Assessment of Soil Organic Carbon Following Wildfires in Northern Evia, Greece: A Digital Soil Mapping Approach

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Introduction

Climate change is profoundly impacting regions such as the Mediterranean, where wildfires are escalating in frequency and intensity. Amplified by rising temperatures and prolonged droughts, these fires not only devastate landscapes but also trigger secondary environmental hazards, particularly soil erosion. They significantly alter soil properties, rendering the land more susceptible to erosion due to the loss of vegetation cover and the destabilization of soil structure. Monitoring changes in Soil Organic Carbon (SOC) in fire-affected areas is crucial for understanding the long-term impacts on soil health and ecosystem resilience.

Focusing on the wildfire-stricken region of Northern Evia, Greece, we utilized open Copernicus data, namely Sentinel-2 optical data and the European Digital Elevation Model (DEM), to apply a **digital soil mapping analysis** to map topsoil SOC content in the croplands. The study area encompasses 28 sq. km with 49% of the crops being tree crops (mostly olive groves) while the rest are seasonal.

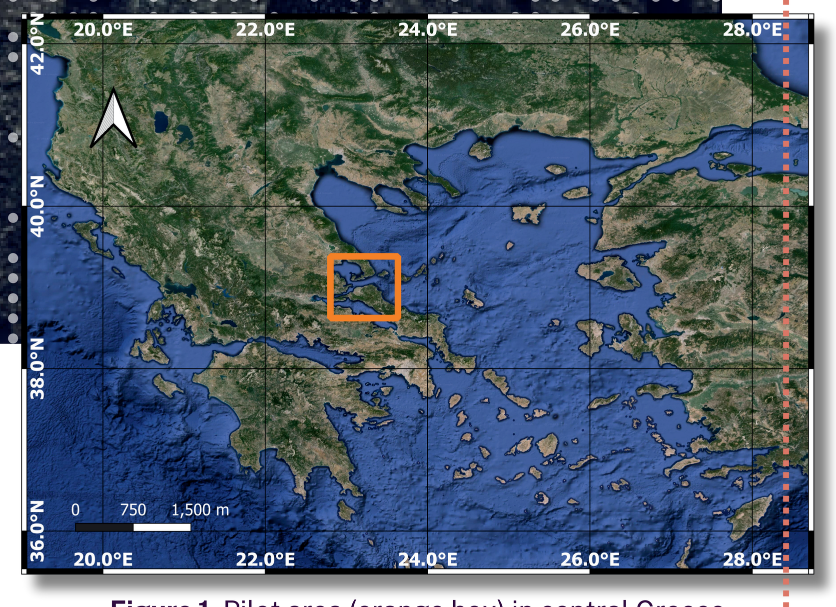

Figure 1. Pilot area (orange box) in central Greece.

The study area was adjacent to a mountainous terrain covered with forests that was burned down in the experienced wildfires

Analysis

SOIL MEASUREMENTS

Sampling was performed by examining bare soil reflectance composites and performing clustering for the seasonal crops, while random sampling was conducted for perennial crops. 38 soil samples were collected and analyzed in the laboratory using the Walkley–Black to quantify SOC levels.

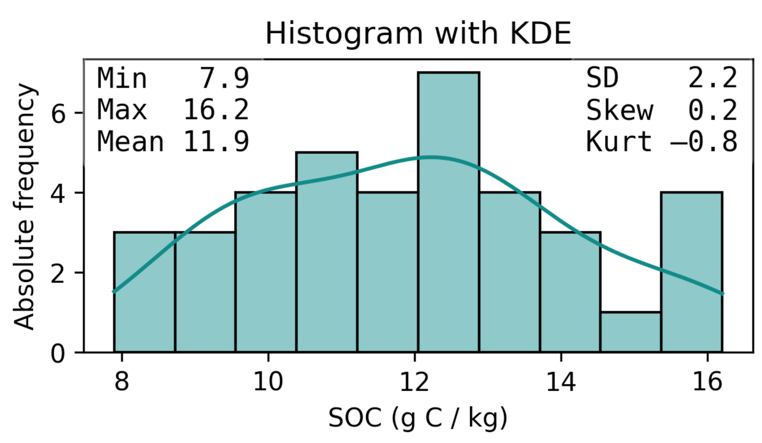

Figure 2. Distribution of SOC content of the collected field samples.

AI MODELLING

The **Random Forest (RF)** learning algorithm was employed using **leave-one-out cross-validation** to infer SOC from the Sentinel-2 and DEM data. At each fold, the RF model was optimized using grid search. The final SOC map resulted as the mean prediction across all models. The final prediction image was masked using the scene classification layer of Sentinel-2 and the 2018 CORINE Land Cover data.

RESULTS

The RF regression model attained an acceptable accuracy of estimation (scatter plot below), despite the relative low variance of the data and relying solely in optical remote sensing and elevetation data.

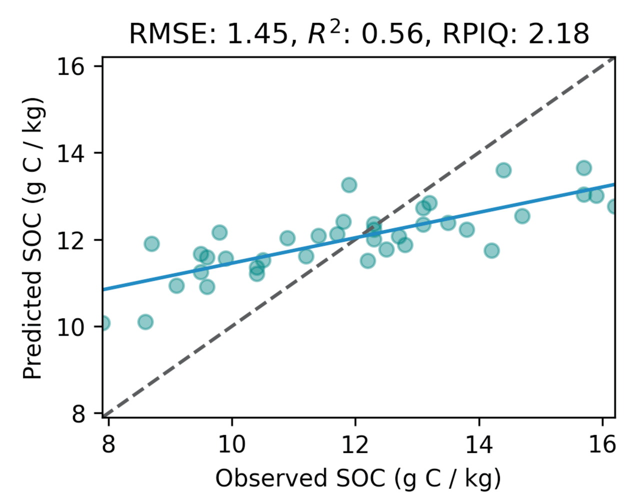

Figure 3. Scatterplot depicting the model's accuracy in the independent test set.

From point soil data ...

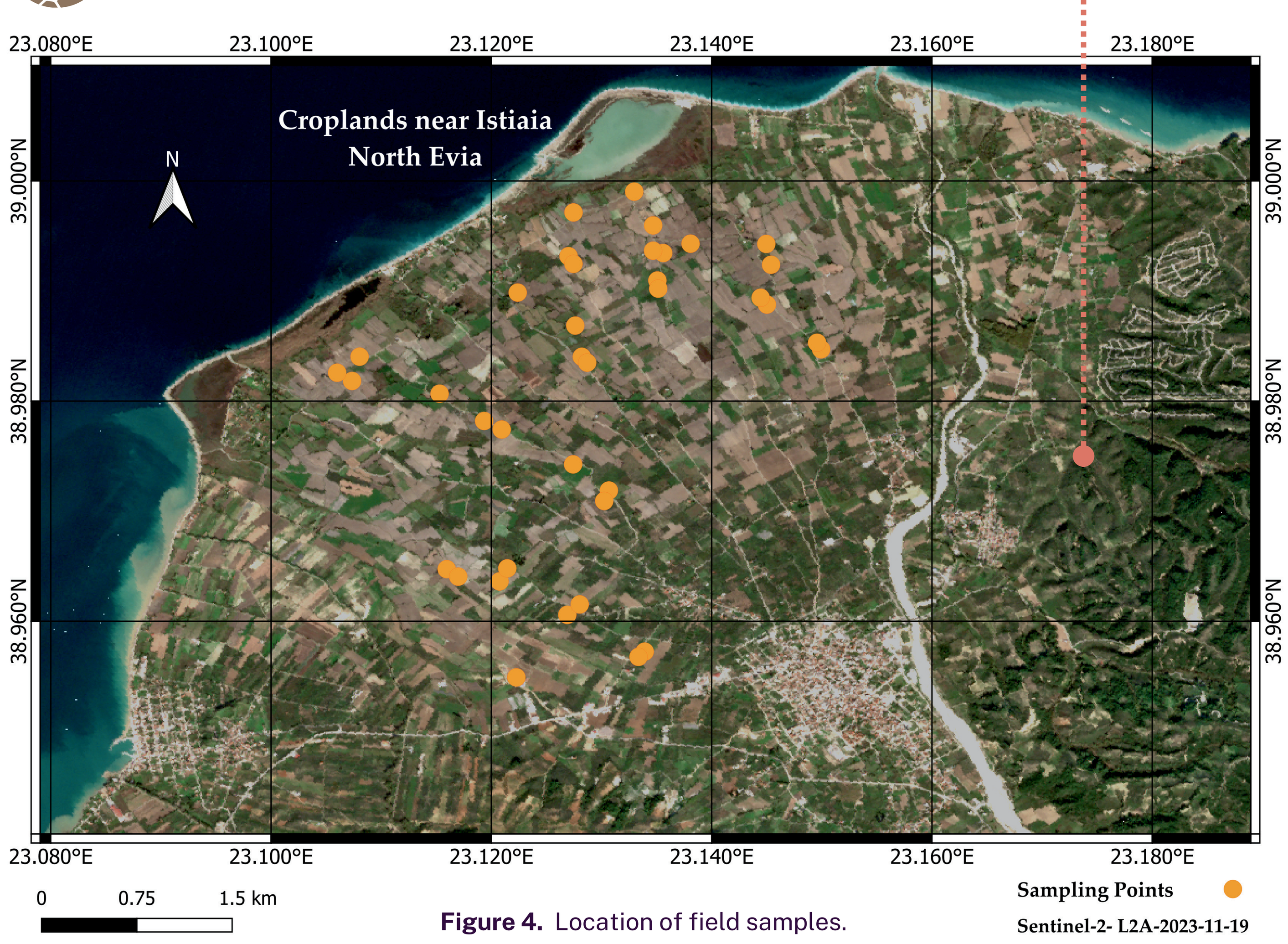

Figure 4. Location of field samples.

... to AI-based prediction map

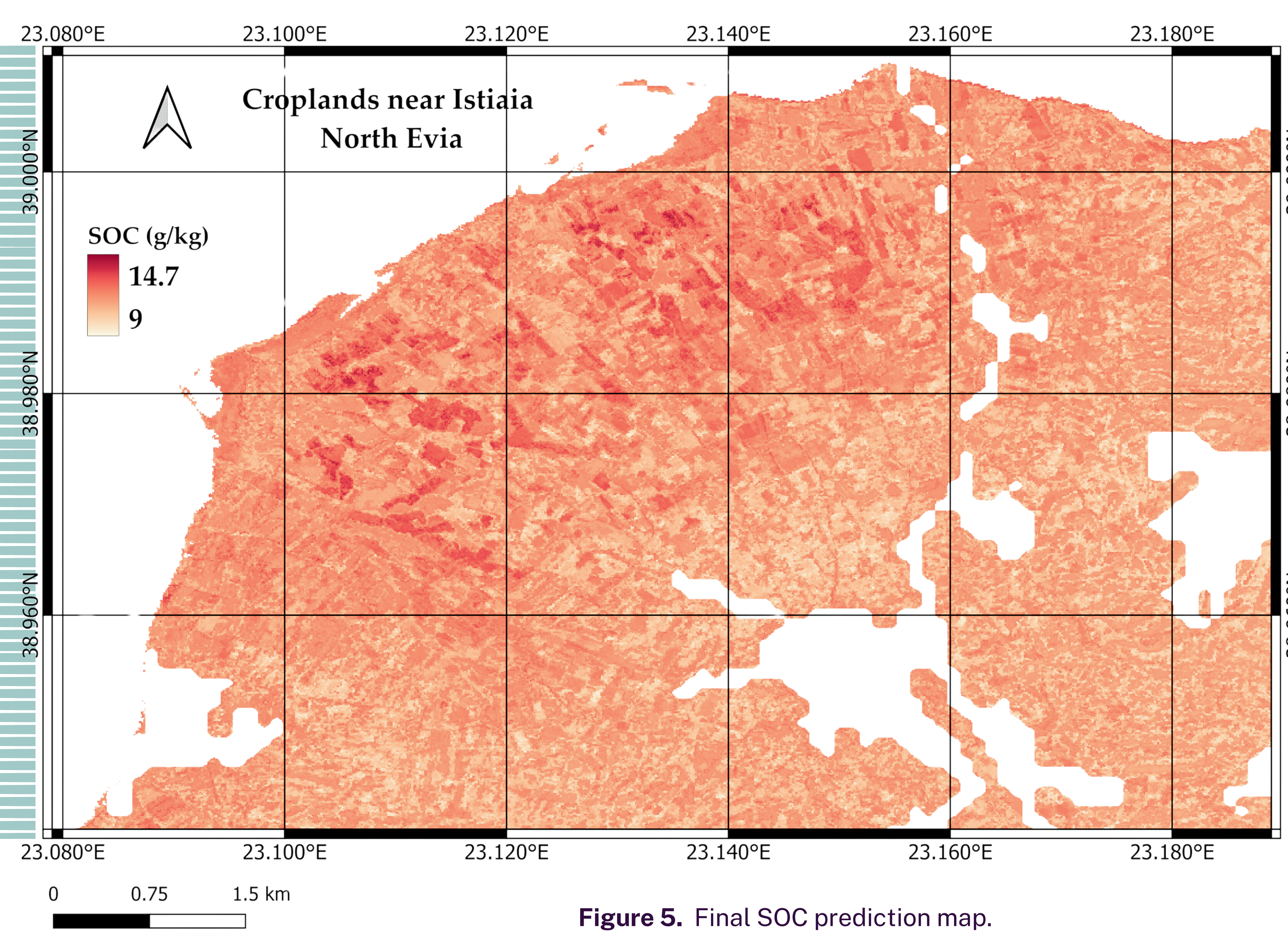

Figure 5. Final SOC prediction map.

Our digital soil map

Conclusions

Through the amalgamation of satellite-based assessments and laboratory-validated soil measurements, our research offers **a comprehensive overview of the alterations in SOC distribution following the wildfire event**. The detailed mapping conducted after the wildfire stands as a crucial contribution **to understanding the spatial and temporal variations in soil properties and erosion susceptibility** within the wildfire-affected region of Northern Evia, Greece.

To explore more about our work, scan here:

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