Regional Soil Salinity Assessment Using Measurement Data, Archived Data and Satellite Image Data

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1. Introduction

Soil salinization is one of the most important topics of the environmental study. There are many salt affected irrigation fields in arid and semi-arid region in the world. Lower Seyhan Irrigaton Project (LSP) is located in south part of Turkey and irrigation and drainage facilities are installed. The 4th project area in the LSP is planned to be implemented with these facilities and it was reported that there are soil salinization problems (Mahmut Cetin and Cevat Kirda, 2003).

In order to understand the present state of regional soil salinity in LSP, measurements were conducted at two periods, May 5 to June 13 and Nov. 5 to 26. Our research purposes of this year were to assess present state of soil salinity in the LSP and to check an applicability of measurement equipment of soil salinity (EM38-DD, TDR). In this paper, we will show the results of the measurement.

2. Research Area

To grasp the present state of soil salinity distribution in the LSP, researches were conducted in the whole LSP that includes Left bank and Right bank in May 5 to June 13 (Fig.1) and research was conducted along two transects, Transect A and Transect B, in Nov.5 to 26. Two transects (Fig.2) were determined with consideration of Hydrology sub-group's (Prof.Fujinawa, Mr.Furukawa) analysis and advice of Prof.Selim KAPUR of Cukurova Univ., Adana, Turkey. Detail of this area was reported in previous ICCAP interim report (Sevgi et al., 2004)

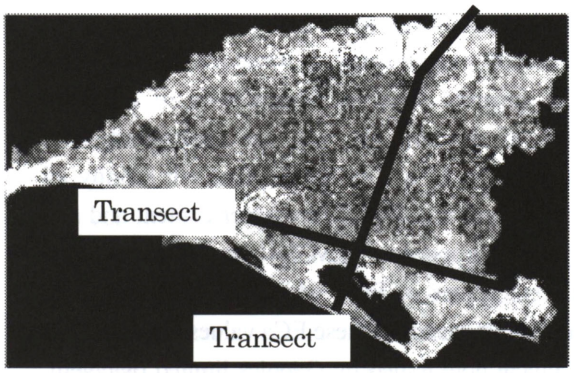

Fig.2 LSP, Transect A, Transect B and measurement points (star mark) (Research period: Nov. 5 to 26)

Table 1 Measurement items, equipment and number of measurement points

Research Period	May 5 to June 13	Nov. 5 to 26
Measurement tools or techniques	EM38-DD and soil sampling	EM38-DD, TDR, soil salmpling
Number of measurement points	48 points	14 points
Soil sampling depth	0-0.15m	0, 0.2, 0.4, 0.6, 0.8, 1.0m
ECa measurement	EM38-DD	EM38-DD, TDR
Gravimetric water content	×	○ (using sampled soil)
Volumetric water content	×	○ (using TDR)
$EC_{1:5}$	○ (using sampled soil)	○ (using sampled soil)
Absolute coordinate	○	○

3. Methodology

Measurement items and details of measurement of soil salinity are shown in table 1. All measurements were made with measurement of absolute coordinate using GPS and these points were plotted in the geo-referenced LSP map and spatial analyses were

done.

4. Result and Discussions

4.1 $EC_{1:5}$, ECa and Water Content

$EC_{1:5}$ and ECe are recognized as salinity index (U.S. Salinity Laboratory Staff, 1954). However, ECa is expressed as follow equation (ex. Rhoades, 1989):

$$ECa = ECw\theta T + ECs \qquad (1)$$

where ECa: apparent electrical conductivity, ECw: electrical conductivity of the soil solution, θ: volumetric water content, T: transmission coefficient, ECs: apparent electrical conductivity of the solid phase of the soil. As you can understand from equation (1), ECa does not express soil salinity all the time and it is affected by water content and soil physical properties. EM38 can measure two different values of ECa, which are ECv and ECh. The characteristics of these ECa values are written in Technical note issued by Geonics limited (McNeill, 1980). Fig.3 shows the profiles of gravimetric water content at the measured points in Nov. 10. As Fig.3 shows here, profiles of water content at the measurement points were not uniform. Fig. 4 shows the profiles of soil salinity ($EC_{1:5}$). Various types of soil salinity profiles were recognized. Soil series of measurement points ranged from clay to silt soil (data not shown in this paper). If one wants to use ECa as soil salinity, index needs to calibrate ECa to actual $EC_{1:5}$ or ECe or other salinity index. To calibrate ECa as soil salinity considering with non-uniform gravimetric (volumetric) water content and soil series are very difficult so that simple regression analysis between $EC_{1:5}$ and ECa were employed. Figs5, 6 show the results of regression analysis between $EC_{1:5(0\text{-}0.15m)}$ and ECv, ECh, respectively. Figs7, 8 show the results of regression analysis between $EC_{1:5(0\text{-}1.0m)}$ and ECv, ECh, respectively. Subscripts of $EC_{1:5}$ are soil depth of soil samples and so $EC_{1:5(0\text{-}1.0m)}$ represents average value of $EC_{1:5}$ for 0-1.0m soil depth.

Results showed that better relationship between $EC_{1:5}$ and ECv, ECh in both measurements instead of inconsistent profiles of water content, soil salinity and soil series. There are some problems of statistical significance in regression analyses, however, we assumed that ECa values (ECv, ECh) measured by EM38-DD could be regarded as soil salinity and calculated spatial distribution using ECv value.

4.2 Result of Analysis of Regional Soil Salinity Distribution

Figure 9 shows the distribution of soil salinity in the LSP. Degree of soil salinity was increasing from upper stream to down stream of the project area. No saline fields were observed in the upper part of LSP (1st to 3rd project area). Some parts of 4th project area were affected by severe soil salinity. Cotton was representative crop in saline prone area of 4th project area.

Results of soil salinity degree along Transect A and Transect B are shown in Fig.10. Some severe soil salinity areas were observed in the 4th project area. Soil salinity values along with Transect B were distributed randomly. There were areas where severe saline field was situated next to non-saline cultivated field across drainage canal. Water quality of the drainage canal was not good, one of the drainage water EC was over 8.0mS cm^{-1}. In some cases of this situation, it was seemed that land use and cropping pattern affect leaching of soil salinity. High

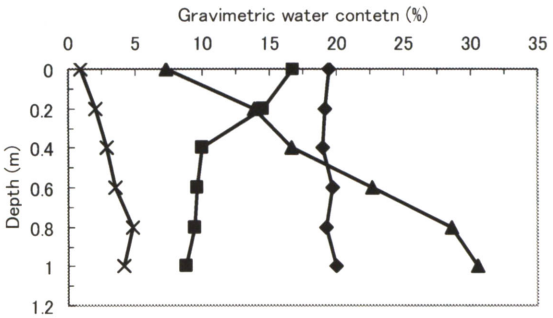

Fig.3 Profiles of gravimetric water content (Research period: Nov.5 to 26)

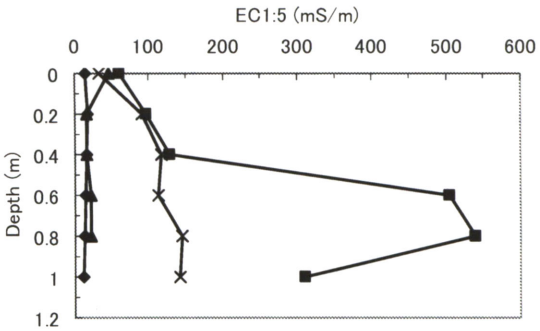

Fig.4 Profiles of $EC_{1:5}$ (Research period: Nov.5 to 26)

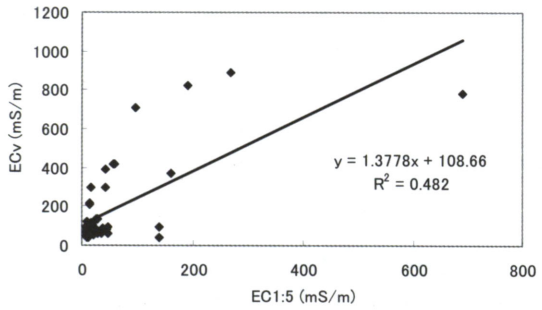

Fig.5 Result of regression analysis between $EC_{1:5(0\text{-}0.15m)}$ and ECv (May 5 to June 13)

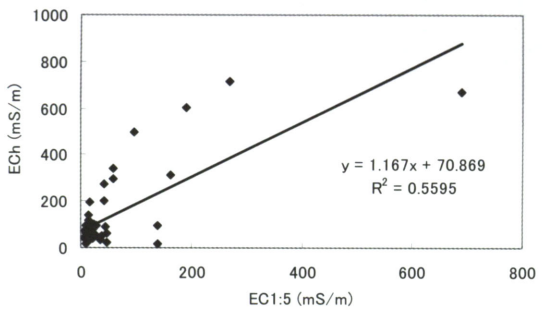

Fig.6 Result of regression analysis between $EC_{1:5(0\text{-}0.15m)}$ and ECh (May 5 to June 13)

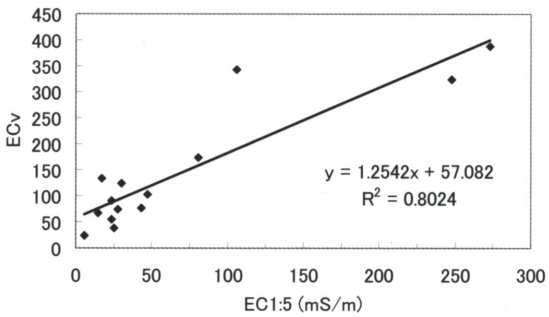

Fig.7 Result of regression analysis between $EC_{1:5(0\text{-}1.0m)}$ and ECv (Nov. 5 to 26)

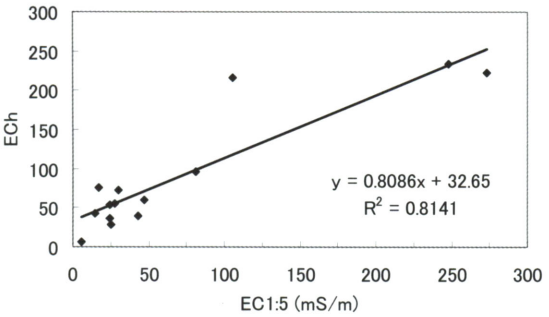

Fig.8 Result of regression analysis between $EC_{1:5(0\text{-}1.0m)}$ and ECh (Nov. 5 to 26)

salinity was observed below 0.6m soil depth of the non-saline field. It seems that there are many "potential" salinity area and we must take care of this point.

5. Summary

Under several soil series and several profiles of soil water content, high availability of EM technique usage in the LSP was confirmed. Degree of soil salinity is increasing from up stream part to down stream part of the project area. High soil salinity points were observed in the 4th project area. It is supposed that there are many "potential" salinity areas in the 4th project area. Degree of soil salinity often depends on its land use so that we need to make a soil salinity hazard map with consideration of it.

References

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Sevgi D., Nagano, T. and Watanabe, T. (2004): Irrigation system and improvement in the Lower Seyhan Plain, The interim report of ICCAP

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Fig.1 LSP and measurement point (check mark)
(Research period: May 5 to June13)

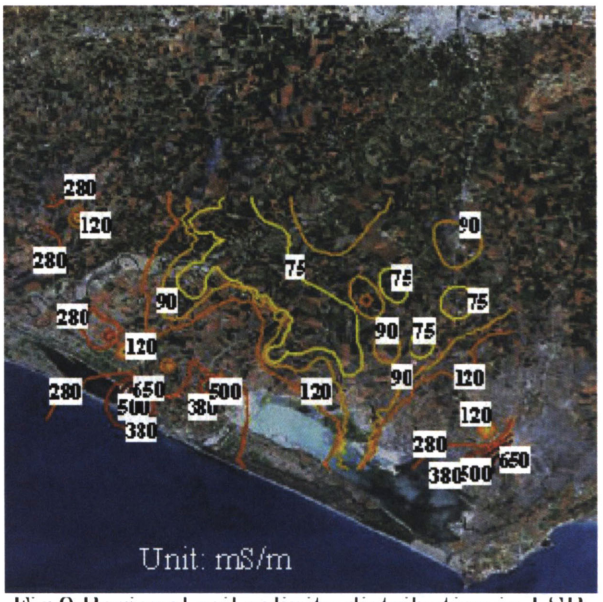

Fig.9 Regional soil salinity distribution in LSP

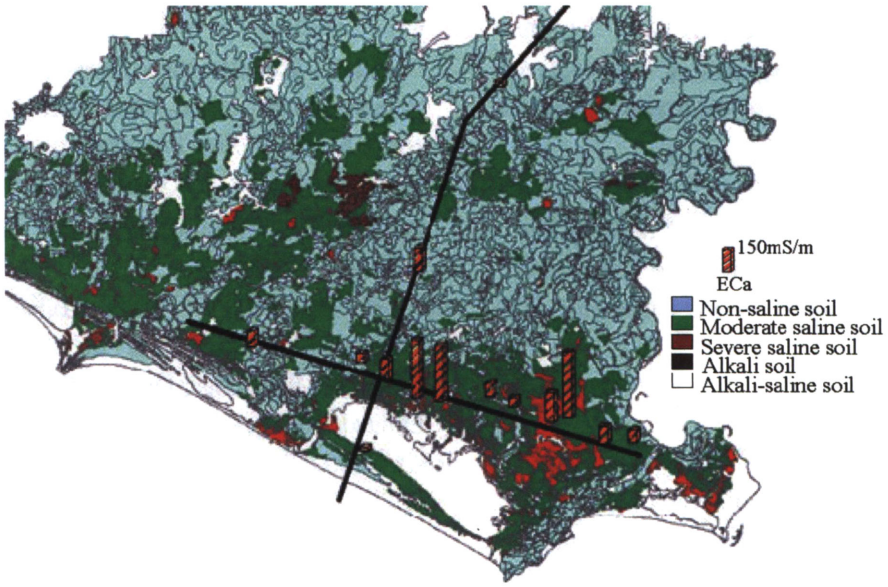

Fig.10 Regional soil salinity distribution in LSP