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Assessment of intrinsic vulnerability to contamination for Gaza coastal aquifer, Palestine

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Abstract

Gaza coastal aquifer (GCA) is the major source of fresh water for the 1.5 million residents of Gaza Strip, Palestine. The aquifer is under deteriorating quality conditions mainly due to the excessive application of fertilizers. The intrinsic vulnerability of GCA to contamination was assessed using the well-known DRASTIC method. Detailed analysis of the intrinsic vulnerability map of GCA was carried out and did consider different relationships between the vulnerability indices and the on-ground nitrogen loadings and land use classes. In addition, correlation between vulnerability values and the nitrate concentrations in GCA was studied. Based on the vulnerability analysis, it was found that 10% and 13% of Gaza Strip area is under low and high vulnerability of groundwater contamination, respectively, while more than 77% of the area of Gaza Strip can be designated as an area of moderate vulnerability of groundwater contamination. It was found that the density of groundwater sampling wells for nitrate concentration is high for the moderate and high vulnerability zones. The highest first quartile, median, mean, and third quartile of nitrate concentrations are reported in the high vulnerability zones. Results of sensitivity analysis show a high sensitivity of the high vulnerability index to the depth to water table.

Keywords: Groundwater; Vulnerability; Agriculture; Fertilizers; Management; Coastal aquifers; Palestine

1. Introduction

Groundwater is the most important water resource on earth (Villeneuve et al., 1990). The quality of groundwater is generally under a considerable potential of contamination especially in agriculture-dominated areas with intense activities that involve the use of fertilizers and pesticides (Giambelluca et al., 1996; Soutter and Musy, 1998; Lake et al., 2003; Thapinta and Hudak, 2003; Chae et al., 2004). The issue of protection of groundwater against pollution is of crucial significance (Zektser et al., 2004). The concept of groundwater vulnerability is a cornerstone in the evaluation of the risk of groundwater contamination and in the development of management options to preserve the quality of groundwater (Fobe and Goossens, 1990; Worrall et al., 2002; Worrall and Besien, 2004).

Groundwater vulnerability maps provide useful information to protect groundwater resources and to evaluate the potential for water quality improvement with changes in agricultural practices and land use applications (Burkart and Feher, 1996; Rupert, 2001; Connell and Daele, 2003; Babiker et al., 2005). In addition, such maps can be used for regional planning and development of groundwater resources since they provide a preliminary indication of possible contamination risks of groundwater (Fobe and Goossens, 1990; Worrall et al., 2002).

Groundwater vulnerability mapping is based on the idea that specific land areas are more vulnerable to groundwater contamination than others (Gogu and Dassargues, 2000). Hence, groundwater vulnerability assessment delineates areas that are more susceptible to contamination due to the hydrogeologic factors and anthropogenic sources and shows areas of greatest potential for groundwater contamination. In general, this connotes the estimation of the potential for contaminants to migrate from the land surface through the unsaturated zone until reaching the areas of interest (Connell and Daele, 2003). As such, the concept of groundwater vulnerability is important for a rational management of groundwater resources and

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