

## SALT WATER INTRUSION MODELING OF AN AQUIFER IN THE NORTHWEST OF MAHARLU LAKE

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### Abstract

*The objective of this research is preparation a saltwater intrusion model for a coastal aquifer in the northwest of Maharlu lake Sout-East of the city of Shiraz, where the coastal aquifer is the single supply source of fresh water for irrigation. The saltwater intrusion from the lake has been widely caused the deterioration of the water quality.*

*In this study, the SEAWAT-2000 computer code, a three dimensional finit difference model, used to study the intrusion mechanism and the groundwater system. After data collection including qualitative and quantitative data and geology and hydrogeology of the study area in the field, a conceptual model were prepared. On the basis of collected data, condition of the aquifer in February 2008 were taken as the initial condition and the length of calibration and verification periods consequently were taken 150 and 121 days after this time. After model calibration and verification, the aquifer conditions for the next year is predicted considering the following strategies :*

*1. The present condition for the next year, and 2.higher of Lake water level during the next year. However, with the constructed model, other strategies could be tested base on the more likely situation.*

### Introduction

Coastal aquifers are important supply sources of fresh water in numerous area of the earth. The problem of saltwater intrusion has been widely caused the deterioration of water quality in these sources. As fresh water flows from the aquifer towards the coastline an aquilibrium condition will be established between saltwater and freshwater. The installation of pumping wells within the coastal aquifer will to disturb this equilibrium and if the extraction rate is too large, it could cause adrop in the water table and will decrease the amount of freshwater towards the shoreline and increases the amount of saltwater flow from the shoreline towards the fresh water aquifer.

Various case studies of sweater intrusion have been published in the past decades for example, the relation between sea-level changes and saltwater/freshwater interface has been studied for the aquifers in the North American coastal plain (Meisler et al. 1984), New Jersey(Navoy 1991; Lennon et al . 1986). Mahasa and Nagaraja (1996) discussed the general relation between groundwater recharge and seawater intrusion applying the Gyben-Herzberg equation, Ranjan et al (2006) applied a numerical model based on the sharp interface assumption to analyze the effects of climate change and land use on coastal groundwater resources in Sri Lanka.

This paper described a salt water intrusion modeling for a coastal aquifer in the Northwest of Maharlu lake.

Maharlu Lake is a salt lake located 27 km southeast of Shiraz (Fig 1 shows the location of the study area) . There are many fresh coastal aquifers around this lake that naturally are

recharged by fresh water entering from the landward karstic aquifer. The hydraulic equilibrium could be disturbed due to large extraction rate and consequently dropping in groundwater table level. In consequence, the lake saltwater with high salinity ( $E_c$  more than 300ms/cm in summer) could flow towards the freshwater aquifer. The salinity of this lake salinity is much more than the oceans salinity, therefore the aquifer salinity could change very much even with a low equilibrium disturbance. For this reason, the management and maintenance of this aquifer is very difficult and important.

### **Method of study**

The main purpose of this work was the prepared saltwater intrusion model and determine the interface zone between salt and freshwater. With this aim the SEAWAT-2000 computer code was chosen as a salt and density- dependent ground water flow simulator. This computer code contains considerably more functionality than the piror released of version. This code was chosen primarily because it compares well with other density-dependent flow models in terms of the accuracy and execution time. In fact, new solvers for the flow equation (Hurbaugh et al. 2000; Mehl and Hill 2001) that may reduce model execution times is part of model codes.

A finite-difference grid comprise a uniform cell size of 35 by 35 meters and 43 row and 45 columns. Boundary condition were assigned to the model domain based on the general knowledge and field data wich includes a constant- head and constant-salinity boundaries of the lake boundary. A constant flux of ground water, representing general flow of the ground water towards the coast originating from the karstic formation in the North of the aquifer. (Fig2, shows the isopotential map and position of the pizometer and wells).

Aquifer properties including effective prosity, hydraulic conductivity, longitudinal dispersivity and etc. based on the field data and general knowledge is used. The collected data, condition of the February 2008 were taken as the initial condition. Model calibration is achieved through a trial-and error approach by adjusting the zonation and the values of four key parameters : TDS(kg/m<sup>3</sup>), hydraulic conductivity, recharge rate, effective porosity and dispersivity. In result of the model calibration the hydraulic head and concentratin(TDS) values calculated by SEAWAT model matched with the observed values to a satisfactory degree. Calibration and verification periods were chosen to be 150 and 121 days respectively. Fig3(a, b) illustrate scattered diagrams between observed and calculated head and concentration values for calibration period. Fig (a, b) shows scattered diagerams after verification. Fig5(a, b, c) show the zonation of hydraulic conductivity, effective prosity and dispersivity values of the aquifer materials.

Constructed model also showed the good fit between observed and calculated values after calibration and verification periods, Fig6(a, b). In order to determine the interface location across the lake saltwater and freshwater aquifer (A-A') longitudinal cross section the model was ran for February and July 2008 and the results are shown in Fig6(a, b). The Fig 6a showsthe result for February 2008 that the interface is stretched up to 600m inward to the aquifer. Fig 6b shows the interface zone up to 400m from the lake line for July 2008. The reason that the interface zone is shorter for the month July in compare with the month of February, inspite that the ground water extraction is higher in summer season(July), in that during this time the lake water level decreases substantidly due to the high evaporation rate and lower discharge to that.

## **Conclusion**

The purpose of this study was to construct model to aid in management of the groundwater resources of the coastal aquifer in Northwest of the Maharlu lake from the futur contamination by seawater intrusion. For this purpose a three-dimensional numerical model of density-dependent groundwater flow and misicible salt transport is developed to assess the current extent and predict the future condition of the lakewater intrusion in the study area. The model incorporates regional geologic, hydrogeologic feature and field data. The SEAWAT codeused in this study, well producted the model and simulate the condition of the aquifer in realation to the lake water. After clibration a reasonabaly good match between observed and calculated head and concentration was achieved. Interface was located in about 400 to 600m from the coastline in dry and wet seasons. The model prediction shows that future water level and concentration decrease, if all condition remain the same as those for July 2008 (afetr 1 year) due to lack of precipitation in this year salt water moves toward the lake.

## **Refrences**

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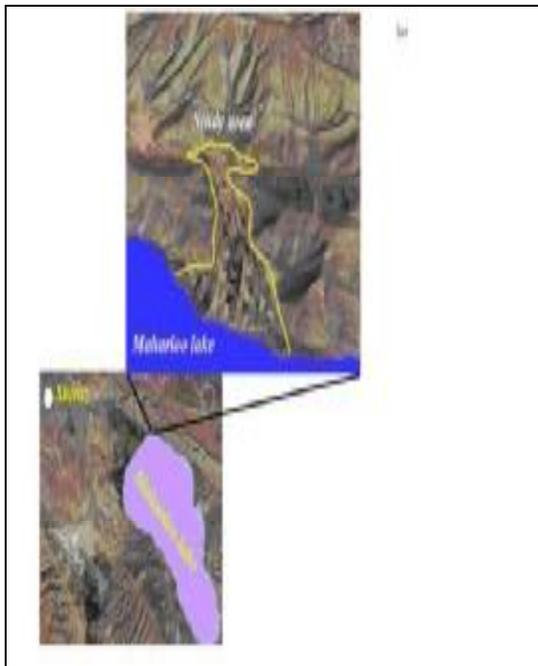


Fig 1: Location of study the are

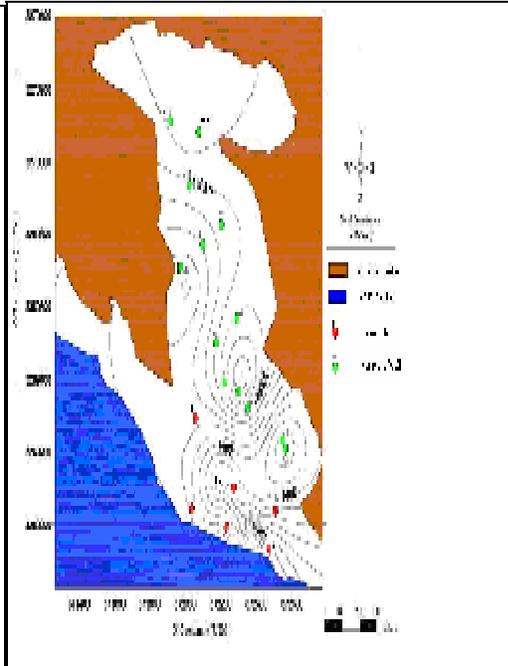


Fig 2: Isopotential map(February 2008) and distribution of piezometer and pumping wells

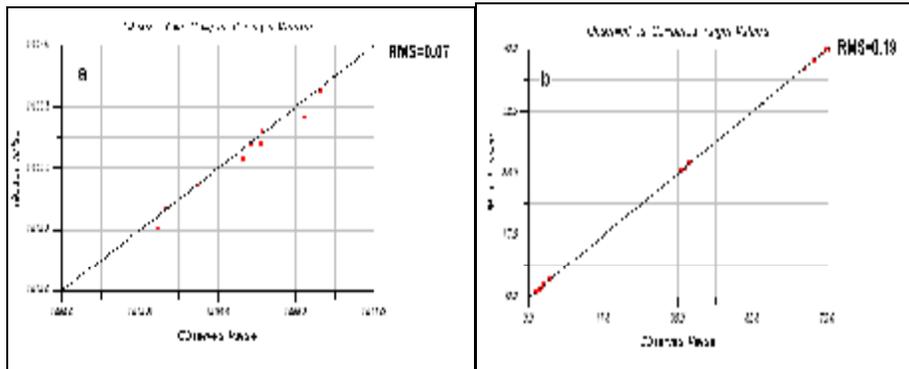


Fig 3: Scatter diagram showing the goodness of fit between the observed and calculated head(a) and concentratin ((b)for calibratin period

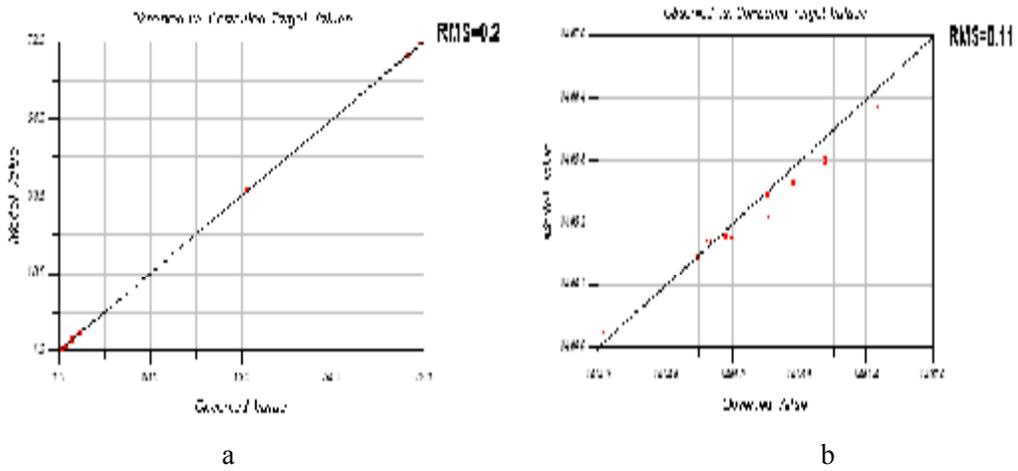


Fig 4: Scatter diagram showing the goodness of fit between the observed and calculated head(a) and concentration after(b) verification of model

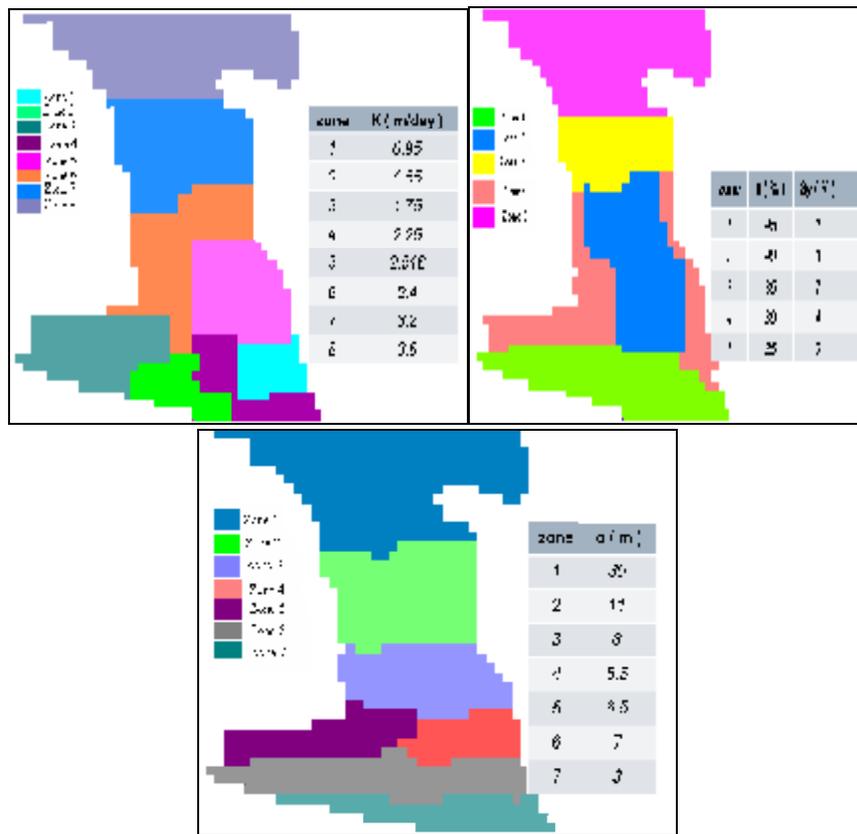
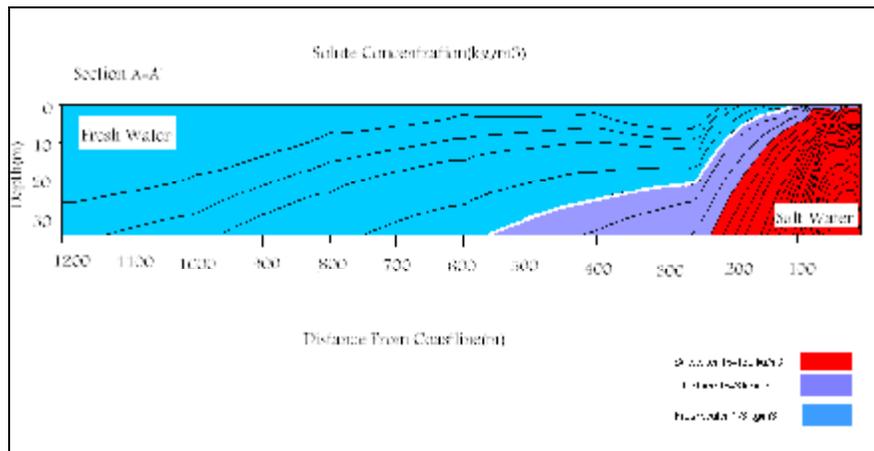
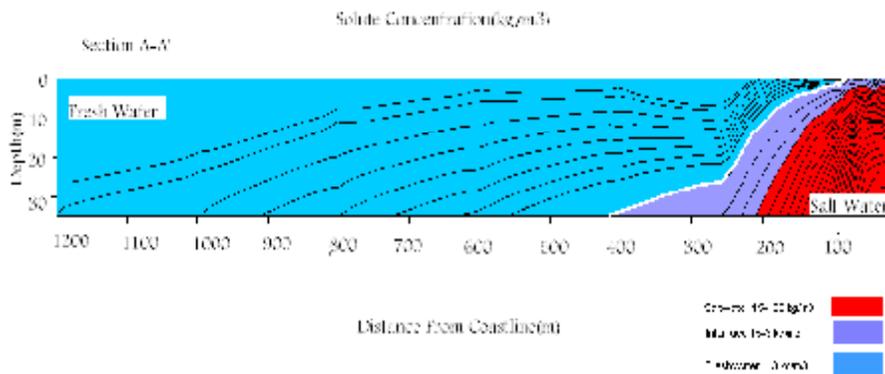


Fig5: Hydraulic parameters after calibration (a): hydraulic conductivity (b): storage coefficient and(c): dispersivity



a



b

**Fig 6: The result of model calculation showing the interface of lake and aquifer water for February 2008(a) and July 2008(b)**