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# High-Resolution Soil Organic Carbon Mapping Using Sentinel-2 and Gaussian Process Regression on Google Earth Engine

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## INTRODUCTION & AIM

Accurate assessment of soil organic carbon (SOC) is fundamental to evaluating risks of land degradation, soil fertility decline, and climate-related vulnerabilities in rapidly transforming urban–agricultural landscapes. This study presents a remote-sensing-driven SOC estimation framework that integrates Sentinel-2 multispectral imagery, Gaussian Process Regression (GPR), and Google Earth Engine (GEE) to produce high-resolution SOC maps for the ICAR–Indian Agricultural Research Institute (ICAR-IARI) region of New Delhi, India.

## METHOD

Soil fertility parameter value | Sentinel -2 spectra

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Machine Learning using Gaussian Process Regression (GPR)

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Migrating GPR model to GEE

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Choose an image of a particular date

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Apply soil mask (remove vegetation, water, and urban areas using NDVI, NDWI, NBAI)

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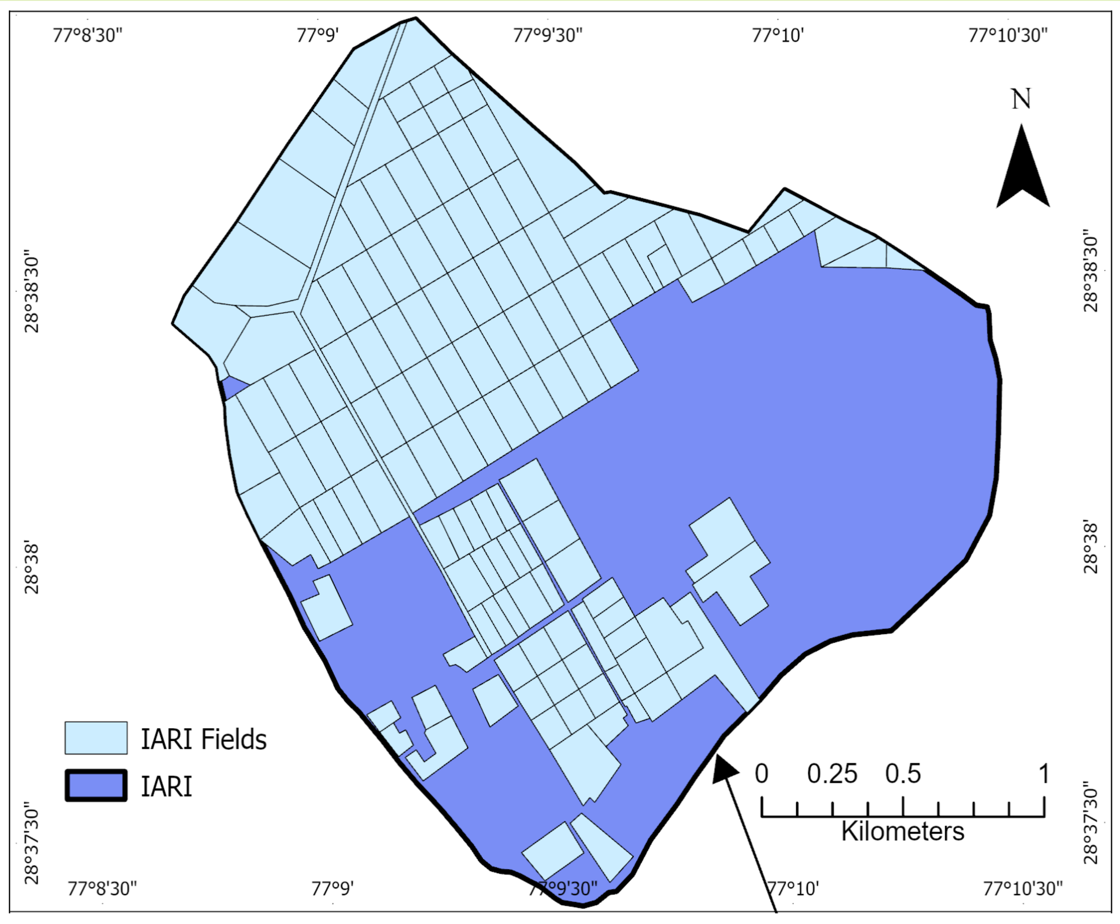
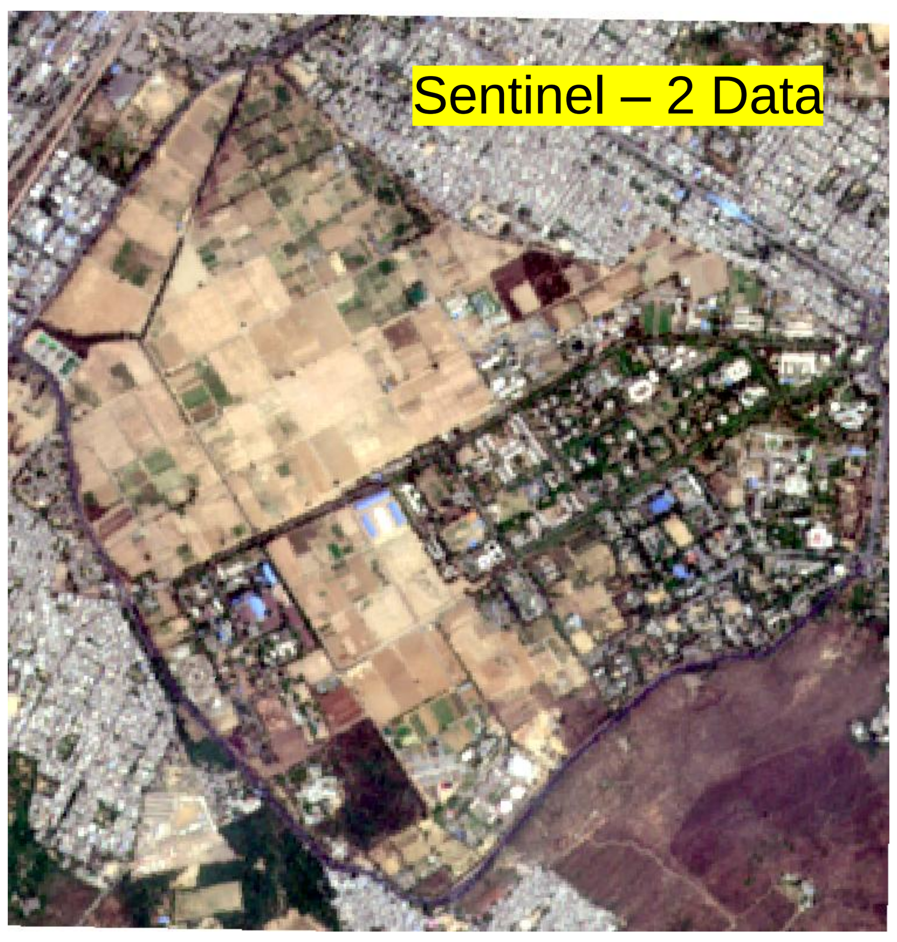
Soil Parameter Map

- Ground-measured soil fertility parameters were paired with Sentinel-2 surface reflectance spectra to train a GPR model, which achieved strong predictive performance ($R^2$ = 0.67, RMSE = 0.099, MAE = 0.075) across 78 soil samples.
- The trained model was then migrated into GEE to enable scalable, cloud-based SOC prediction. A cloud-free Sentinel-2 image acquired on 25 May 2018 was used, and a multi-index soil mask (NDVI, NDWI, NBAI) was applied to remove vegetation, water bodies, and impervious surfaces, thereby ensuring SOC mapping was limited to exposed soil.
- The resulting SOC map demonstrates clear spatial variability influenced by land use, irrigation patterns, and management practices, highlighting zones of lower carbon content that may be at higher risk of degradation.

## RESULTS & DISCUSSION






## CONCLUSION

By combining machine learning with openly accessible satellite data and cloud computation, this framework provides a rapid, transferable method for soil-quality risk assessment. The approach supports evidence-based planning, monitoring of anthropogenic impacts on soil health, and identification of priority zones for carbon-enhancing interventions, contributing to broader goals of sustainable land management and climate-impact mitigation.

## FUTURE WORK / REFERENCES

Extensive validation over a large area, various soil types and textures.