Food and Agriculture Organization of the United Nations

GLOBAL SYMPOSIUM ON SOIL INFORMATION AND DATA

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EMI technique: Rapid appraisal of soil salinity at regional scale

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GLOBAL SOIL PARTNERSHIP

Introduction

➢ Owing to the semi-arid climate, large areas extensively developed for irrigated agricultural production.

❑ Whilst irrigation to has brought prosperity, there have been some isolated environmental impacts.

❑ Soil salinity is serious environmental problems adversely affecting crop yield, soil health and socio-economic conditions for the farming communities.

❑ 3% of global topsoils and more than 6% of global subsoils are affected by salinity or sodicity > 100 countries across all the continent

❑ SAS India: 6.73 mha, Projected 16.25 M ha by 2050

India losses ~17 M tonnes of food grains annually

Introduction

Two type

Destructive : (Traditioinal)soil sampling

Constraints

- Labour intensive
- Time Consuming
- High cost
- Low Spatial Representation

Non Destructive :

1. Geophysical Methods: EM-38, EM-31, TDR, Resistivity Meter

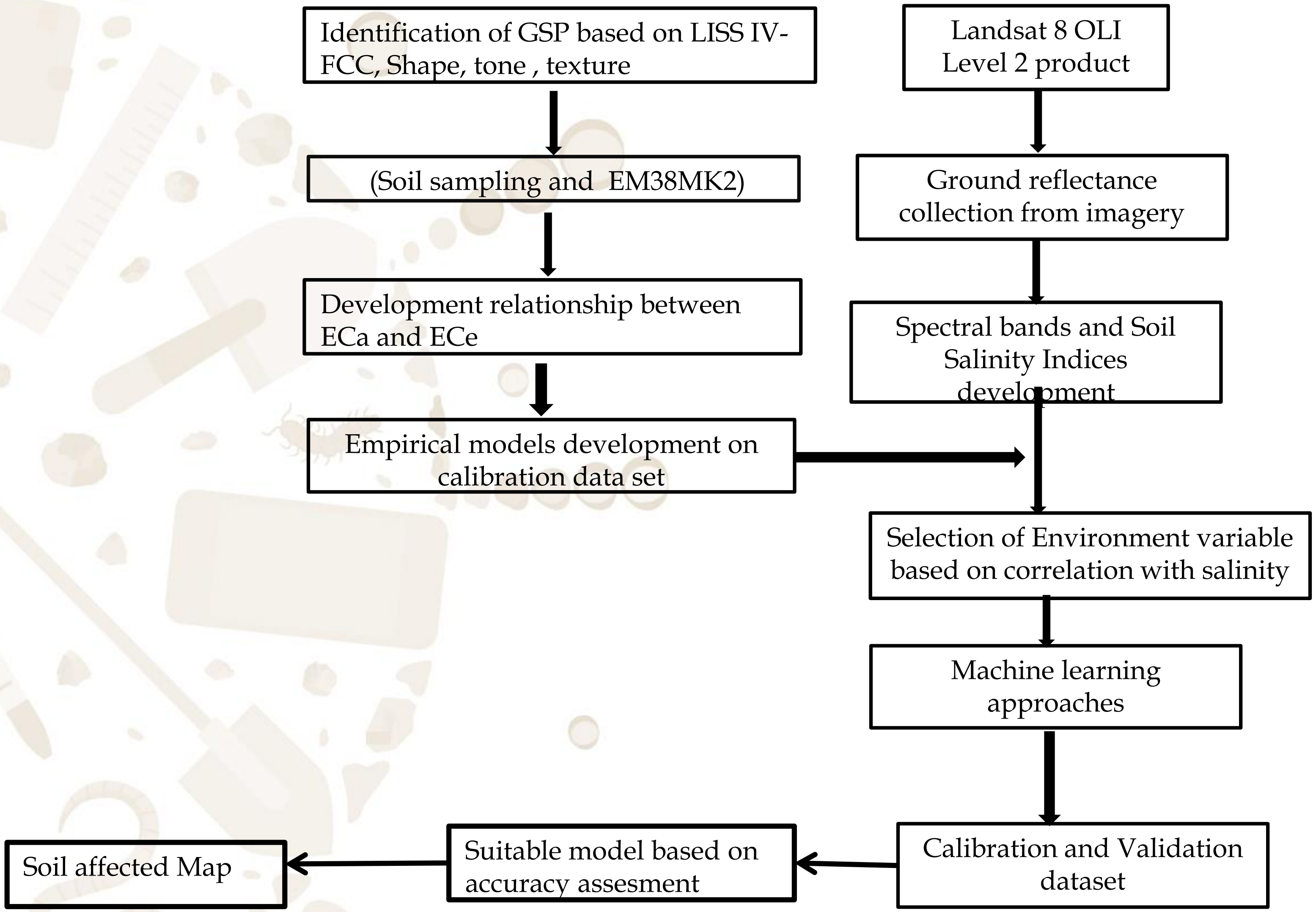
2. Remote sensing- Airborne, Space borne

- ❑ Machine learning approaches offer a powerful and versatile toolkit for salinity mapping that can complement and enhance traditional remote sensing methods, leading to more accurate and actionable information

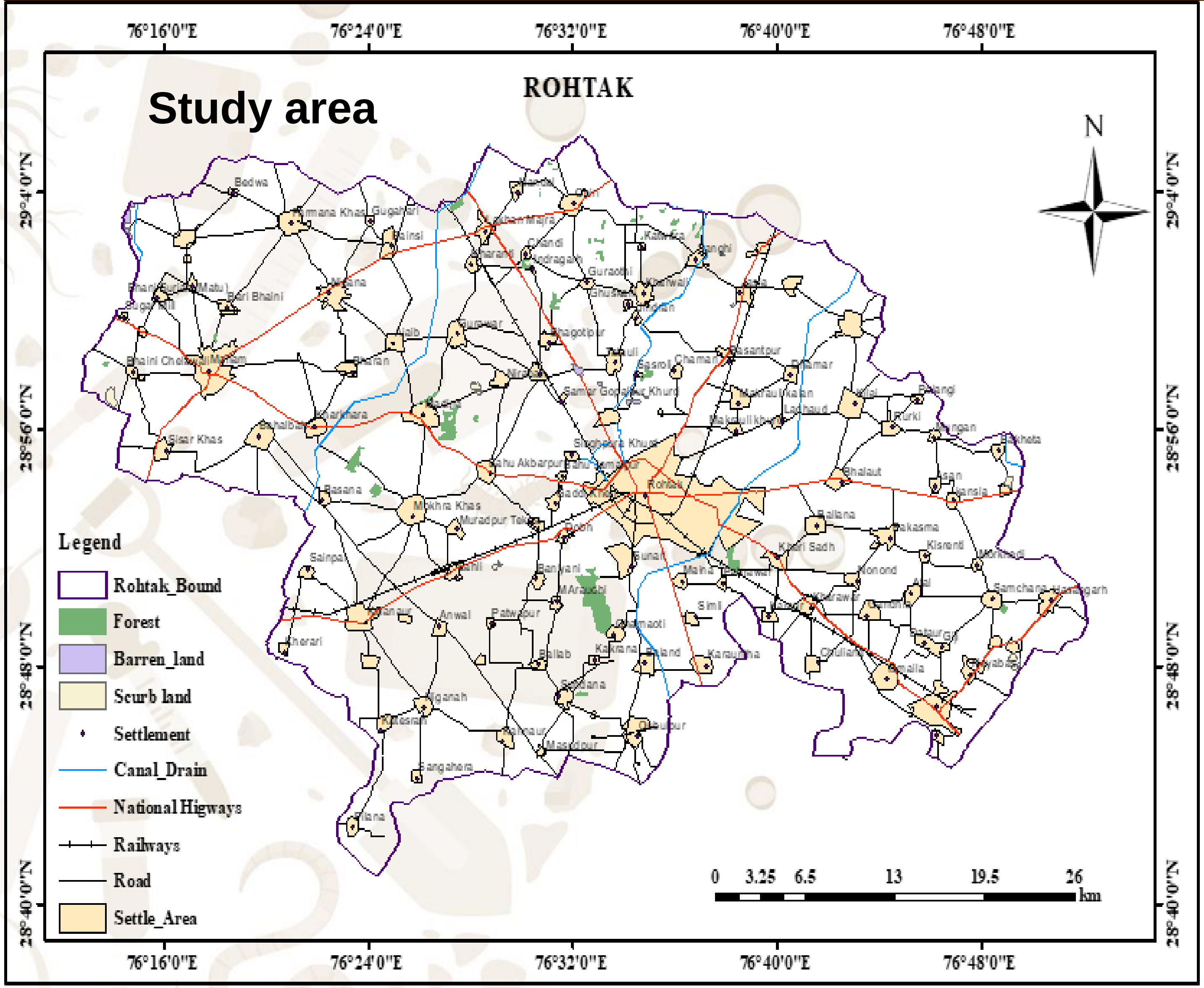
Objective of Research

Rapid soil salinity assessment (DSM) using optical remote sensing and geophysical electromagnetic induction techniques at regional scale (District level)

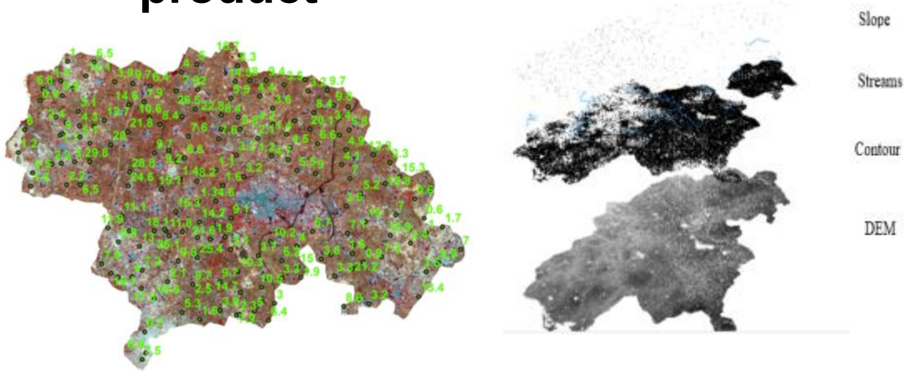
Material and Methods



Material and Methods

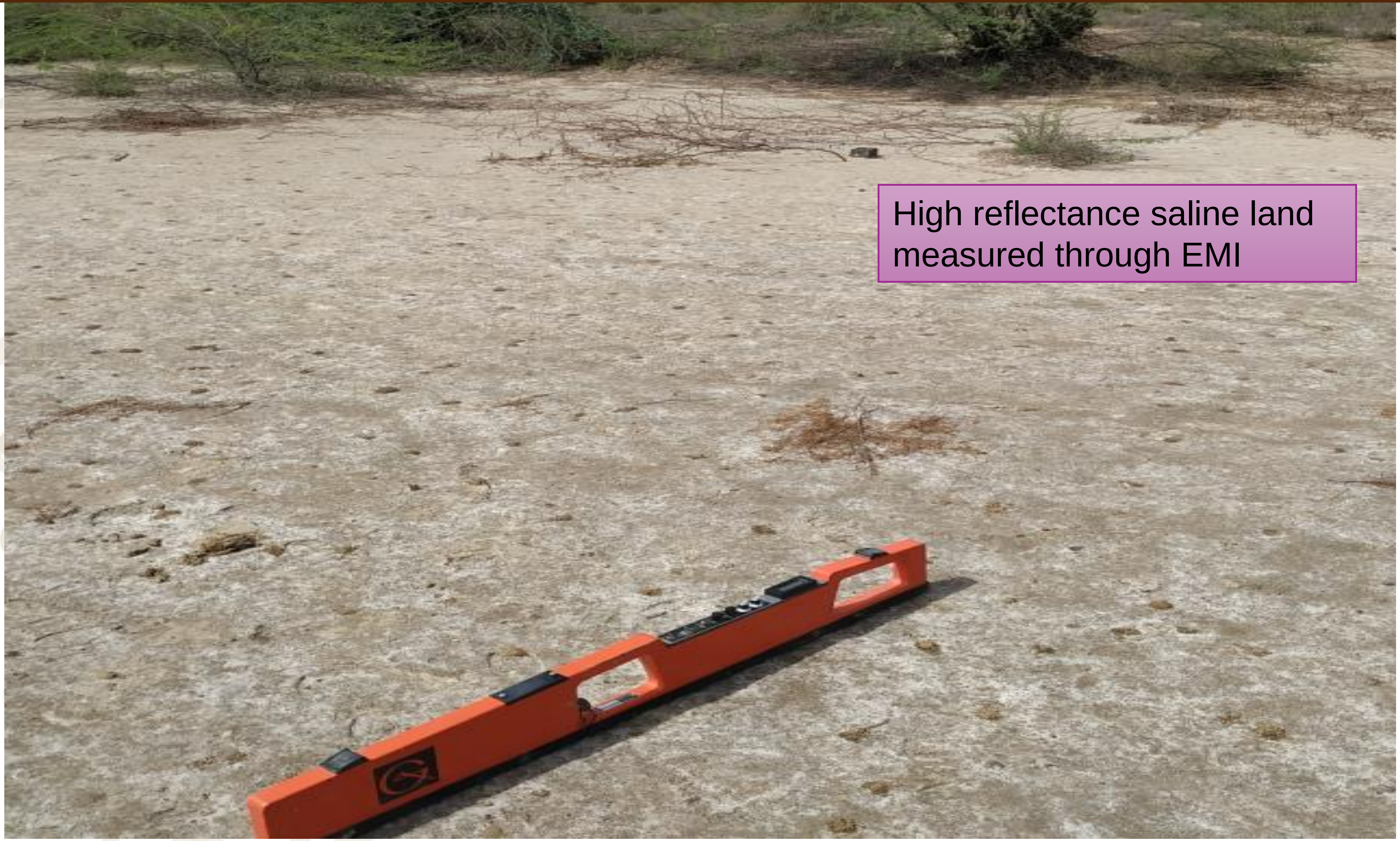


Remotesensing Imagery:
Landsat 8 OLI Level 2 product



Salinity Measurement: EMI apparoach

Material and Methods

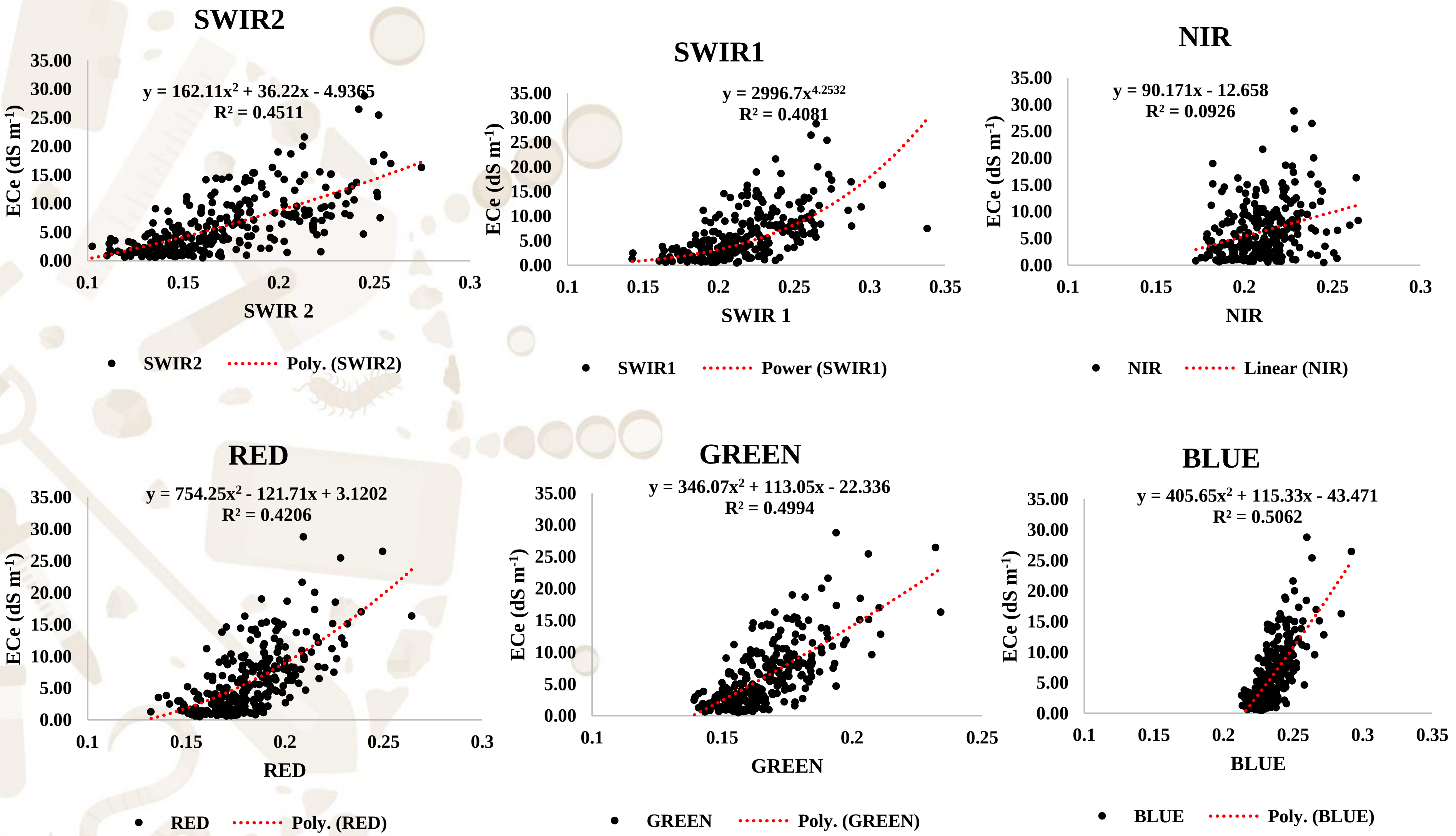


Results

Correlation with EMI (Apparent Conductivity) and Soil salinity (ECe)

	Ave ECa	Ave ECe	Av pH	Ave Na	Av K	Ave Ca+Mg	Av Cl	Ave SO4	Ave CO3HCO3
Ave ECa		0.862***	-0.295***	0.83***	0.686***	0.671***	0.775***	0.305***	-0.105
Ave ECe	0.862***		-0.417***	0.957***	0.75***	0.798***	0.909***	0.396***	-0.195**
Av pH	-0.295***	-0.417***		-0.344***	-0.359***	-0.417***	-0.399***	-0.139	0.342***
Ave Na	0.83***	0.957***	-0.344***		0.752***	0.791***	0.932***	0.439***	-0.17*
Av K	0.686***	0.75***	-0.359***	0.752***		0.611***	0.751***	0.224**	-0.164*
Ave Ca+Mg	0.671***	0.798***	-0.417***	0.791***	0.611***		0.768***	0.349***	-0.218**
Av Cl	0.775***	0.909***	-0.399***	0.932***	0.751***	0.768***		0.397***	-0.182*
Ave SO4	0.305***	0.396***	-0.139	0.439***	0.224**	0.349***	0.397***		0.003
Ave CO3HCO3	-0.105	-0.195**	0.342***	-0.17*	-0.164*	-0.218**	-0.182*	0.003	

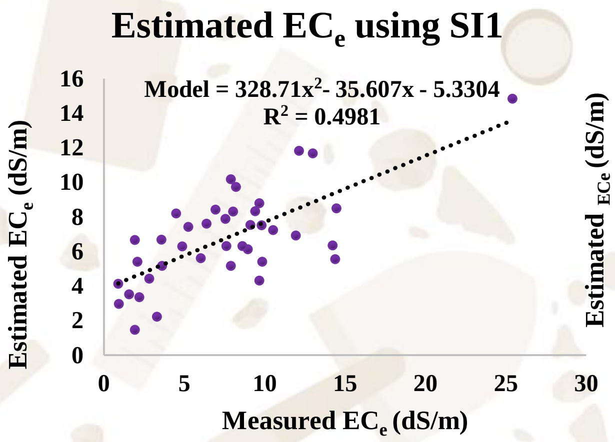
Correlations between EC_e and spectral reflectance at different bands of Landsat 8 OLI image

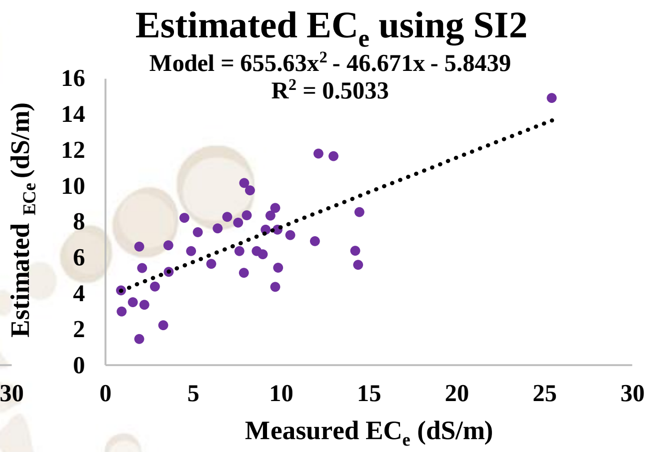


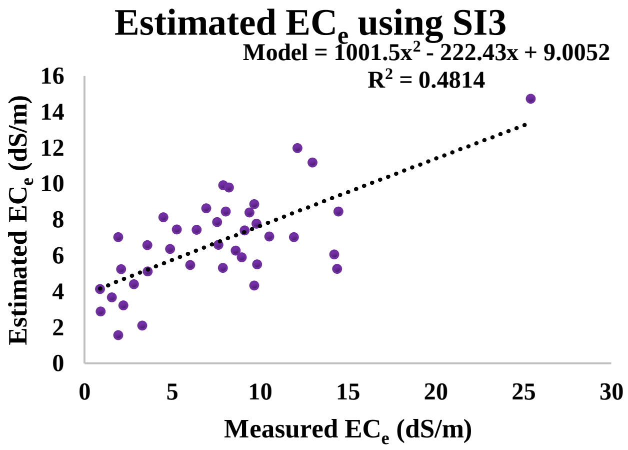
Salinity Model

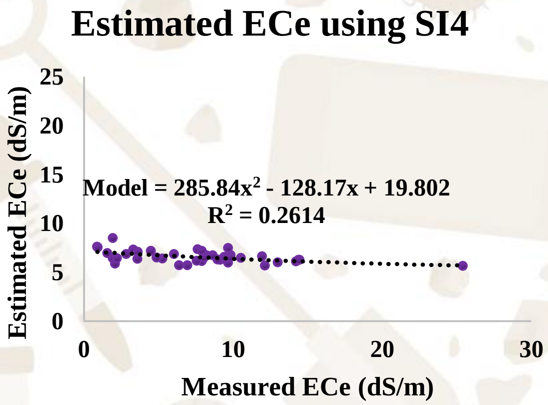
Salinity Index	Model (n = 210)	R^2
$SI1 = \text{sqrt}(green^2 + red^2)$	$EC_e = 328.71x^2 - 35.607x - 5.3304$	0.4548
$SI2 = \text{sqrt}(green \times red)$	$EC_e = 655.63x^2 - 46.671x - 5.8439$	0.4587
$SI3 = \text{sqrt}(blue \times red)$	$EC_e = 1001.5x^2 - 222.43x + 9.0052$	0.4569
$SI4 = (red \times NIR)/green$	$EC_e = 285.84x^2 - 128.17x + 19.802$	0.0152
$SI5 = blue/red$	$EC_e = 3383.5e^{-5.138}$	0.23
$NDSI = (RED - NIR)/(RED + NIR)$	$EC_e = 169.31x^2 + 73.936x + 9.8724$	0.1563

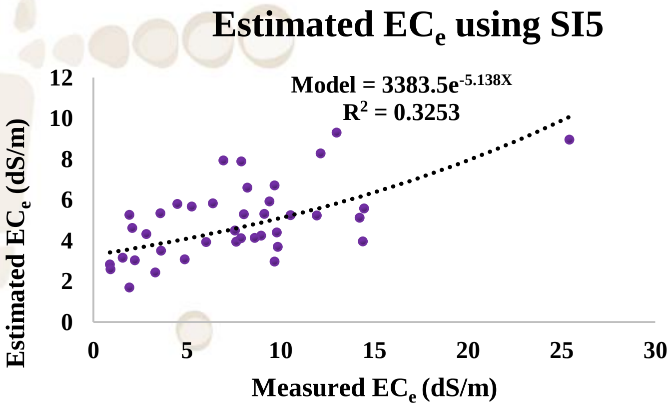
Correlation of EC_e derived from Landsat 8 OLI and observed EC_e from field survey data by EMI for

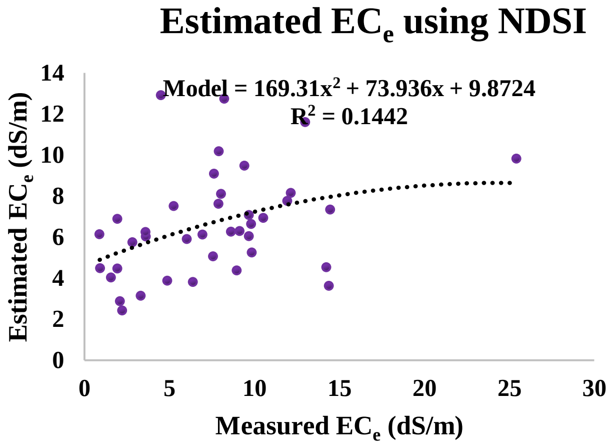










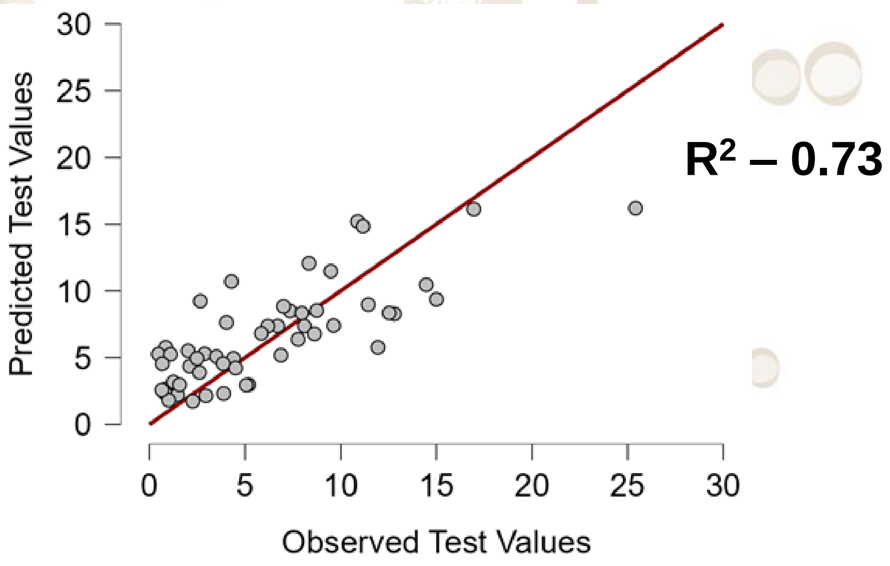


Machine learning Approach

To increase the soil salinity prediction accuracy from remote sensing machine learning techniques was adopted.

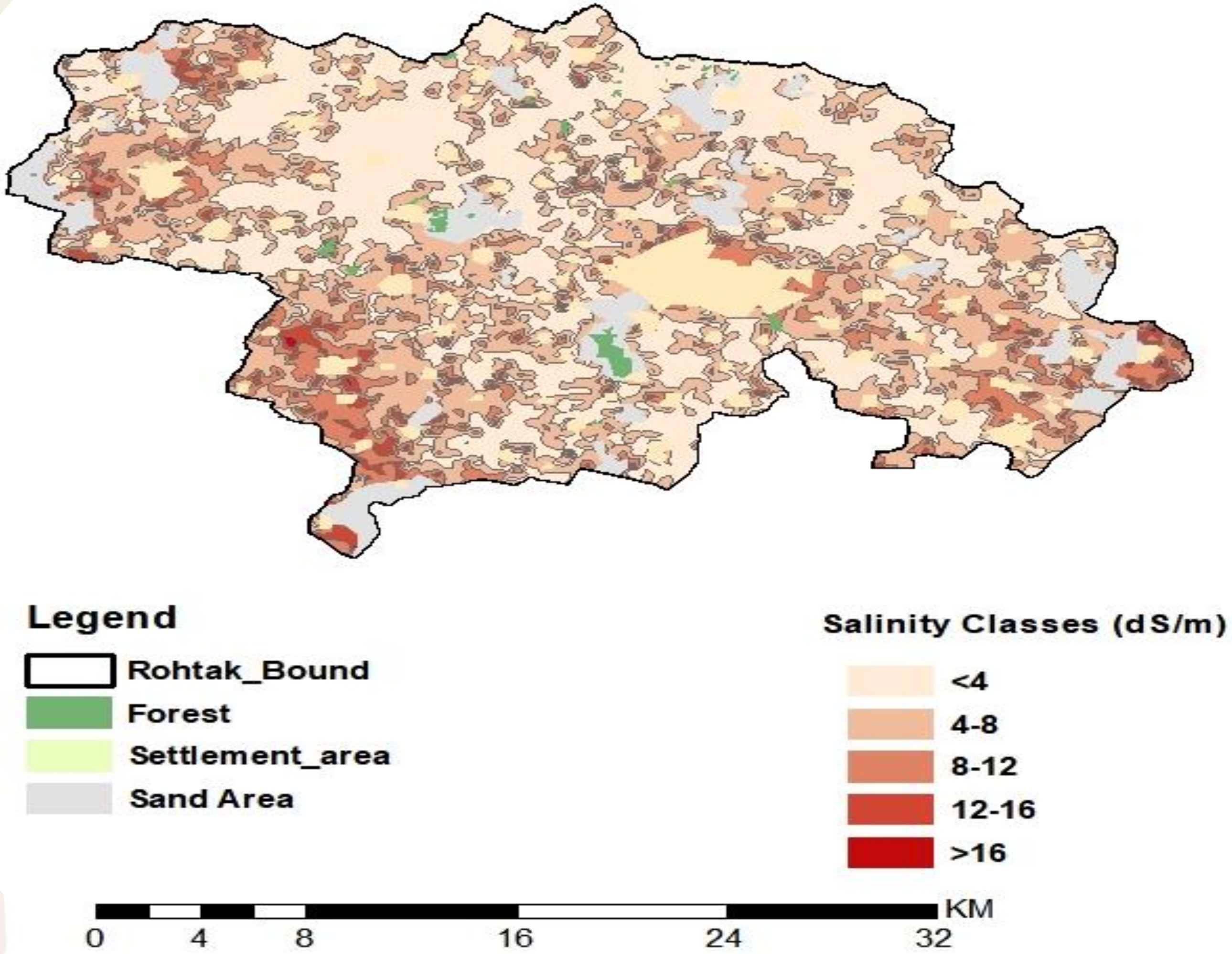
At the first step different environmental covariates used in the study were correlated with soil salinity (EC_e) and significant correlating factors were selected as model environment covariates (Spectral Band, SI-1 and SI2, Ratio spectral, NDSI)

Prediction of Soil salinity using machine learning methods



Soil salinity map predicted using best machine learning method (Random forest)

Soil salinity map predicted using best machine learning method (Random forest)



56% area affected by salinity.

Salient Findings

- For rapid detection and risk zone of salinity identification at Rohtak district soil samples and Apparent conductivity readings (EC_a) of 285 locations (2021) were collected based on the LISS IV satellite imagery.

- Significant R^2 observed between ECa and ECe.

- To increase the soil salinity prediction accuracy from remote sensing machine learning regression techniques was adopted. At the first step different environmental covariates used in the study were correlated with soil salinity (EC_e) and significant correlating factors were selected as model environment covariates.

- It was observed that random forest regression had the highest predicting accuracy with high coefficient of determination (R^2-0.73). These random forest regression model select for estimating soil salinity.

- Based upon the Electromagnetic induction techniques derived apprent conductivity readings, EC_e, Remote sensing and through RF machine learning soil salinity map was prepared. it was noticed that more than 56% area of Rohtak district was affected by soil salinity.

Conclusion

The results of the study indicated that soil salinity (ECe) can be rapidly identified and characterized through EMI techniques and salinity prediction accuracy significattly improved using machine learning approaches This methodology is useful in rapid mapping of saline soils at regional scale.

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