

## Investigation on Nitrate Concentrations in Groundwater Resources of Marand Plain and Groundwater Vulnerability Assessment Using AVI and GODS Methods

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### Extended Abstract

#### Introduction

More than 90% of drinking water in cities around the world and about 40% of the agricultural water are supplied from groundwater resources. Thus, groundwater quality is considered as an inevitable issue. One of the most important parameter which can show the quality of drinking water is nitrate concentration. Nitrate enters the groundwater and surface water through the decomposition of human and livestock wastes, industrial outputs and leaching of agricultural fertilizers. Typically, the concentration of nitrate is higher in shallow groundwater and decreases with increasing depth and toward downstream due to the diffusion process, mixing and dilution with low nitrate groundwater.

#### Materials and Methods

Marand plain is located in East Azarbaijan Province in the northwest Iran, with an area of approximately 826 square kilometers. The plain is a part of Caspian basin. Groundwater resources of the plain have been formed in quaternary alluvial sediments. The sediments formed in the mountain range pediments are coarse and gradually the grain sizes decreases towards the central parts of the plain and turned into clay and silt at the end parts. Zilbir Chay and Zonouz Chay are important rivers in the study area. Based on the results of geophysical investigations and geological logs, there are three types of aquifers including unconfined, confined and semi-confined in the plain (Fig. 1). Unconfined aquifer is formed in ancient terraces, recent terraces, alluvial fans and fluvial sediments and the main materials of deposits are gravel, sand, silt and clay. The thickness of the unconfined aquifer varies in different parts of the plain. The southern part of the plain is made of semi-hard conglomerate with Plio-Pliostocene debris and it must be considered as low permeable and semi-permeable regions because of clay and marl layers. Confined aquifer, mostly in the form of ancient alluvial deposits, is covered by clay and marl layers with thicknesses varying from 10 to 30 m. The maximum thickness of the confined aquifer reaches 170 meters in some parts of the plain. The confined aquifer is located in the central and western parts of the plain and even in some parts of the Zilbir Chay and Zonouz Chay Rivers terraces. The semi-confined aquifer is placed in western part of the plain.

To evaluate nitrate contamination, up to 48 samples were collected from shallow and deep wells of the aquifers in July 2012. Analyzed ions are including pH, EC, major cations, anions and nitrates. Nitrate was analyzed by spectrophotometer and other cations and anions by standard methods at hydrogeology laboratory of Tabriz University. Then, the spatial distribution map of nitrate concentration was plotted using the ArcGIS10 software. Groundwater vulnerability assessment was performed by two methods including AVI (Aquifer Vulnerability Index) and GODS (Groundwater Occurrence, Overlying lithology, Depth of groundwater and Soil rates).

### Results and Discussions

#### Nitrate contamination

Evaluation of nitrate concentrations in groundwater of the Marand Plain indicated that nitrate concentrations are over the allowable concentration in drinking water (45 mg/L) in 12 analyzed water samples (Fig. 1). Based on

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nitrate concentrations and land use map, it can be certainly stated that the nitrate concentration are well defined with land use map. However, the particle size distributions of sediments and hydrogeological conditions have a certain role in the distribution of nitrate concentrations. Nitrate concentration in the central and eastern parts of the plain is more than other places because of the active agricultural area, entrance of wastewater to groundwater, unconfined aquifer type and coarse sediments in this part of the plain. The lowest nitrate concentrations were revealed to be in west and northwest parts of the plain. This is due to the low agricultural activity in comparison with other parts of the plain, the confined aquifer condition and fine-grained sediments in this part of the plain.

The nitrate concentrations decrease with increases in the depth of wells.

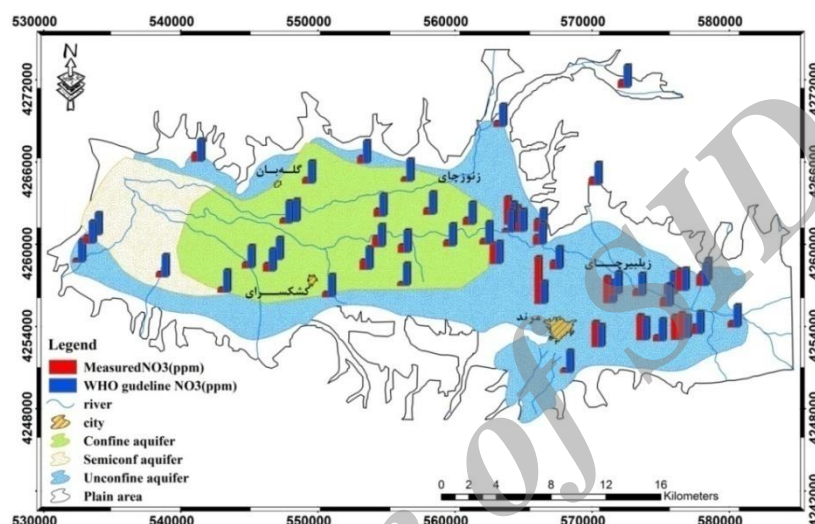


Fig 1. Spatial distribution of nitrate concentration and the maximum allowable concentration

Figure 2 shows the spatial distribution of nitrate concentration and land use map of the study area. This figure shows that the high concentrations of nitrate in the east and southeast part of the plain reflects the extent and intensity of agricultural activity and increase in agricultural fertilizers, including phosphate fertilizers, nitrogenous and potash in this regions. Moreover, unconfined aquifer type and coarse sediments result in an increase in the permeability of the aquifer and the rapid nitrate leaching from the unsaturated zone and also lead to increase in nitrate concentrations in this part of the plain. The reasons for the lower nitrate concentrations in the central and western parts of the plain are the type of the aquifer (confined aquifer), fine-grained sediments and undesirable quality of water for agricultural purposes.

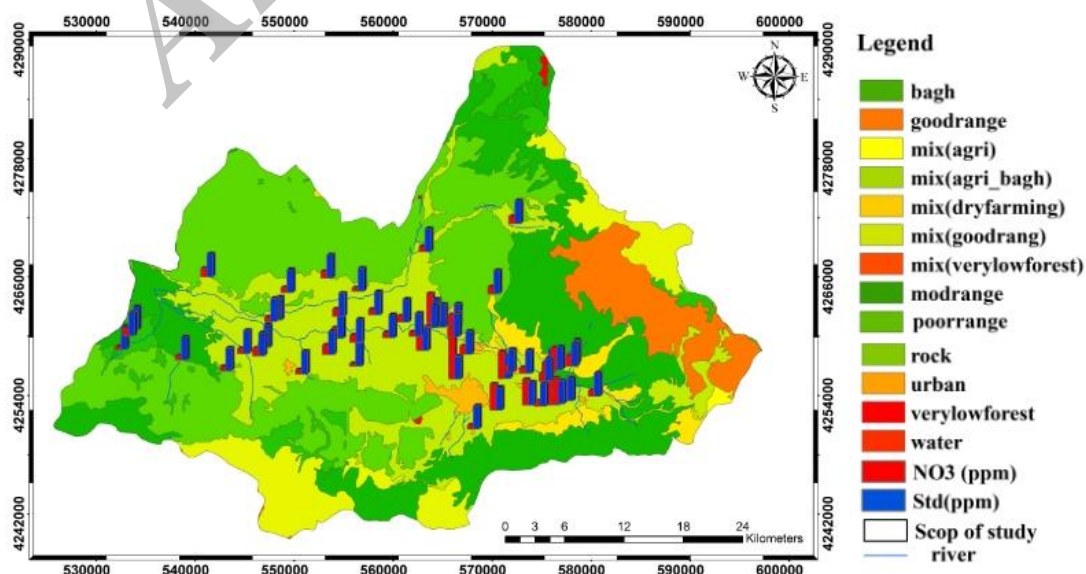


Fig. 2. Comparison of variation in nitrate concentration with land use map

### Vulnerability of Marand plain groundwater

To determine the contamination potential of the plain, two vulnerability assessment methods named as AVI and GODS were used. Vulnerability mapping with AVI and GODS methods (Fig. 3a,b) show that those parts of the plain where contain unconfined aquifer type have the highest contamination potential whereas those parts of the plain containing confined aquifer condition have lowest contamination potential.

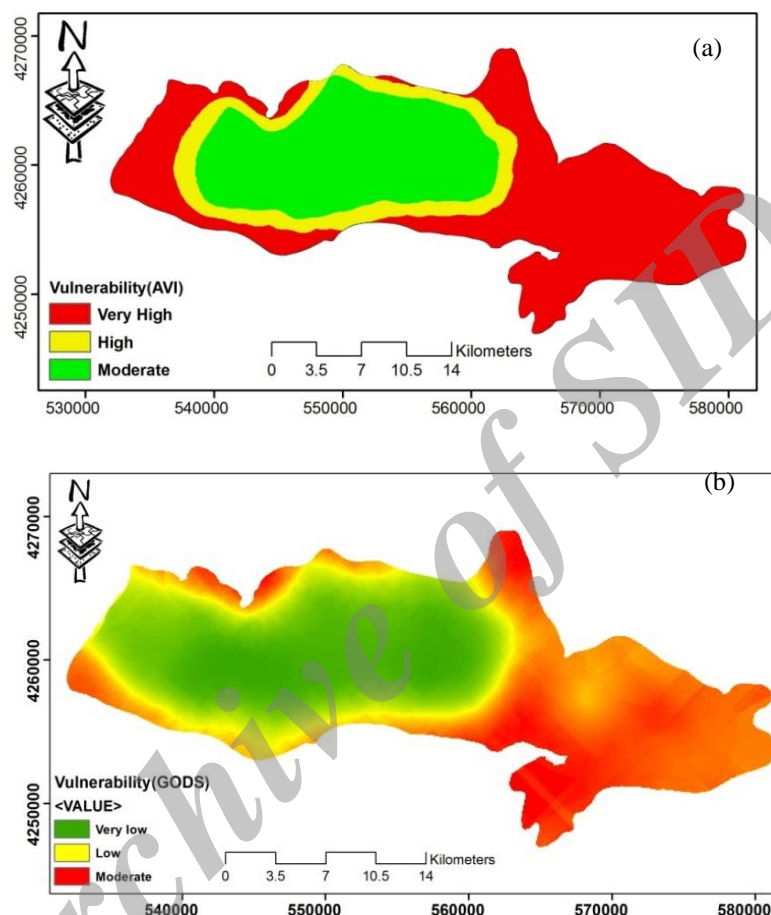


Fig. 3. Vulnerability map of a) AVI and b) GODS methods

### Conclusion

It can be concluded that the concentrations of dissolved oxygen in water decrease with increase in depth, hence it is possible to enhance denitrification process and remove some amount of nitrate. The study revealed that areas with unconfined aquifer type have the highest contamination potential and the areas with aquifer condition have lowest contamination potential.

**Keywords:** groundwater contamination, groundwater vulnerability, Marand Plain, nitrate.