Development of validation data sets for a transient hydro-salinity model using EM-38 soil surveys, irrigation water monitoring and forage analysis

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Introduction

- Soil salinity is a major factor affecting irrigated agriculture in today's world, especially in arid and semi-arid regions.
- The western San Joaquin Valley (WSJV) of California is a highly productive agricultural area affected by salinity and drainage problems.
- Re-use of saline-sodic drainage water (DW) to irrigate salt-tolerant forage crops such as alfalfa and 'Jose' tall wheatgrass is an attractive option because it reduces the volume of saline DW requiring disposal (and discharge of salt, boron and selenium to the San Joaquin River) and it extends the irrigation water supply.
- Sustainability of forage production using saline irrigation waters requires adequate leaching to push salts below the root zone. There is need to develop a robust computer model aimed at improving soil and water management in saline water reuse projects.

Study Site

- SJRIP (San Joaquin River Improvement Project).
- 6000 acre saline drainage water (DW) re-use facility located northeast of Firebaugh, California.
- Forages: '*Jose*' tall wheatgrass (TWG) (4,000+ acres), alfalfa (ALF) (950 acres) and pistachio (80 acres)
- Provides drainage service to Grasslands Drainage Area (~ 100,000 acres of highly productive farmland)
- Operated by Panoche Water District: managing saline DW since 1998 to comply with strict environmental regulations to reduce selenium, salt and boron discharge into San Joaquin River.

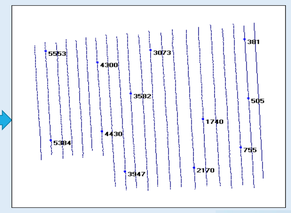
Objectives

- Collect soil, irrigation water and forage production data to validate and refine the CSUID-II model (Colorado State University Irrigation and Drainage model).
- Conduct EM-38 soil salinity surveys to assess the spatial distribution of salts in the fields.
- Developing GIS maps to help provide the guidelines for the district to manage saline water application and leaching.

Outline of Steps involved

EM-38 Soil Survey

ESAP



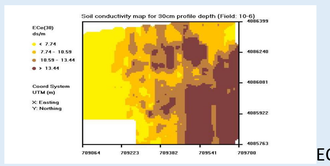
Generate Sampling Design

Soil Sampling

Lab Analysis

ESAP
- Spatial stat analysis
- Calibration equation
- Basic stat etc.

ECe = b0 + b1(z1) + b2(x)



Salinity Map

Materials and Methods

- EM-38 soil surveys were conducted to assess the spatial variability in soil salinity in selected fields (ECa measurement).
- Surveys were done in transects of ~30 meters apart.
- ESAP software was used to determine number and location of soil salinity samples to obtain from field.
- Soil samples were taken from 12 locations at 30 cm depth increments for each field.
- pH, ECe, gravimetric water content and saturation percentage were measured.
- ECa data measured by EM-38 was calibrated with the ECe of soil samples.
- Irrigation samples were collected in July and August.

Results

Table 1	Average ECe(ds/m) of each sampled depth for all the surveyed points in each field.			
	TWG		ALF	
Depth(cm)	**10-6** *(88 acres)*	**13-1** *(70 acres)*	**13-2** *(128 acres)*	**13-6** *(74 acres)*
0-30	10.6	13.3	9.56	5.89
30-60	13.9	19.9	14.0	9.3
60-90	12.2	21.1	16.5	10.9
90-120	12.7	23.6	17.2	10.5
Average	12.5	19.5	14.4	9.2

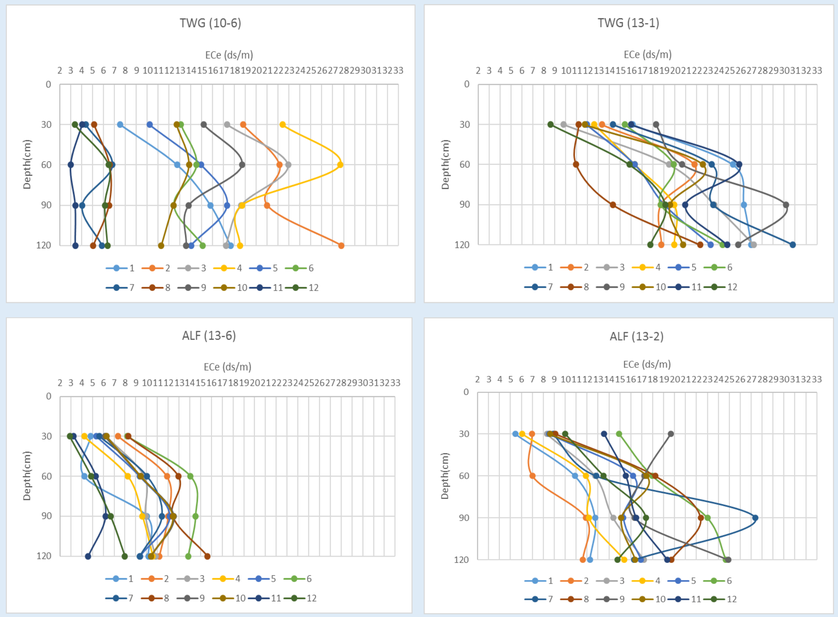


Fig 1. *Graphs showing ECe of the sampled 12 sites at four depths.*

Table 2.	Irrigation water composition							
Field	**Forage**	**ECw** *(ds/m)*	**pH**	**B** *(mg/l)*	**Cl** *(mg/l)*	**SO_4** *(mg/l)*	**SAR**	**HCO_3** *(mg/l)*
10-6	**TWG**	5.73	8.2	9.46	945	1570	6.88	135
13-1	**TWG**	1.8	7.5	2.86	453	1153	4.79	154
13-2	**ALF**	0.87	8.15	0.84	113	188	3.83	81
13-6	**ALF**	2.13	7.95	1.83	516	1184	3.38	156

Fig 2. *Maps showing the salinity distribution in fields (top left to right, clockwise, 10-6, 13-1, 13-2, and 13-6) for average ECe of the sampled soil profile (0-120cm).*

Conclusions

- All the fields had lower ECe at 0-30 cm depth than higher depths indicating some degree of leaching.
- Field 13-1 (TWG) had highest average ECe followed by 13-2 (ALF). The soil salinities of >12 dS/m in a large portion of the field suggest substantial yield reductions (alfalfa has a salinity tolerance threshold of 2.0 dS/m ECe).
- Alfalfa fields receive irrigation water of lower salinity, however field 13-2 has very high soil salinity. Suggests a need for increased leaching in this field.
- Individual salinity profiles shapes reveal that in some cases, salinity is not lowest in the top 60 cm (root zone of the forages), indicating a need for better management, e.g. increased leaching.

Future work

- EM-38 Salinity surveys at end of each season to assess change in salinity levels.
- Assess dry matter production in the various salinity zones to determine how much salinity is impacting forage yield.
- Collection of forage samples for Na, K, K/Na determination to assess the toxic ion stress from the salinity.
- Validation of the CSUID-II Irrigation and Drainage Model for estimation of leaching requirements for forage production.

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