



Spatio-Temporal Analysis of Multi-Year Landsat 7 Data for Regional Scale Soil Salinity Assessment

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1. Introduction

Despite decades of research in soil mapping, characterizing the spatial variability of soil salinity across broad regions remains a crucial challenge.

In this study we explored the use of multi-year Landsat 7 canopy reflectance data (30×30 m resolution) for regional-scale salinity assessment in the western San Joaquin Valley (WSJV, ca.1.5 × 10⁶ ha), California, USA.

Additionally, we aimed to characterize the effects of meteorological settings, soil type, and crop type on the Landsat 7 (L7) – soil salinity relationships.

2. Materials and Methods



Seven years of Landsat 7 canopy reflectance (2007-2013)

Vegetation Indices evaluated in the study.

Index	Formulation ^a
Normalized Difference Vegetation Index	$NDVI = \frac{(NIR - R)}{(NIR + R)}$
Enhanced Vegetation Index	$EVI = g \times \frac{(NIR - R)}{(NIR + c_1 \times R - c_2 \times B + L)}$
Salinity Index	$SI = \sqrt{G \times R}$
Green Atmospherically Resistant Vegetation Index	$GARI = \frac{NIR - [G + \gamma \times (B - R)]}{NIR + [G + \gamma \times (B - R)]}$
Canopy Response Salinity Index	$CRSI = \sqrt{\frac{(NIR - R) - (G \times B)}{(NIR \times R) + (G \times B)}}$

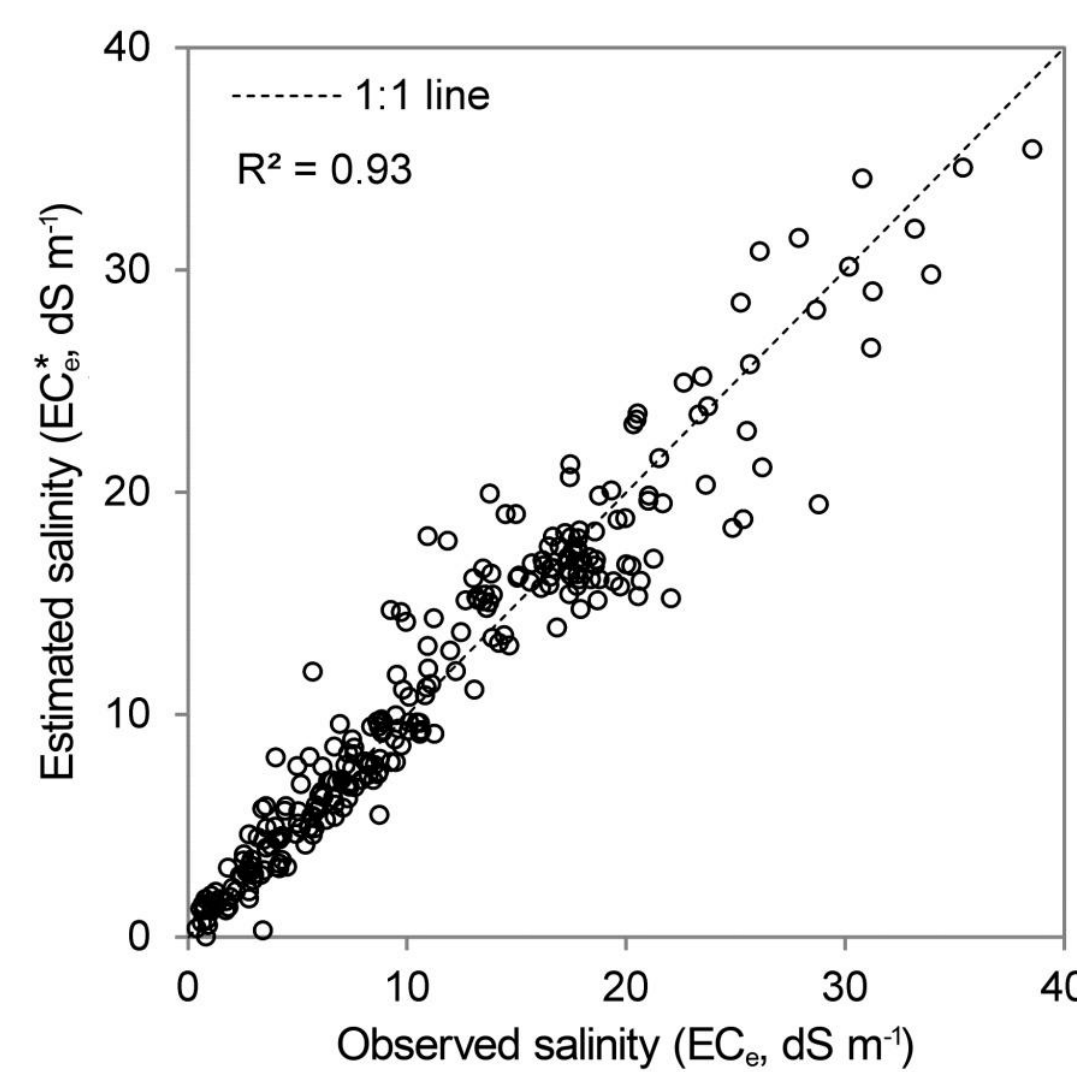
^a Landsat 7 spectral bands: blue (B), green (G), red (R), near-infrared (NIR), infrared 1 (IR1), and infrared 2 (IR2). Aerosol and soil correcting parameters: g, c₁, c₂, l, and γ.

Ground truth salinity: ca. 5000 indirect salinity values (EC_e^{*}) estimated, on a 30×30 m block support, from the relationships of ca. 300 direct salinity measurements with intense surveys of apparent electrical conductivity.

Twenty-two fields (total area 542 ha)

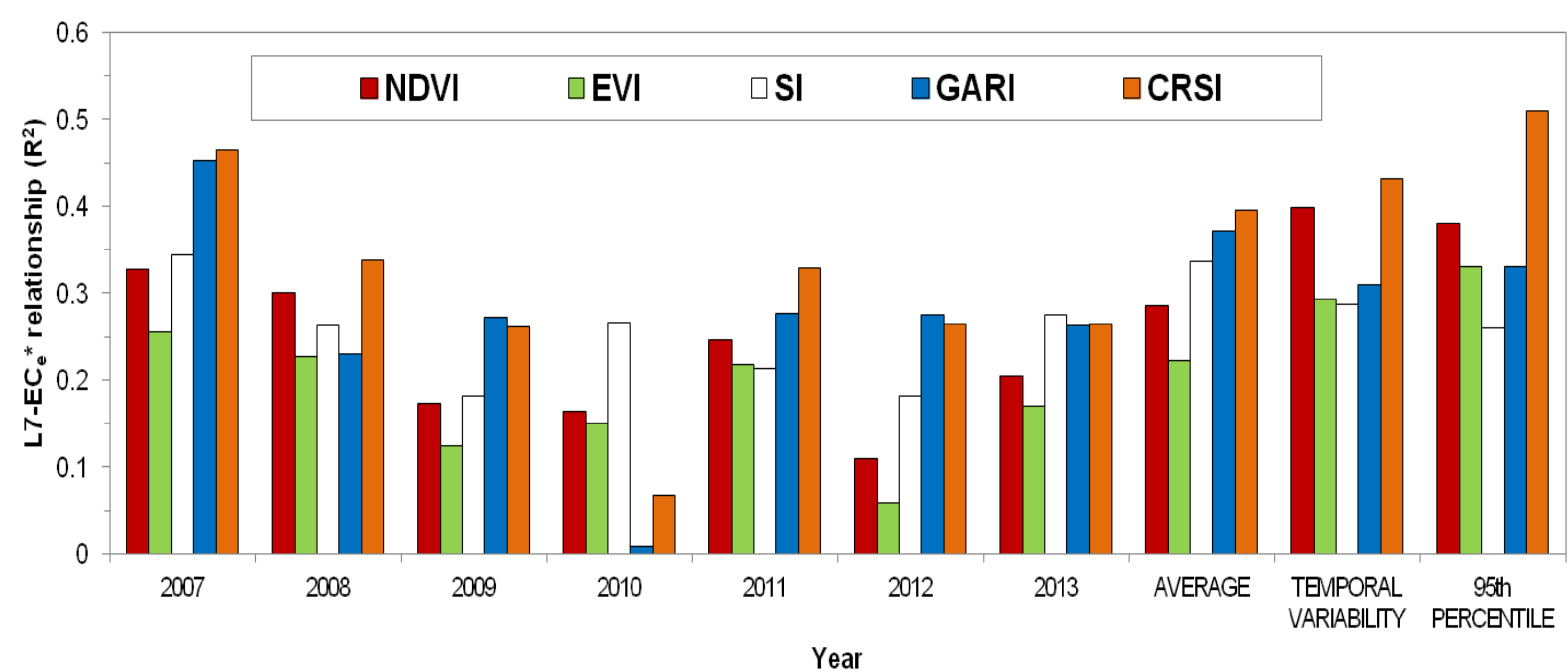
Five soil Orders (Entisols, Inceptisols, Mollisols, and Vertisols)

Fields were **cultivated with:** alfalfa, cotton, garlic, maize, melon, oats, onion, pistachio, safflower, tomato, triticale, and winter wheat. Some fields were kept as pasture and fallow.

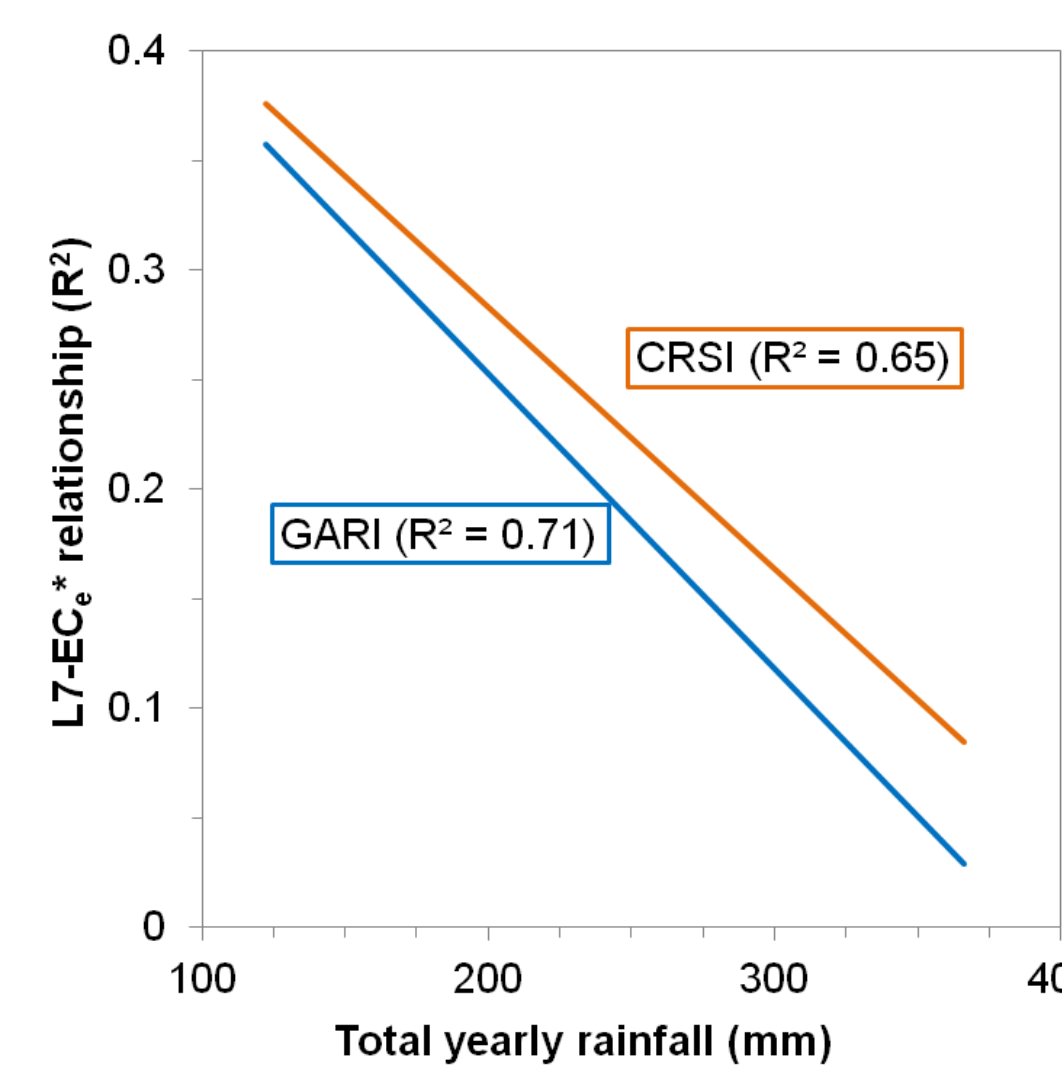


3. Results

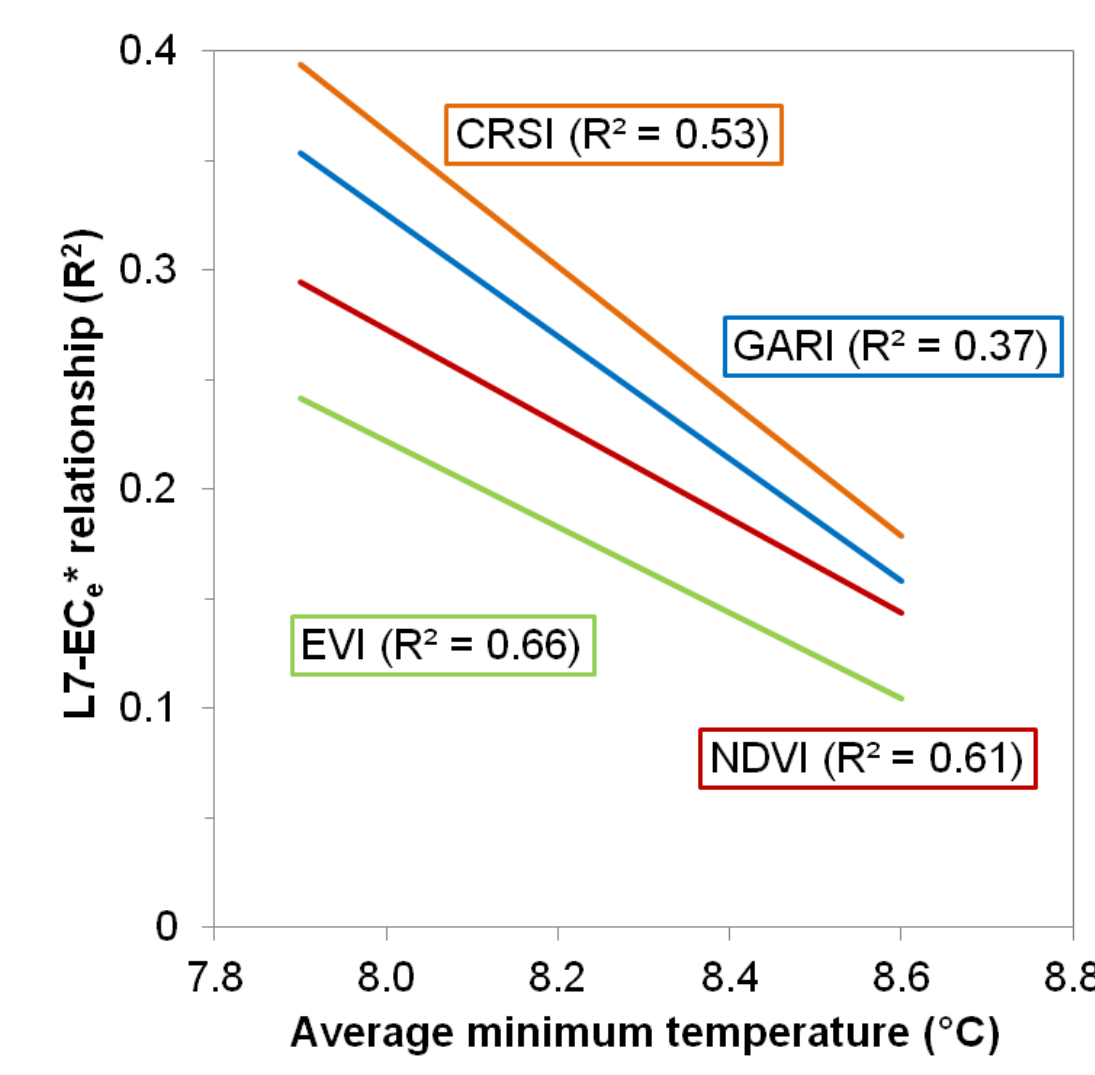
• Multi-year Analysis of L7 data highlights soil salinity effects



• Meteorological settings

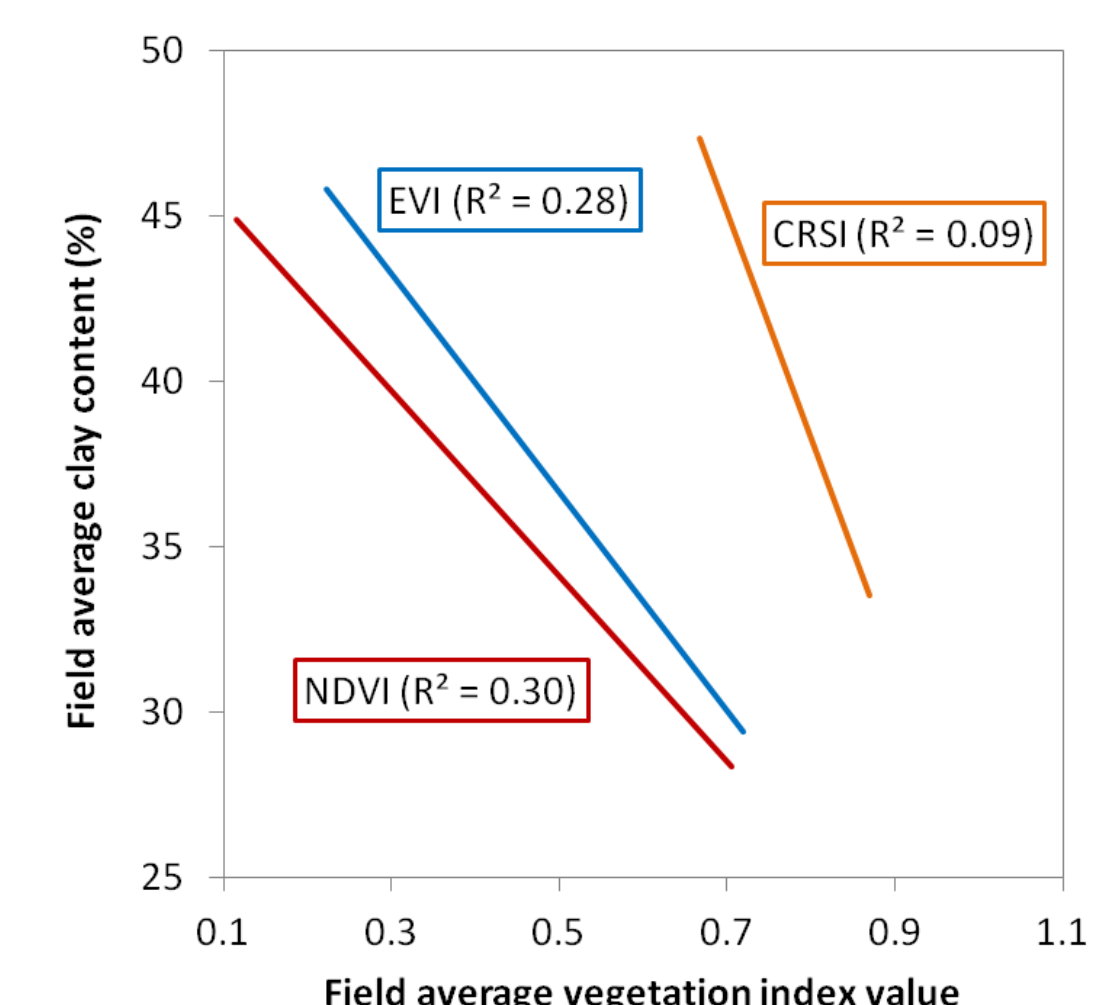


Some of the L7-EC_e^{*} relationships are negatively influenced by yearly rainfall and average minimum air temperature across the WSJV.

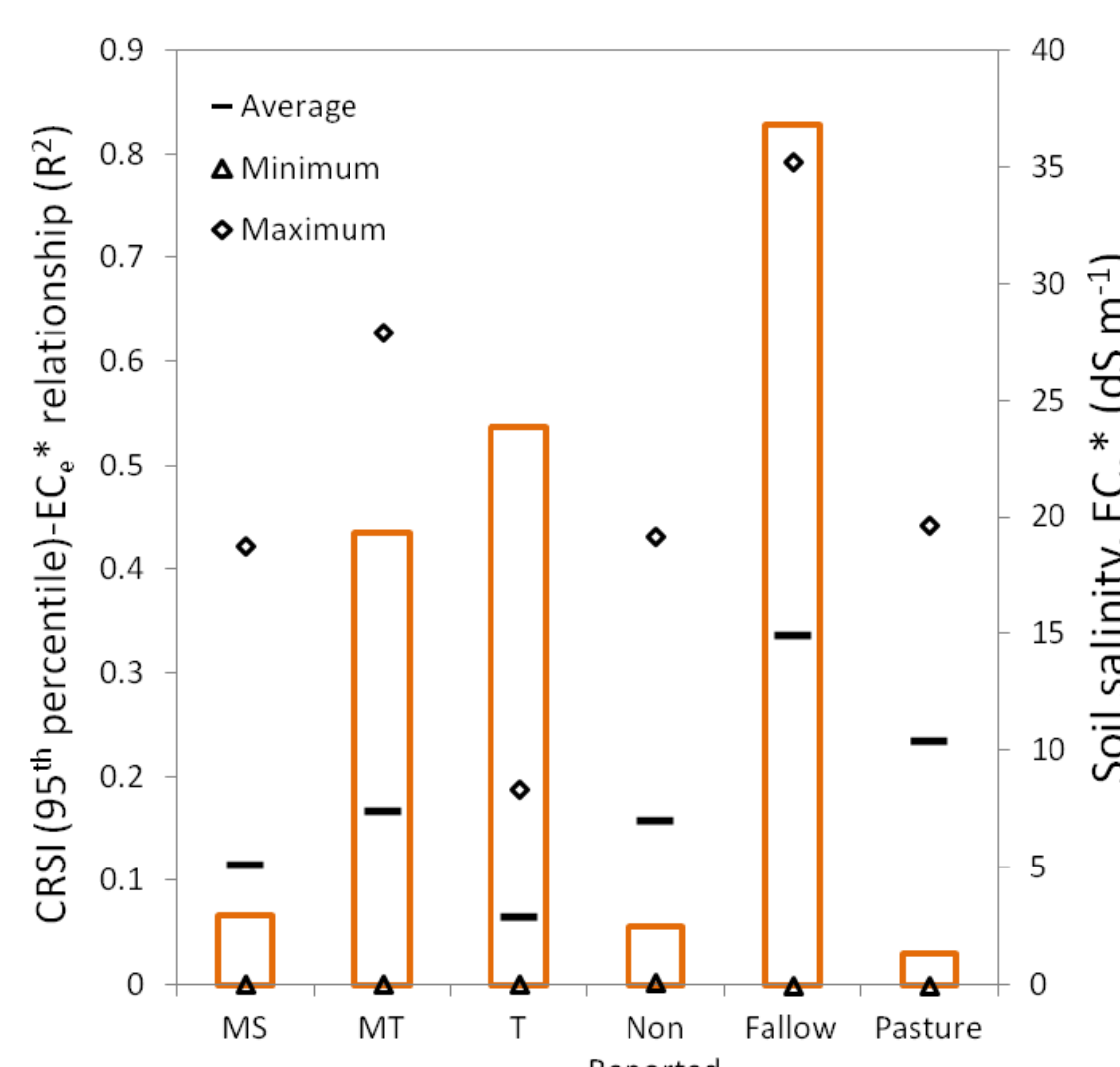


• Soil type

- NDVI, EVI, and CRSI are also correlated with soil texture (data from the SSURGO database).
- The finer the soil the weaker the L7-EC_e^{*} relationships in the near-infrared wavelengths.



• Crop type



- The more salt sensitive the crop, the steeper the slope of its relationship with salinity.
- Moderately salt tolerant and tolerant crops are characterized by high R² in the L7-EC_e^{*} relationships as crop status decreases gradually with increasing salinity.

4. Concluding Remarks

Multi-year Landsat 7 canopy reflectance can be used to assess soil salinity with good accuracy at regional scale.

We observed great variability in the L7-salinity relationships, due to meteorological settings, soil texture, and crop type. Future research will focus on the realization of a salinity map for the WSJV using the multi-year L7 reflectance data.

Read more about this: E. Scudiero, T.H. Skaggs, and D.L. Corwin (2014). "Regional Scale Soil Salinity Evaluation Using Landsat 7, Western San Joaquin Valley, California, USA". *Geoderma Regional*. DOI: 10.1016/j.geodrs.2014.10.004