Assessment of Subsurface Water Environment

-Impacts of Climate Change on Groundwater Systems in the Lower Seyhan River Basin -

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1. Introduction

To assess impacts of climate change on groundwater systems of the Lower Seyhan River Basin (LSRB), a 2-D vertical model based on SIFEC and a 3-D model based on MODFLOW and SEAWAT2000 were constructed using hydrogeologic features of LSRB, calibrated with observed data, and run for various climate change scenarios.

Fig.1 shows the area subject to the 3-D analysis, which is surrounded by the Berdan-Tarsus river in the west, the Mediterranean in the south, the Ceyhan River in the east, and the mountain foot in the north. A transect passing through the city of Adana to the Mediterranean via a western part of the Akyata Lagoon was considered to be a groundwater streamline based on the observed data of groundwater table height and thus adopted for the 2-D analysis. Both of the models include the vertical dimension ranging from the land surface of some 20 meters above to the relatively impervious layer of some 300 meters below the seal level.

The 3-D model is consisted of finite difference cells of 500m × 500m in horizontal plain and 20 m in vertical direction. The 2-D model was composed of triangular elements of different sizes where small elements were used in unsaturated zone near land surface and zone of transition from fresh to salt water.

2. Calculated Results for the calibration stage

Both models use observed or estimated

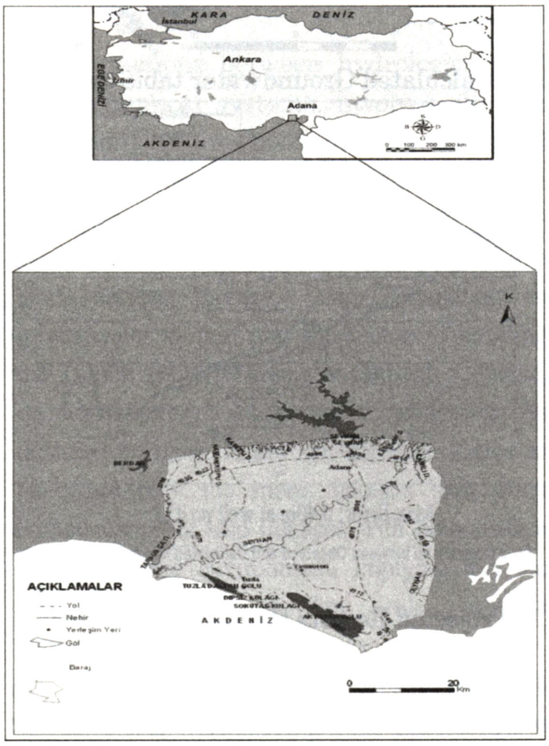


Fig.1 The area for Impact Assessments

physical parameters such as hydraulic conductivity and dispersivities, and the reliability of the model outputs depends on the accuracy of the parameters. To check the validity of the models, calculated results are usually compared with observed hydraulic heads for groundwater flow and salinity concentrations for salt water intrusion.

Fig.2 shows the calculated distribution of hydraulic heads in 2000 which was obtained by running the 3-D model as an unsteady state problem starting from 1990.

Fig.3 is the result for the calibration run of the 2-D model which is well compared with observed groundwater table heights.

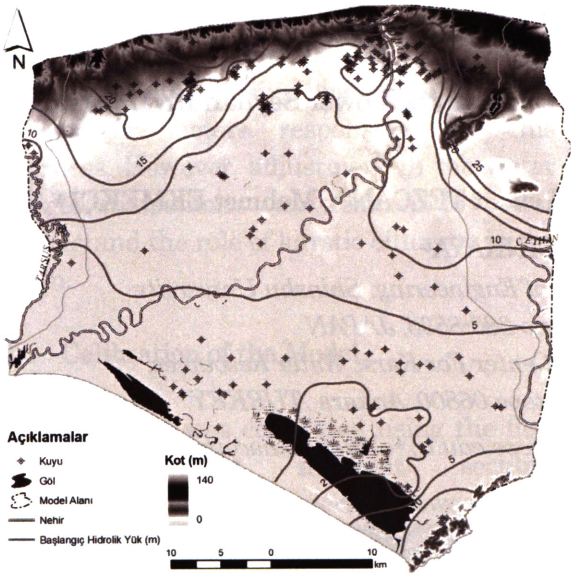
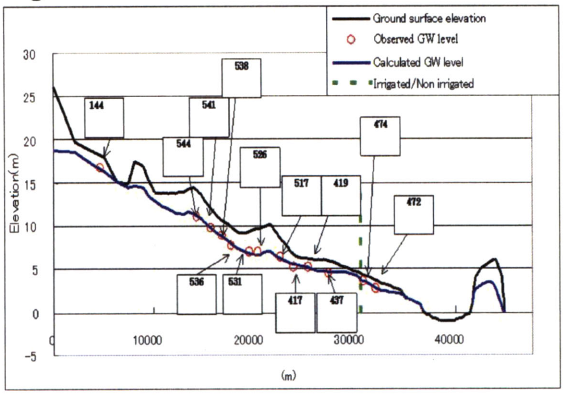


Fig.2 Calculated Groundwater table contours



Max Error: 0.40m at well no.417

Fig.3 Comparison between Observed and Calculated Groundwater Table

3. Projected Results for future scenarios

Provided with future changes in precipitation, evapotranspiration, river discharge, etc, models can be applied to assess impacts of climate change on groundwater flow and storage, salinity of groundwater and lagoon water, saltwater intrusion into aquifers, water logging, and salt accumulation on land surface, .

The 3-D model adopted a scenario where the sea level rise is 40 cm in 2020 and 80 cm in 2070, while the prescribed head along the north boundary was shifted from 20 m in 2000 to 18 m in 2020 and 15 m in 2070, the recharge rate was decreased by 20 % for the period 2000-2020 and by 40 % for the period 2020-2070, and abstraction was increased by 20 % during 2020-2070.

The projected results showed decrease in groundwater resources and advance of transition zone toward inland. The amount of groundwater storage was also evaluated by using the 3-D model, and it declined from 35,000 m^3/d in 2010 to 13,000 m^3/d in 2070 due to the climate change.

The factors for the scenarios are mainly consisted of see level rise, recharge rate, and abstraction rate. Any combination of these factors makes up scenarios. In the assessment performed using the 2-D model, only sea level rise was taken into consideration, and the other factors are to be combined in the following projections.

The result showed that the sea level rise of as much as 0.88 m/century did not affect salinity distribution at the end of 2070 significantly. However, global warming is considered to keep sea level rising for as long as millennium. Thus, this kind of short ranged projection may not be enough to evaluate its real devastating characteristics.

The distributions of velocity vectors for scenarios with and without the sea level rise did not differ so much. However, the sea level rise accompanied reduced inflow across the north boundary due to the reduction in hydraulic gradient. Groundwater table heights were not affected to a measurable degree by the sea level rise either, since recharge and abstraction rate remained the same as in the calibrated stage.

The projected accumulation of salt on land surface increased drastically due to the sea level rise. Thus, drainage practice is strongly recommended in the future to minimize the impacts of salt accumulation on land surface.

It was assumed that the level of the Mediterranean rises as much as 0.572 m in 2070 and its salt concentration remains unchanged throughout the period of the projection. Furthermore, the level of the lagoon water was also assumed to remain the same as the Mediterranean, which means that the lagoon is supplied with the sea water via stream. The projected temporal changes in concentration of the lagoon water reached to an equilibrium state suggesting that salt supplied by seeped-out groundwater containing salt and evaporation of water from the lagoon is balanced with the supply of sea water with constant salinity.