between Nador and Medjez Amar. and gypsum marl) and Quaternary (terraces of heterogeneous alluvium).

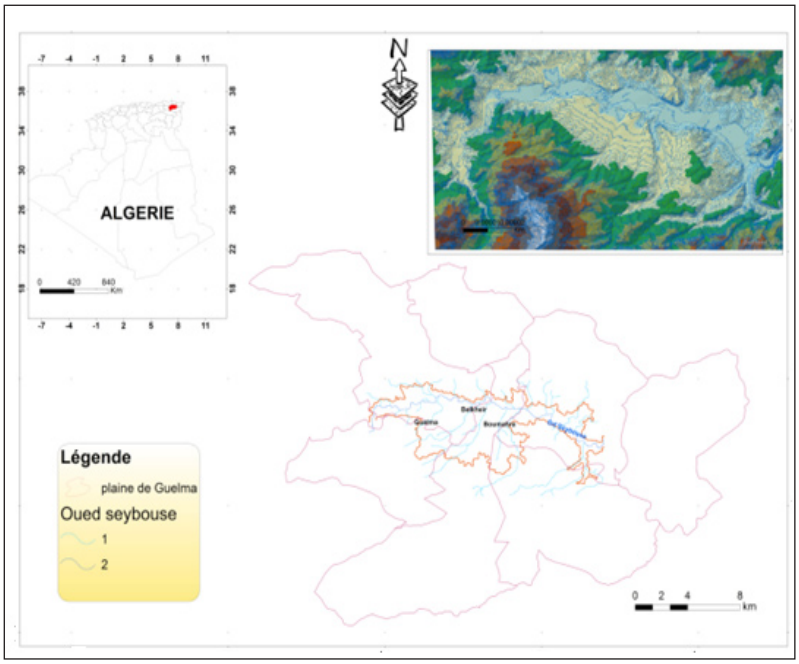

Figure 1. Map of geographical location of study area.

MATERIALS AND METHODS

Vulnerability Assessment using the GOD Method

The GOD method was developed by Foster in 1987. It presents the aquifer's vulnerability to vertical percolation of pollutants through the unsaturated zone and does not address the lateral migration of pollutants into the saturated zone. The GOD method uses an empirical approach where the vulnerability of aquifers is defined according to the inaccessibility of the saturated zone, in the sense of the penetration of the pollutant, and the attenuation capacity that the overlying layer presents to the zone. saturated [3]. The approach used for this model uses three parameters, namely; the first resides in the identification of the type of aquifer according to its degree of confinement (Ci), the second corresponds to the depth of the aquifer (Cp) and the third is defined by the lithology of the aquifer (Ca). The scores assigned to the classes of the different parameters are less than or equal to "1" The GOD Index (GI), which assesses the vulnerability of the aquifer to pollution, is obtained by multiplying these three parameters Mapping the vulnerability to pollution of aquifers by the GOD method is done by calculating the GOD index (GI) according to equation (1).

$$GI = Ca \times Ci \times Cp \quad (1)$$

Elaboration of Maps of the Specific Parameters of the Vulnerability of the Aquifer by the God Method

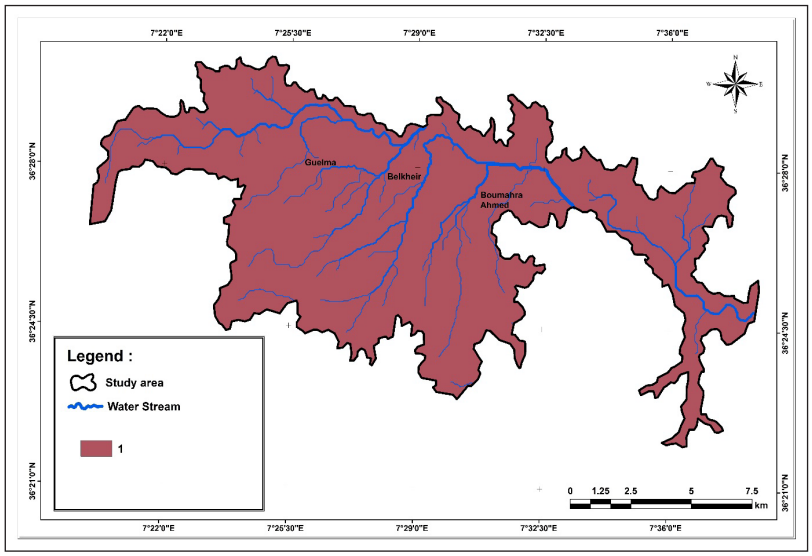

Figure 2. Map of the typical parameter (G) of the alluvial aquifer of Guelma plain.

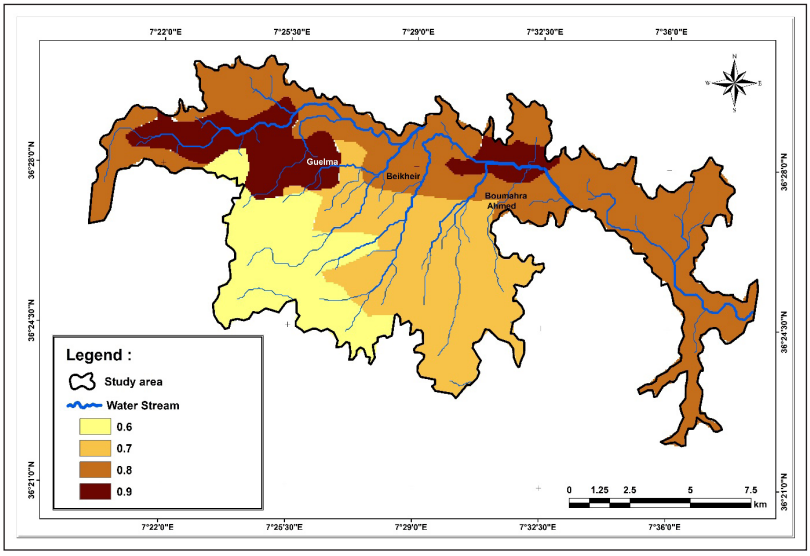

Figure 3. Map of parameter (O) nature of the unsaturated zone

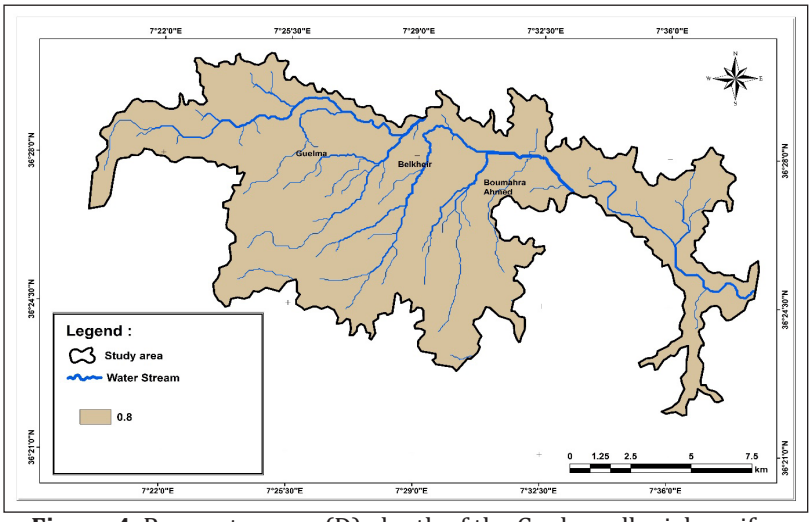

Figure 4. Parameter map (D), depth of the Guelma alluvial aquifer

The application of the GOD method at the level of the plain of Goleman allowed the realization of a map of vulnerability, of which we observe three classes of vulnerability (Figure 5), as follows:

- The low vulnerability class which represents 18% of the area of the study region. It corresponds to vertisols, clayey and not very permeable, located to the south-east of the plain,
- The medium vulnerability class represents 51.198% of the mapped area. These values are mainly due to the low slope which is very low (0 to 2%), the average depth of the piezometric surface,
- The high vulnerability class occupying 58% of the entire surface studied. The latter is located in urbanized sectors, this class is mainly due to domestic and industrial discharges, the shallow depth of the piezometric surface of the aquifer which is sometimes zero, the types of lithology and the type of aquifer (free). Similarly, greenhouse crops that have been developed for the national market use large quantities of nitrates.

Table 1. Intervals of GOD Index values and corresponding classes

Interval	Class GOD
0,0 – 0,1 0,1 – 0,3 0,3 – 0,5 0,5 – 0,7 0,7 – 1,0	Vulnerability very low Vulnerabilitylow Vulnerabilitymedium Vulnerabilityhigh VulnerabilityVery high

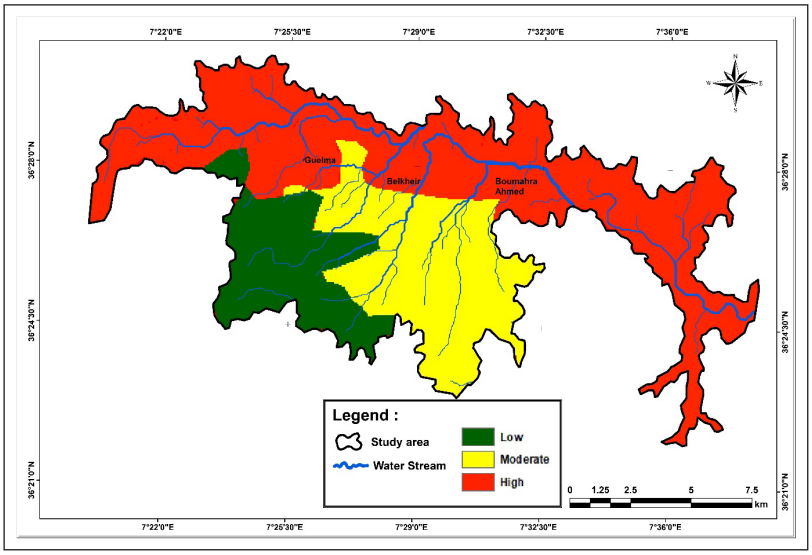

Figure 5. Degree of vulnerability to pollution by the GOD method

CONCLUSION

The Guelma alluvial aquifer's vulnerability to pollution could be estimated thanks to the use of GOD methods. From the plain's center toward the northern borders, this vulnerability grows. This growth is a result of the distribution of the sources of pollution. The vulnerability is divided into three classes: "Low," "Medium," and "High," according to an analysis of the vulnerability map produced by the application of the GOD method. The most vulnerable perimeters must now be subjected to a strict control to define the protection measures to avoid and stop the degradation of this natural source, as the contamination of the groundwater in the study area has been confirmed.

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