The Shallow Groundwater Level Fluctuations and Soil Salinity Problems in the Lower Seyhan Plain

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1. Introduction

Large irrigation projects play an important role in increasing and diversifying agricultural production in Turkish agriculture. These projects also offer enormous possibilities for generating incomes in rural areas and in undeveloped regions. The Lower Seyhan Irrigation Project, which is considered as one of the most progressive irrigation projects of Turkey, is a multipurpose project implemented for irrigation, drainage, flood control and hydroelectric energy production. It is well known that this irrigation project realized in The Lower Seyhan Plain has resulted in important achievements in increased yields, employment and economic welfare as well as reduction of social problems. However, despite of all these positive accomplishments, there also exist some problems such as excessive water use, high water tables, salinity and insufficient water measurements.

This study seeks to analyze historical changes of shallow groundwater fluctuations and groundwater salinity in relation to irrigation and land use.

2. Study Area

The study area is the Lower Seyhan Irrigation Project area, which is bordered in the north by the Taurus Mountains, in the east by the river Ceyhan, in the west by the river Berdan, and in the south by the Mediterranean Sea.

The planning of water resource development on the River Seyhan started in 1939. In the 1940s, a diversion dam, flood control barriers, and two main conveyance channels were constructed with an irrigated area of 18.500 ha. In 1956, the Seyhan Dam was completed and the hydroelectric power plant started its operation with an installed capacity of 54 megawatts, an average annual power generation of 350 Gwh.

The Seyhan Dam and its reservoir also serve for flood control for 24,500 ha of agricultural land and the city of Adana, and the area surrounding the reservoir is used for recreation. The available volume of surface water from the river Seyhan, damned in the Seyhan reservoir, is sufficient to irrigate the project area of 175 000 ha, and water quality is most suitable for irrigation purposes.

The major soils of the plain are Cambisols, Luvisols, Vertisols, Calcisols and Arenosols with profile depths varying from 40 to 200cm (Dinç at al.1990).

The River Seyhan, with its tributaries, supplies the project mentioned here with irrigation water with a watershed comprising

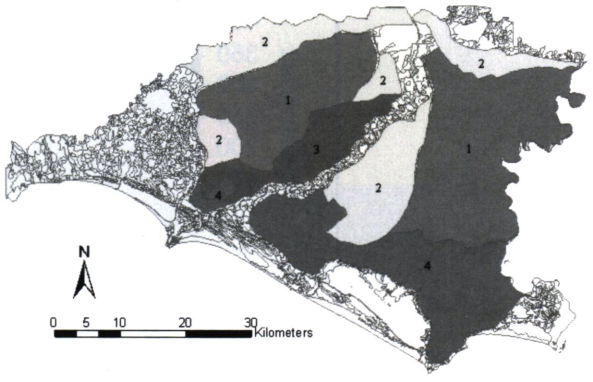

Fig. 1 Development stages of Lower Seyhan Irrigation Project

about 19,300 square kilometers. The rivers annual discharge is 6, 3 billion cubic meters, the quality class of the Seyhan river water is C2 S1, and this means that there is a very low sodium hazard and a medium salinity hazard via irrigation.

The LSIP area comprises an area of 175,000 ha, with installations for irrigation and drainage facilities and with on farm development work. The LSIP was planned to be developed in three stages at first, but after some time due to the high investment costs incurred, the area of stage 3 was reduced, and the most problematic part of the plain was designated for the stage 4 projects. Drainage networks of all stages have been almost completed by the General Directorate of State Hydraulic Works (DSİ-Turkish acronomy).

The main problems for the present of LSIP are, a. the diversification of the cropping pattern increasing the water demand, b. the excess use of water, c. the high groundwater table which was partly caused by over-irrigation (4th stage area). The 4th stage irrigation development area is problematic due to the high groundwater table, i.e., the salinity that is caused by the impeded drainage.

3 Materials and Methods

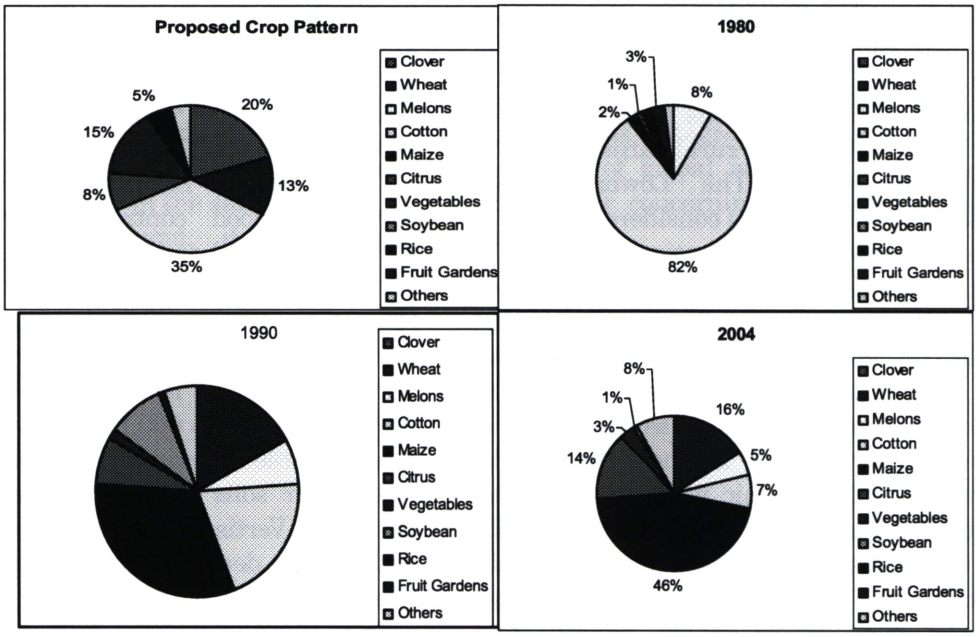

Fig.2 Historical change of cropping pattern in the LSIP

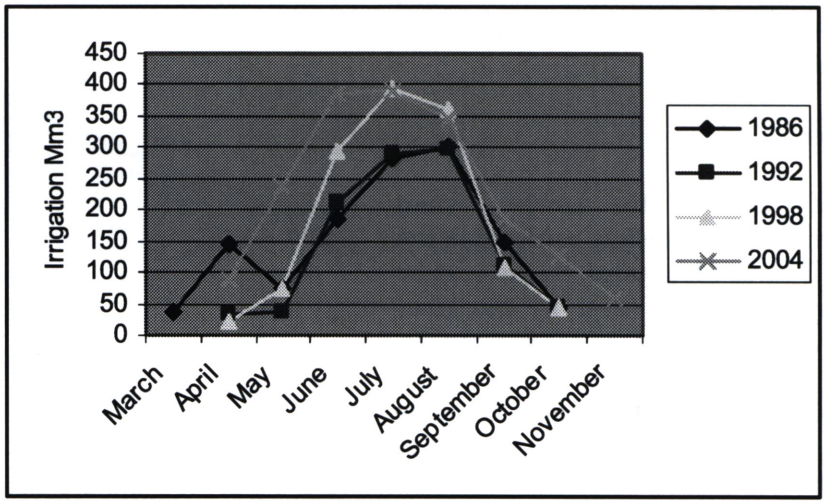

Fig.3 Seasonal irrigation water use in the LSIP

The DSI archived data were used to determine the seasonal changes of groundwater, in relation to land use and irrigation.

The groundwater depths were measured monthly at 1134 groundwater observation wells (maximum depth: 4m) with EC measurements of water samples taken once a year during the peak irrigation month (usually July) by the DSI.The data of three different years (1983, 1993, and 2003) with 10-year intervals were chosen to determine the groundwater fluctuation.

The Arc GIS Arc View version 8.2 was used for analysis of the dataset.

4. Results and discussion

4.1 Crop Pattern

Figure 2 illustrates the change of cropping patterns in the years 1980, 1990 and 2004. Because of socio-economical reasons (increase of labor cost and instability in the prices of agricultural products), there

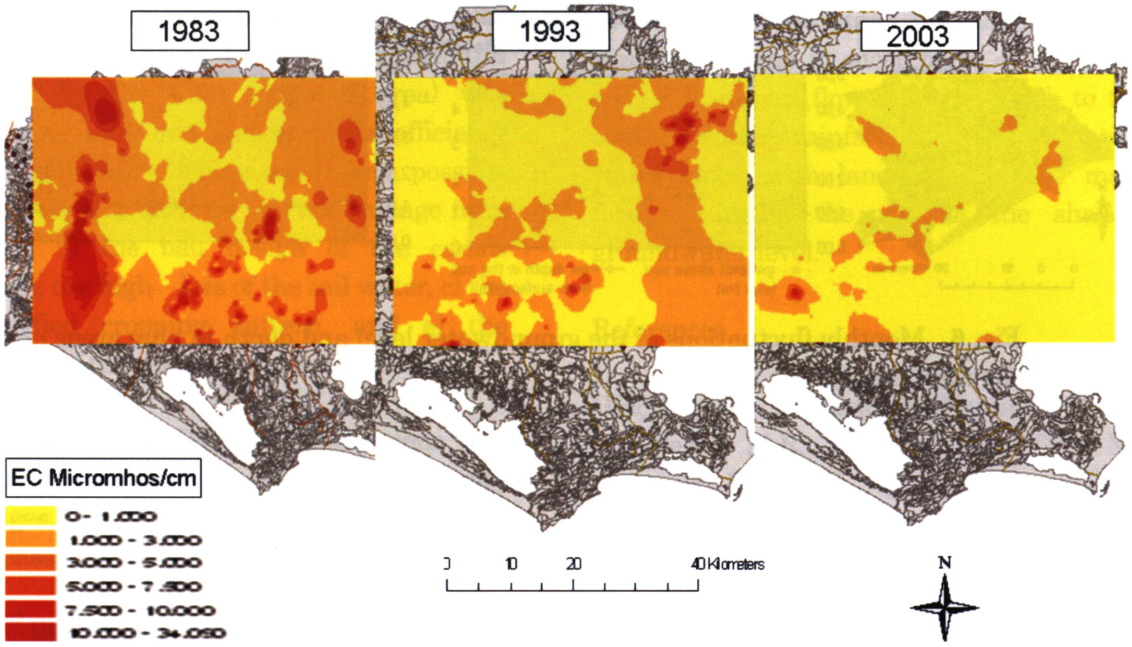

Fig.4 Change in groundwater salinity on the left bank of the LSIP.

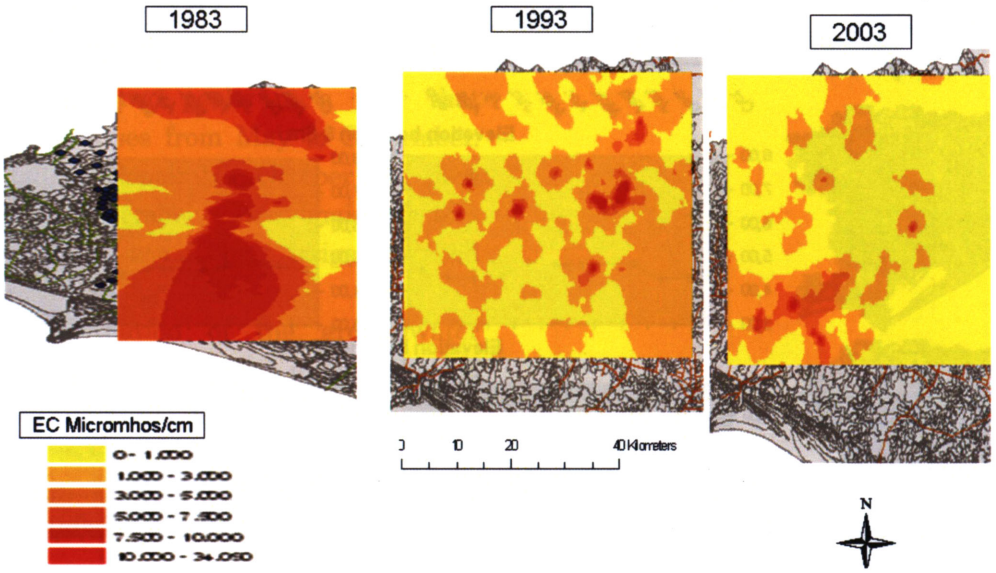

Fig.5 Change in groundwater salinity on the right bank of the LSIP.

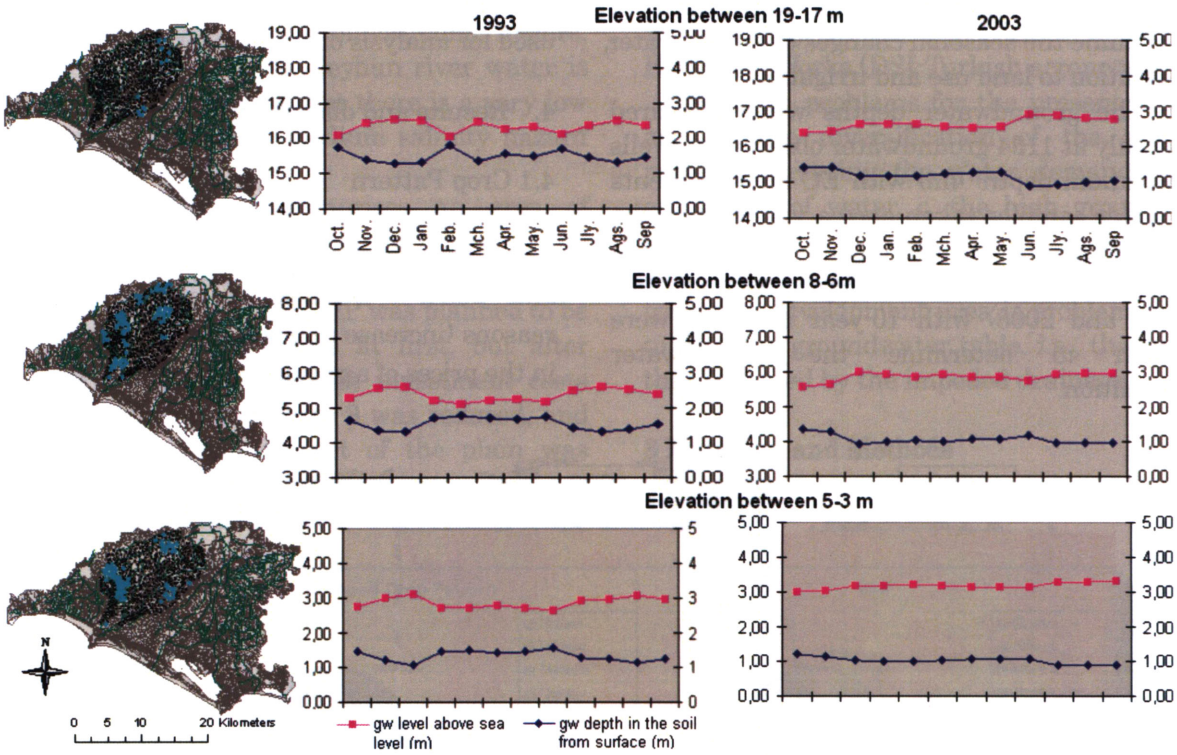

Fig. 6 Monthly fluctuations of the groundwater level and depth in blue areas on the right bank of the LSIP.

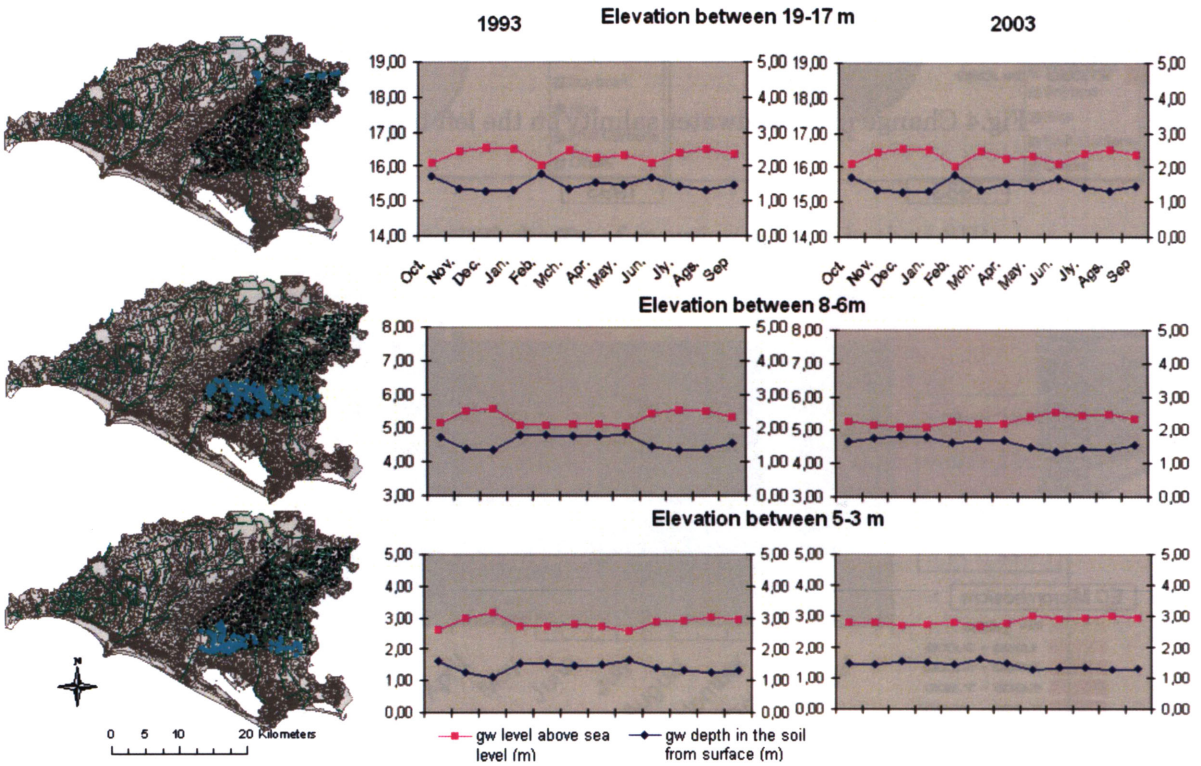

Fig. 7 Monthly fluctuations of the groundwater level and depth in blue areas on the left bank of the LSIP.

were significant differences between the proposed cropping pattern and the materialized at the three different periods.

The diversified cropping patterns were the cause of the increase in the water demand, especially of maize consuming more water than cotton.

4.2 Irrigation Water Use

An increasing trend, in the gross irrigation depth, in the recent years was detected in the study area as shown in Fig.3. The gross irrigation depth of the LSIP (irrigation intake at the Seyhan Regulator divided by the total irrigated area) was exceeding 1000 mm and irrigation efficiency was below 50%. There are many possible causes for this such as, a) the leakage from canals, b) the bad design of the canals causing the high loss of the tail water, c) the diversified cropping pattern, and e) the over-use of the water in the farm land.

4.3 Ground Water Salinity Distributions

Figures 4 and 5 visualize the salinity changes in 10-year intervals with the decrease in the high saline areas.

4.4 Shallow groundwater fluctuations

Figure 6 and 7 show the monthly groundwater fluctuations with similar patterns in all different elevations and a flow direction from the north to the south. The trends reveal two peaks in a year that groundwater rises from May to September, and it falls in September, October and rises again in November. The main factors affecting this trend are irrigation and rainfall.

The fluctuation of the groundwater depth ranges from 1m to 1.5 m from the soil surface in the upper and middle parts of the plain. This is close to 1 m in the lower part of the plain and the depth of the fluctuation range is similar in the selected years.

5. Conclusion

The results obtained in the irrigated area, indicated that the groundwater salinity has continuously decreased in the past 20 years in the upper and middle parts of the plain and that the salts were most probably leached out of the system through the drainage. However there still exist some saline areas in the southern part of the plain, close to the end of the irrigation infrastructure.

The groundwater fluctuations have similar patterns in most parts of the plain with a dominant flow from the north to the south. Winter rainfall and the irrigation water along with land use are the main factors causing the rise of the shallow groundwater level.

References

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