Sustainability of Irrigation with EM Induction Technique

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Abstract

Assessing Sustainability of irrigated agriculture using the Electromagnetic Induction technique

Short title: Sustainability of Irrigation with EM Induction Technique

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Sustainability of irrigated agriculture in Central California is threatened by increased salinization of land and water resources. Intensive irrigation and fertilization, use of saline water and inadequate drainage have resulted in the salinity build up. Increase in soil salinity has been observed in many cropping systems including orchards. Therefore, there is a need to use rapid and cost-effective tools to assess the extent of salinization for developing adequate crop production and land management practices. We applied an electromagnetic induction (EM) technique to map soil salinity through non-invasive and rapid measurements of electrical conductivity. The survey results demonstrated that the EM method could accurately and reliably describe the large spatial and temporal variability in salinity observed across the lands. By identifying the precise locations and levels of salt loading, the EM surveys could help in the development of irrigation and soil management strategies.

Keywords: Salinity, Irrigation, EM survey, Conductivity

OUTLINE

- Background/Research Activities
- EM Salinity Mapping
- Case Studies

Research activities

- **Use of remote sensing technologies: EM, satellite/aerial imagery, GIS**
  - Soil and water resources management
  - Precision agriculture
- **Agronomic studies**
  - Fertilizers
  - Barrier crops
  - Seeds
- **Environmental studies**
  - Land application of effluent and drainage waters

Evidence of Soil Salinity

Field Variability – Salinity/Sodicity

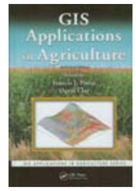
Near Lemoore, CA

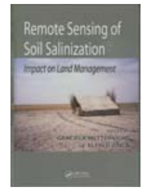
Soil salinity mapping

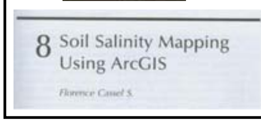
- **Objective**: Assessing soil salinity in agricultural fields
- Use of **Electromagnetic induction** (EM) technique
- Develop salinity **maps using GIS**

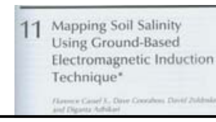
References on Theory

- **EM technology and GIS**





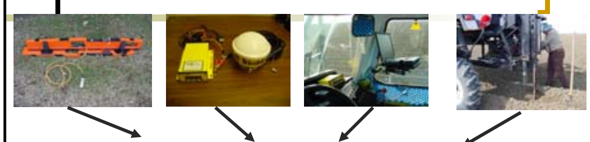




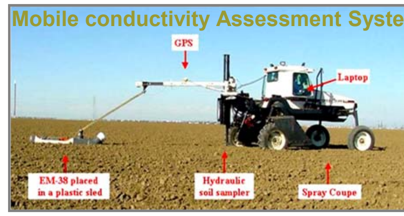
Steps in EM salinity mapping

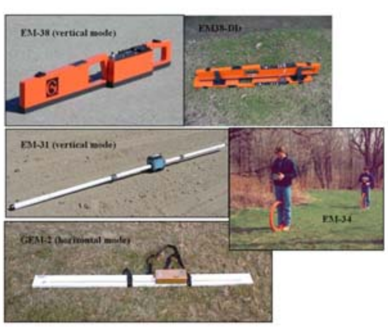
- ***Data acquisition***
- ***Data calibration***
  - ***ESAP software***
  - ***Ground truthing***
  -
- ***Mapping soil salinity from point data using GIS and other software***

Survey equipment



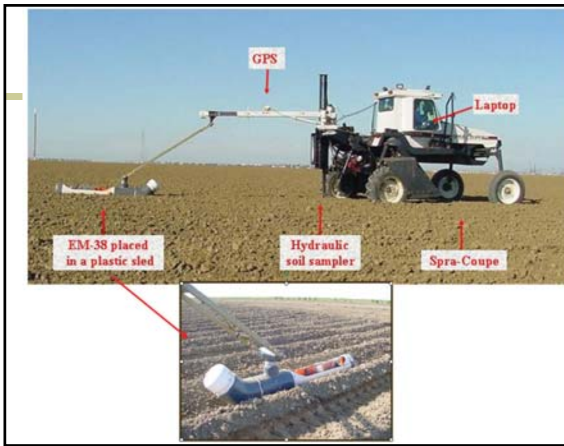
Mobile conductivity Assessment System





EM sensor

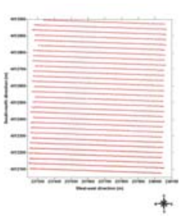
- Length **(intercoil spacing)= 3.3 ft**
- Weight **= 6.6 lb**
- Operating frequency**= 14.6 kHz**
- Depth of measurement
  - **Horizontal = 3 ft**
  - **Vertical = 6 ft**
- Measurement accuracy **= ± 5% at 30 mS/m**

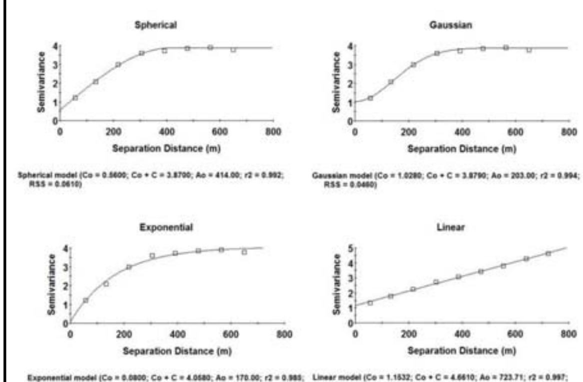


http://www.ars.usda.gov/Services/docs.htm?docid=8918

Data acquisition - mobile

- EM and GPS data recording along furrows: every 30-40 ft
- 10-15 measurements per acre
- Total of 1500-2250 measurements per field
- Survey time: 2½ - 3 hours (150 ac)
- Calibrate EM data: soil sampling at 6-12 locations

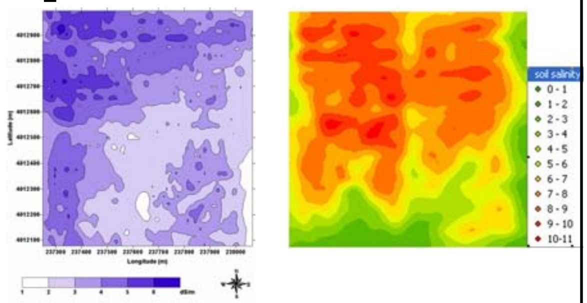




Soil salinity mapping

- Generate soil salinity maps, based on calibrated EM data
- GIS: Spatial analysis
- Surface maps of soil salinity
- In addition, maps of boron, gypsum, and moisture distribution

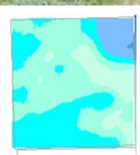
Soil salinity mapping



1. Effects of Irrigation Drainage

Agricultural fields subjected to IFDM practices (sequential drainage reuse)

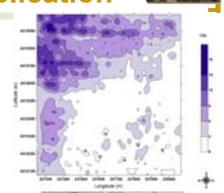
- Survey every year
- Salinity variability across farm
- Recommendations on cropping rotation and drainage applications

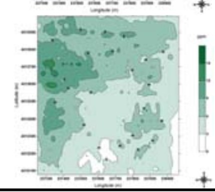


2. Variable rate application

Variable seeding and gypsum application rates based on salinity and boron levels

- Survey before planting
- Variable seeding rate
- Variable amendment applications

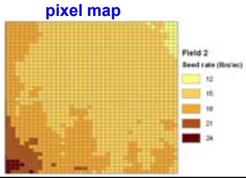




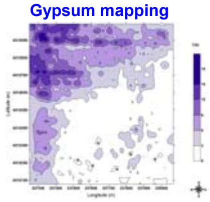
Variable rate equipment

- Guidance System
- Raven controller
- GPS
- Delivery system

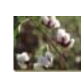
Seed application rate - pixel map



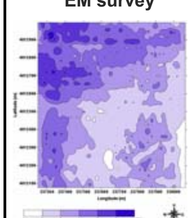
Gypsum mapping



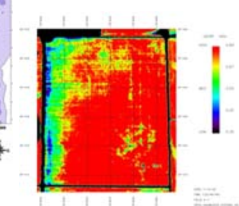
Data comparison



EM survey

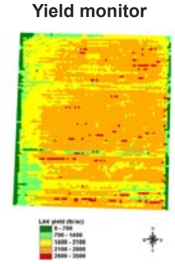


Aerial imagery



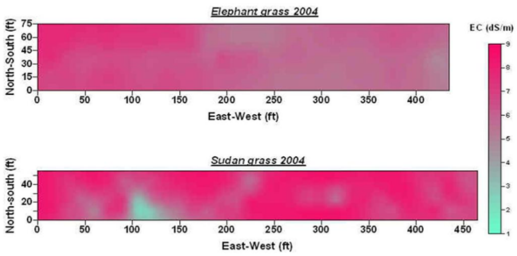
Plant growth (NDVI) map

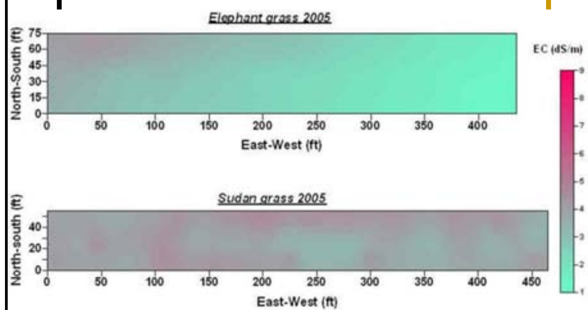
Yield monitor



3. Assessing a bio-filter crop

- Objective: Compare effectiveness of elephant grass vs Sudan/Bermuda grass in controlling N and P contamination





4. Assessing yield potential

Salinization and Yield Potential of a Salt-Laden Californian Soil: an In Situ Geophysical Analysis

Florence Cassel · Dave Goorahoo · Shankar Sharmasarkar

Cassel, F., Goorahoo, D., & Sharmasarkar, S. (2015). Salinization and Yield Potential of a Salt-Laden Californian Soil: an In Situ Geophysical Analysis. *Water, Air, & Soil Pollution*, 226(12), 1-8.

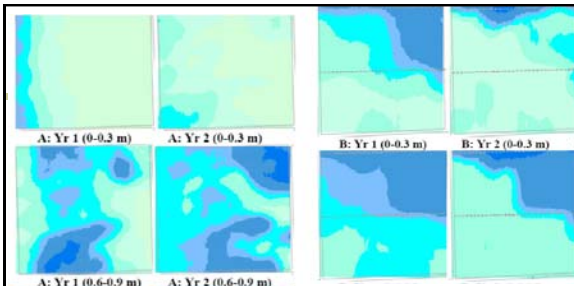


Fig. 2 Raster maps of conductivity distributions showing spatial and temporal variations in moderately (A) and severely (B) affected salinity zones

EC (mS m^{-1})
- 0-199
- 200-399
- 400-599
- 600-799
- 800-999
- 1000-1499
- 1500-1999

Concluding Remarks

Electromagnetic induction technique:

- **Precisely assess levels of salinity and moisture across surveyed fields.**
- **Great potential for quick evaluation of soil properties for irrigation over large areas**
- **Cost-effective alternative to extensive sampling**
- **Valuable tool to assess salt problems and effectiveness of irrigation and salt management strategies**