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Mapping soil salinity by integrating field EC measurements and Landsat-derived spectral Indices by cloud-based geospatial analysis.

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INTRODUCTION & AIM

Introduction

- Soil salinity limits fertility, crop yield, and food security in arid/semi-arid regions.
- Field surveys are costly and spatially limited; remote sensing via GEE provides continuous, cost-effective monitoring.
- Combining spectral indices with field EC measurements enables accurate salinity mapping.

Aim:

Predict soil EC using Landsat 8 indices and field data to produce salinity maps for precision agriculture in Mandi Baha Uddin, Pakistan.

METHOD

Soil Sampling:

Eleven georeferenced soil samples were collected in **Mandi Baha Uddin, Pakistan**.

Electrical Conductivity (EC) was measured in the lab (range: **0.59–1.06 dS/m**).

Remote Sensing Data:

Landsat 8 Surface Reflectance imagery was processed in **Google Earth Engine (GEE)**.

Spectral indices were derived: **Normalized Difference Salinity Index (NDSI)**, **Salinity Index (SI)**, and **Brightness Index (BI)**.

Modeling Approaches:

Linear Regression was applied to relate EC with spectral indices.

Random Forest was also tested for comparison.

RESULTS & DISCUSSION

Regression Model: NDSI was the key predictor (EC = 3.862 × NDSI + 1.71, $R^2 = 0.526$, RMSE = 0.089).

Random Forest: Higher training accuracy ($R^2 = 0.811$) but overfitting due to small sample size.

EC Mapping: 30 m prediction map generated in GEE, classified into FAO salinity categories, validated with field observations.

Key Point: NDSI is reliable for salinity mapping; GEE offers a cost-effective framework for monitoring and land management.

CONCLUSION

- NDSI is the most effective Landsat-derived index for predicting soil EC in Mandi Baha Uddin.
- Linear regression provides moderate accuracy ($R^2 = 0.526$, RMSE = 0.089 dS/m).
- GEE enables cost-effective, spatially continuous salinity mapping.
- Methodology is transferable for precision agriculture and land management in salinity-affected regions.

FUTURE WORK / REFERENCES

- Increase field sampling to improve model accuracy and reduce overfitting.
- Test multi-temporal Landsat imagery for seasonal salinity monitoring.
- Explore advanced machine learning models with larger datasets.
- Integrate salinity maps with crop management tools for precision agriculture.

FIGURES AND TABLES

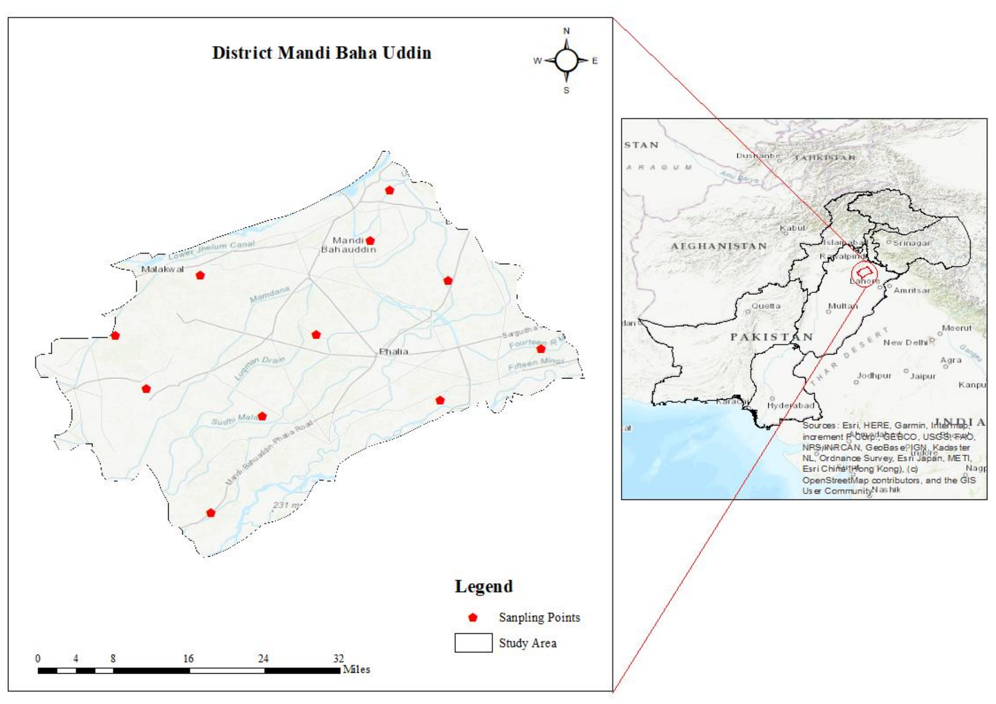

Figure 1: Study area map of Mandi Baha Uddin

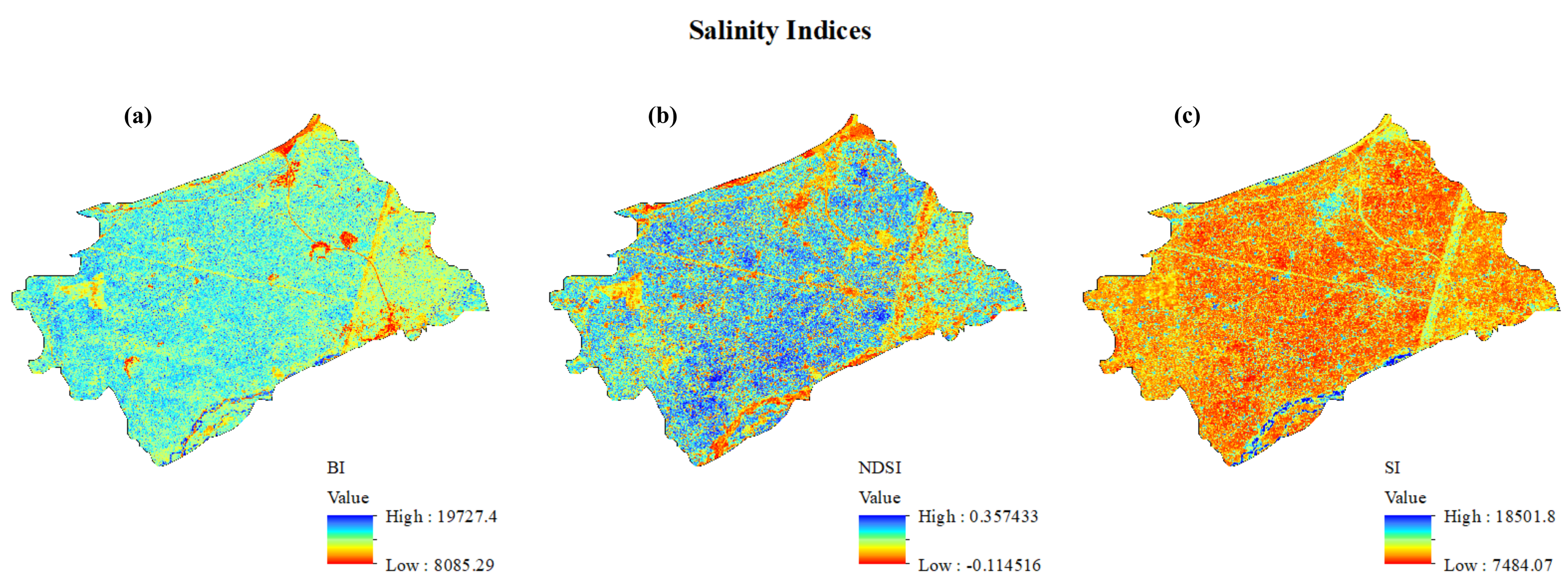

Figure 2: Salinity Indices (a) Brightness Index (BI), (b) Normalized Difference Salinity Index (NDSI), and (C) Salinity Index (SI)

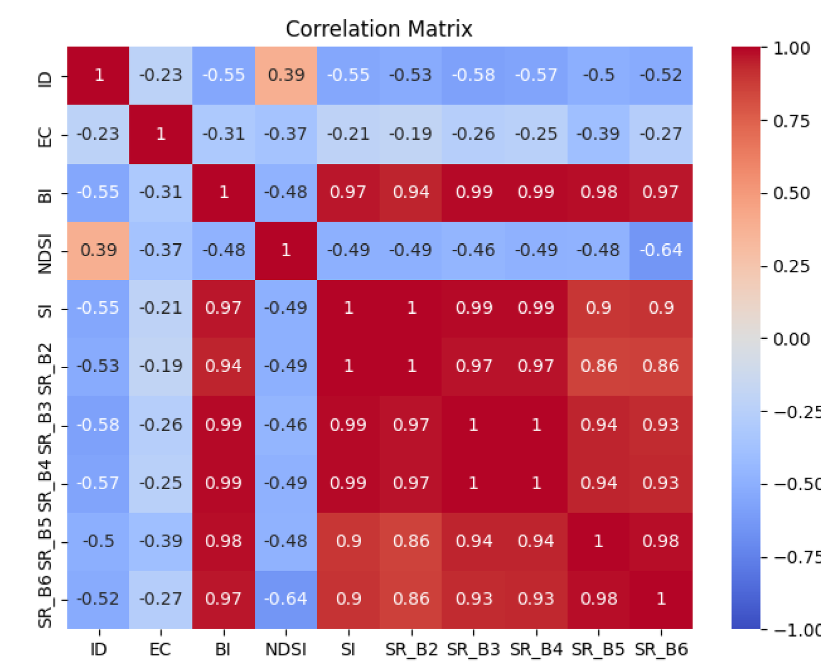

Figure 3: Correlation Matrix between spectral indices and satellite spectral bands.

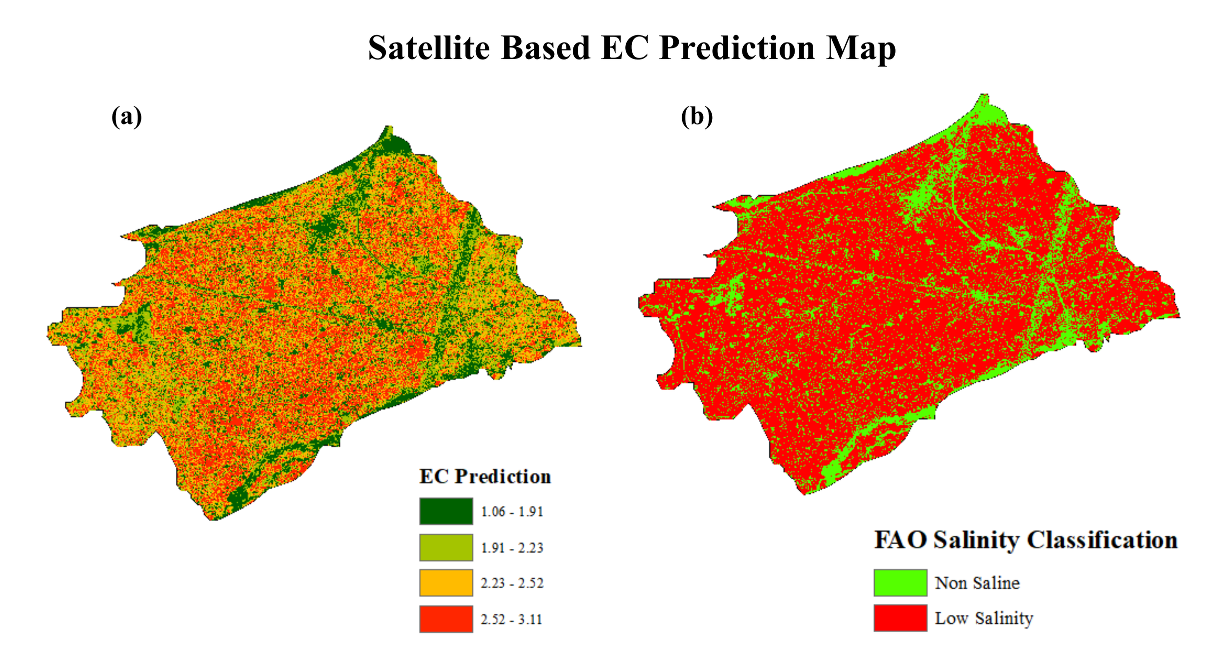

Figure 4: Satellite based EC Prediction Map (a) EC Map and (b) FAO Salinity Classification Map

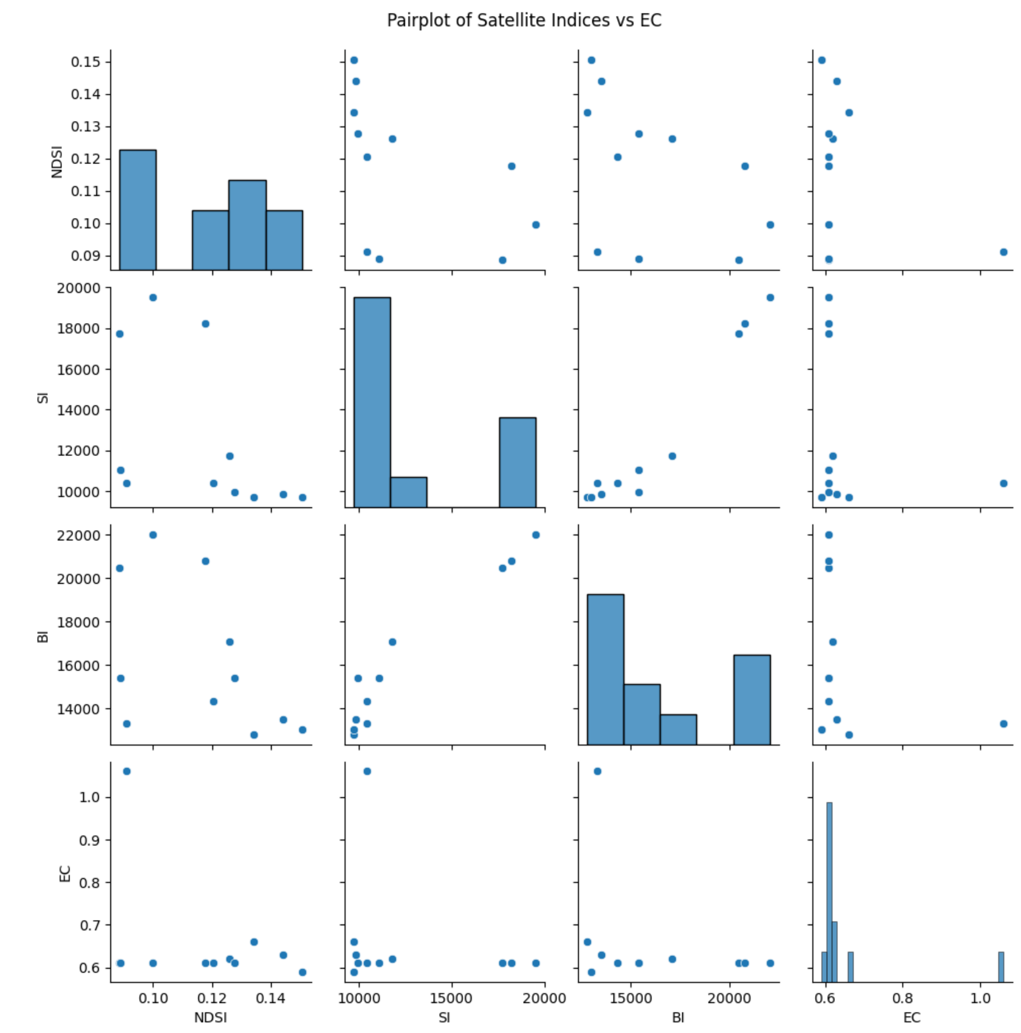

Figure 5: Pair plot showing the distribution and pairwise scatter relationships among the NDSI, SI, BI, and EC satellite indices.

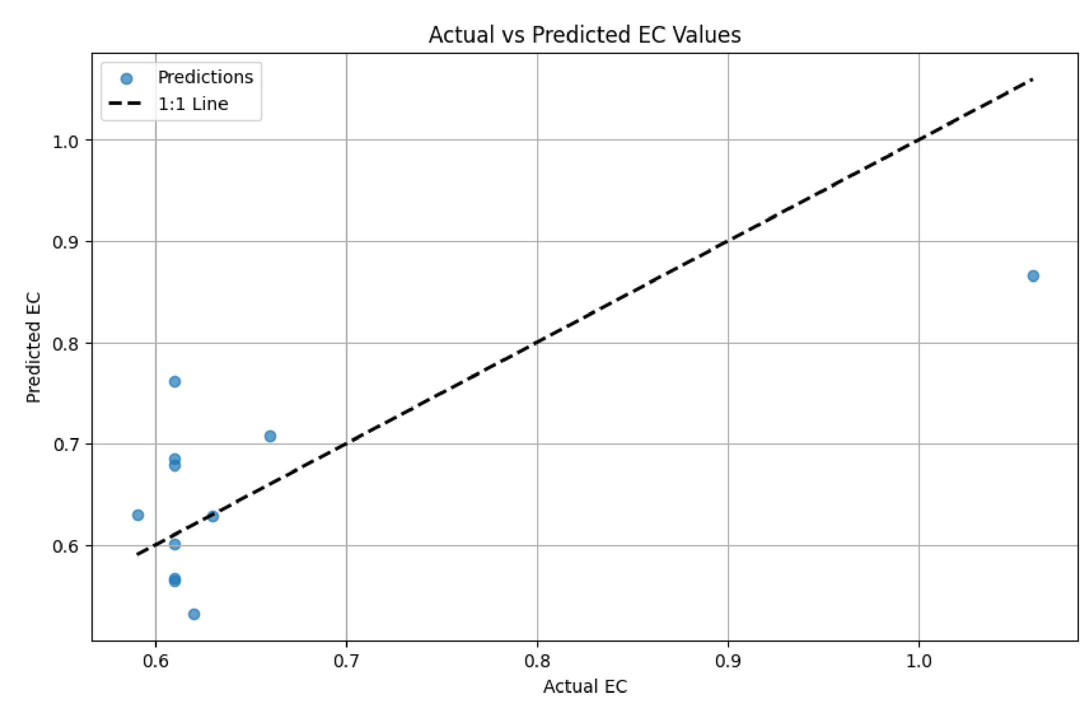

Figure 6: Graphical Representation of Relationship between Actual and Predicted EC Values

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