Progress report of salinity diagnosis in an irrigation project area of delta, Turkey

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1. Introduction

The Lower Seyhan Irrigation Project (LSIP) area is located in the plain of the Seyhan River basin near the Mediterranean Sea (figure 1). The irrigation/drainage facilities of the first three stage areas of the LSIP were initiated at the beginning of the 1960s.The current problem on soil salinity, which developed from thereon is due to the high ground water table of the dominantly clayey soils, induced by the poor drainage and by almost flat topography. The General Directorate of State Hydraulic Works (DSİ) has almost completed the installation of the drainage facilities in the first three areas of the LSIP, and seeks to extend the irrigation to the fourth stage area. The accumulation of salt on the soil surface can be recognized easily in the area, but intensive measurements of soil salinity, ground water level and ground water quality were not conducted earlier and the present state of the salinity conditions were not reported in the recent years. We, thus, started to conduct this study, seeking to determine spatial distribution of the salinity in the area by field measurements and laboratory analysis, of soil and shallow ground water, to be able to shed light on the spatial variability of salinity of the area.

Table 1 Detail of the measurements performed in the study area

Unit: points

	EMI method	Soil sampling		Groundwater		
	Soil salinity (ECv)	ECe	Gravimetric water content	Depth	EC	Na+
June	50	5	5	14	14	14
July	50	5	5	15	15	15
Aug.	50	5	5	13	13	13
Sep.	50	5	5	12	12	12
Oct.	50	5	5	11	11	11
Nov.	50	5	5	11	11	11

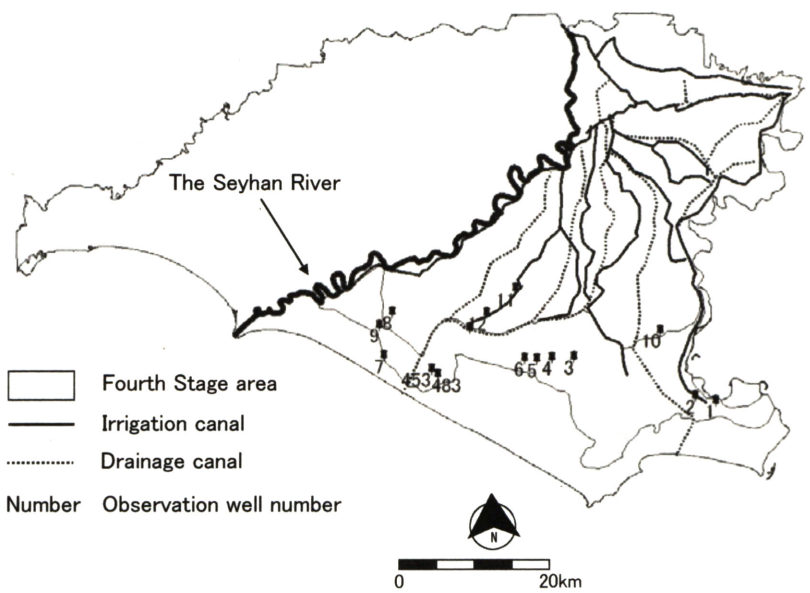

Fig.1. The Seyhan river basin and the LSIP

2. Materials and Methods

To determine the seasonal change and spatial variability of the shallow groundwater level and quality, we installed twelve groundwater monitoring wells in addition to the three previous ones. The groundwater level and its quality (EC) were measured monthly starting from June 2005. The groundwater data were interpolated by the Inverse Distance Weighted method (Johnston et. al., 2001) for the verification of the hypothesis developed for depth-wise continuum. Soil salinity was measured by the electromagnetic induction method (EMI), using the EM38-DD (McNeill, 1980). Systematically collected soil samples were taken in five points, a). to measure gravimetric water content and ECe for calibration and comparison of the measured values by the EMI method (ECv) and, b). for determining soil salinity in the laboratory by an EC conductivity meter. The 50 points of soil salinity were measured by the EMI method in different soil series determined by Dinç et al (1991) and at different land use parcels. Both measurements were done monthly mainly in the forth stage area of the LSIP (Table 1). The absolute coordinates of all measurement points (soil salinity and groundwater), were measured by the GPS system.

3. Results and Discussion

3.1 Groundwater Salinity

Figures 2 and 3 illustrate the fluctuation of the groundwater depth and variation of the groundwater EC, respectively. The monthly fluctuations of the groundwater showed a similar trend almost in all wells. The trends reveal that the groundwater level rises from May to August, and it falls from August to October and rises again in November. The main factors affecting this trend are irrigation and evapo-transpiration. The irrigation water applied from May to August and the precipitation of November have both caused the rise of the groundwater level. The groundwater depth ranged from 0.07m to 2.0m depth except in well number 12.

The groundwater EC of wells of number 2, 9, 8, 10, 12 were under 400 mS/m throughout the measurement period. But, the groundwater EC of the other wells were over 400 mS/m throughout the period. The EC of some wells changed seasonally, but the interaction between the fluctuation of the groundwater depth and variation of the groundwater EC was not found.

Figures 4 and 5 show the distribution pattern of the shallow groundwater depth and groundwater EC of July 2005 (higher groundwater levels correspond to higher EC values), respectively. The values used for interpolation here were average values of the measurement period. It showed that both groundwater depth and EC were getting high from the north to the south (top to bottom of the figure).

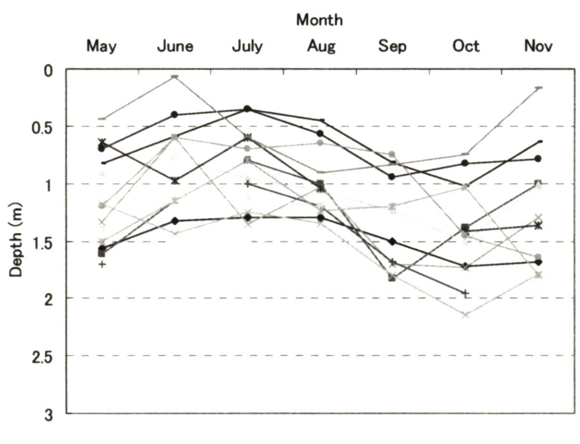

Fig. 2 Fluctuation of groundwater depth

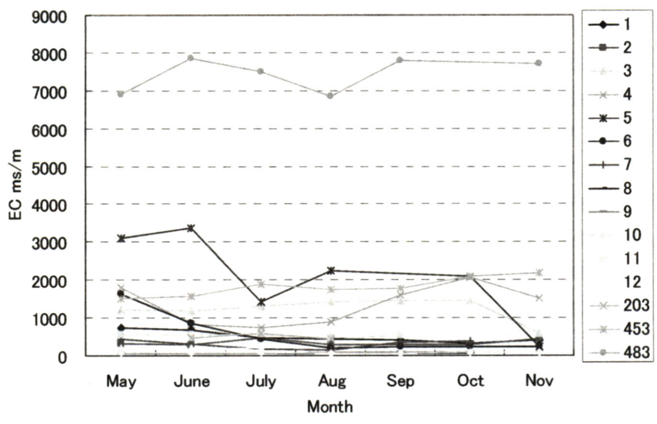

Fig. 3 Variation of groundwater EC

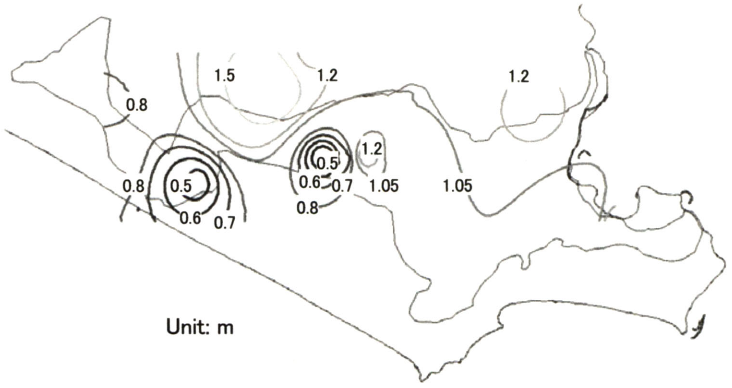

Fig.4 Distribution pattern of groundwater depth

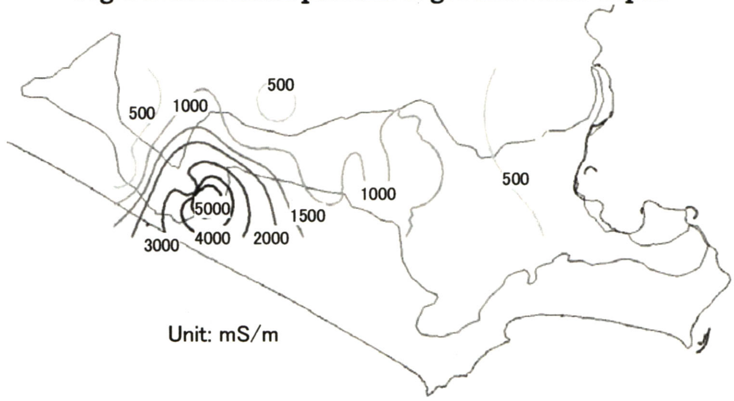

Fig.5 Distribution pattern of groundwater EC

3.2 Soil salinity

The ECa (apparent electrical conductivity) values measured by the EMI method were expressed as ECv values (generally described as ECa). This value is affected by soil physical and chemical properties such as texture, water content, and electrical conductivity (Rhoades et al., 1976).

The measurements were conducted at several soil series, in different soil water conditions (data not shown) and EC values of soil water, in order to examine the relationship between ECv and ECe. Figure 5 shows the relationship between the ECe an ECv values. ECe is the average value from 0 to 1.2 m soil depth and the ECv value is measured by the EMI method, which yields average EC values almost from 0 to 1.5 m soil depth (McNeill, 1980). To examine correlation between ECe and ECv (Corwin and Rhoades, 1982; Wollenhaupt et al., 1986; Triantafilis, 2000; Kume et al., 2003), analysis was done as shown in figure 6. Figure 6 shows the significant relationship between the two, despite the variable conditions encountered at the measurement points. Earlier studies state that many plant species have been effected by ECe values above the threshold limit of 400 mS/m (US salinity laboratory staff, 1954), which most probably is the equivalent of 200 mS/m of ECv obtained in this study (Chhabra, 1996 reported that 400-800mS/m of ECe equals to 100-150 mS/m of ECa).

Figures 7 and 8 illustrate that the ECv

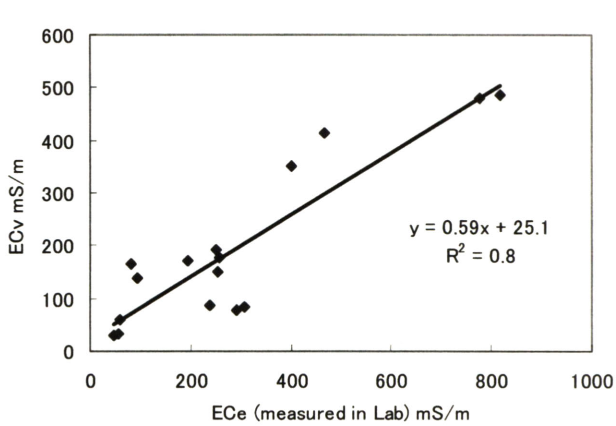

Fig.6 Relationship between ECe (measured in lab.) and ECv (measured by EIM)

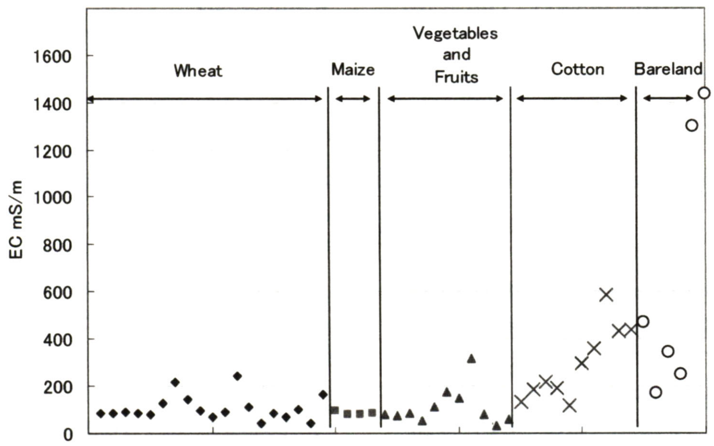

Fig.7 Land use and ECv values

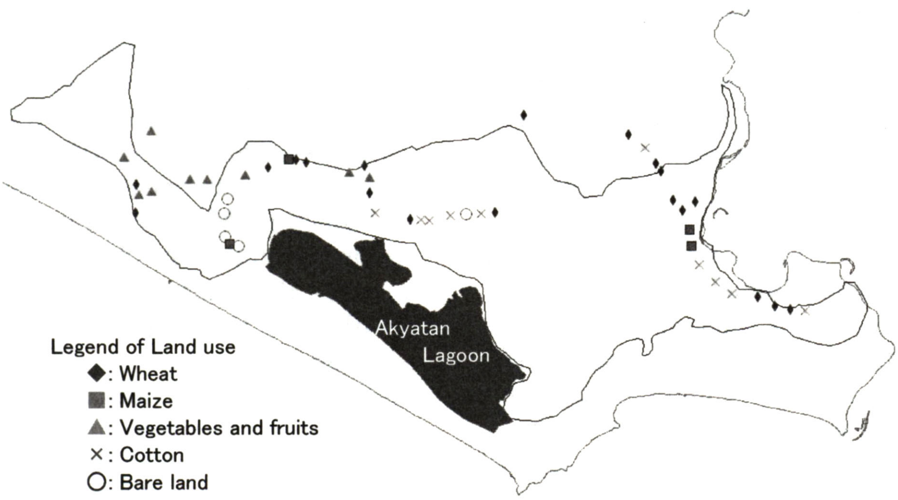

Fig.8 Location of measurement points and its land use

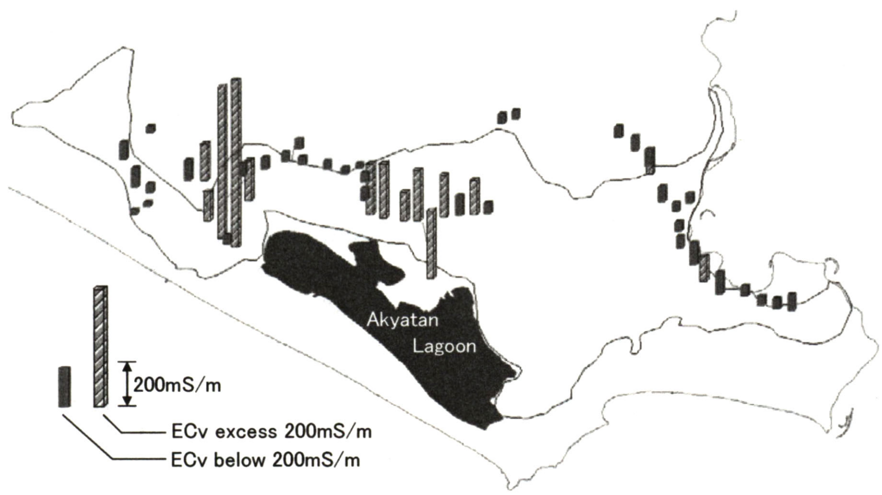

Fig. 9 Location of measurement points and ECv values

values of wheat (except two points), maize and vegetable fields (except one point), and fruit orchards distant to the Akyatan Lagoon were less than 200 mS/m. The data of planting crops and ECv values described in figures are based on June of 2005 and average values of the measurement period, respectively. Five cotton fields located near the Akyatan lagoon were affected by soil salinity, and the other five were not due to their distant location to the lagoon. The bare lands close to the lagoon were also affected by high salinity with the shallow groundwater areas corresponding to the saline areas (figure 9).

4. Conclusions

Seasonal fluctuations of groundwater depth, inconsistent to the magnitudes of the EC values were determined in the study area. Results revealed similar distribution patterns of the groundwater depth and EC. The seasonal changes of the gravimetric water contents were low near the soil surface and moderately high throughout the soil profiles. Values obtained for ECv corresponded with the ECe, and field observations on salinity vulnerability were found to be in agreement with the threshold values of 200mS /m of the former. Wheat, maize and other crops were cultivated on suitable land, .i.e., the slightly saline parts of the delta were allocated for these crops, whereas some cotton fields were located on saline soils adjacent to the bare lands near the Akyatan lagoon and were affected by severe soil salinity despite the attempts to properly manage the land. A comprehensive evaluation of salinity risk is needed to identify the specific factors of salinization of the area regarding land use, soil types, irrigation/drainage facilities and micro-topography. The origin of soil/shallow groundwater salinity is also another intriguing matter in need of particular attention for future studies to follow.

Acknowledgement

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