Assessing the impact of uncertainty in global soil property datasets on soil erosion predictions

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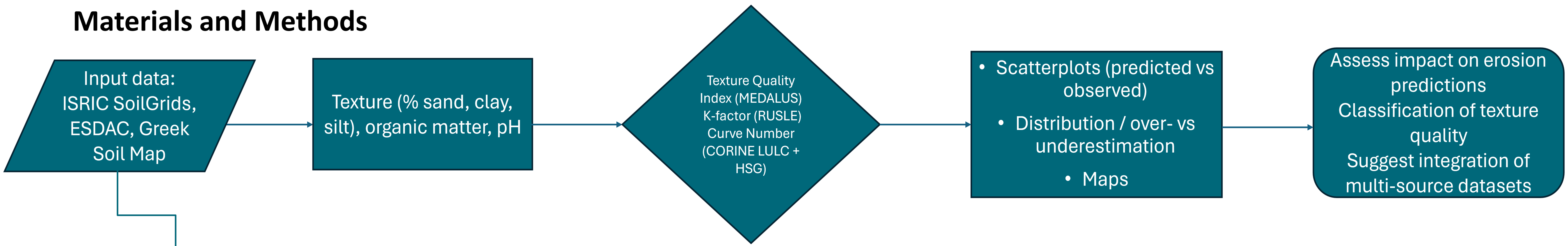
Study Overview

- Soil maps are vital for agriculture, hydrology, climate, and erosion risk assessment.
- Traditional (Greek Soil Map) and digital datasets (ISRIC SoilGrids, ESDAC) contain uncertainties that affect erosion predictions.
- European (ESDAC) and global (ISRIC SoilGrids) soil datasets were compared on accuracy and representativeness against national (Greek Soil Map) soil data, focusing on soil properties, soil texture quality (Texture Quality Index TQI – MEDALUS) [1] and the RUSLE K-factor [2].
- Curve Number (CN) was estimated to evaluate impacts on runoff prediction
- Results reveal dataset discrepancies and highlight the need for improved soil data integration for reliable erosion modeling

Materials and Methods



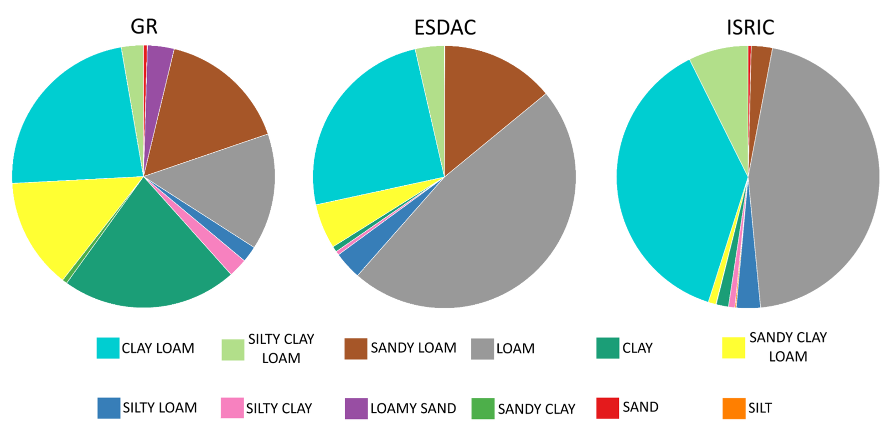


Figure 1: Distribution of soil texture classes based on the values of sand, clay, and silt fractions for each of the three datasets (GR, ESDAC, ISRIC).

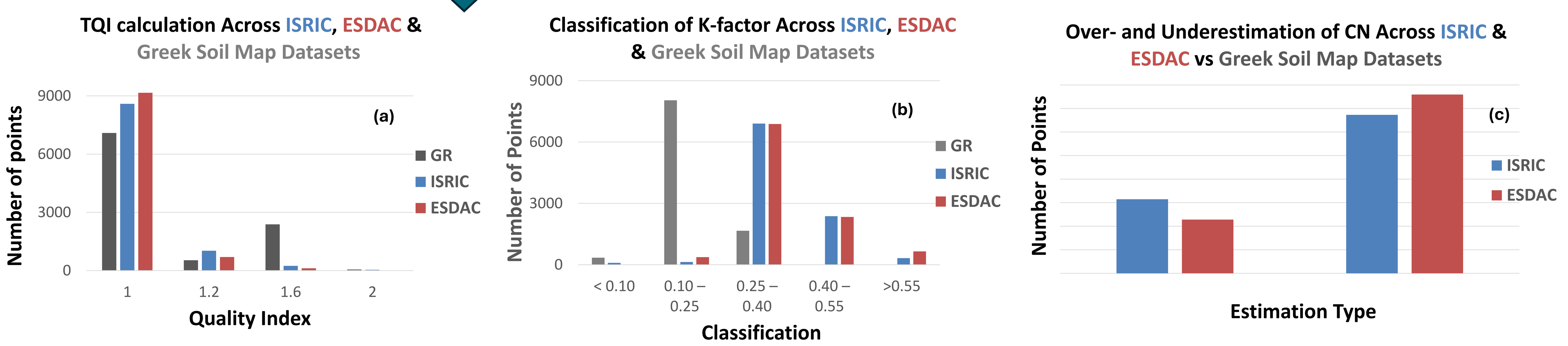


Figure 2: **(a)** Texture Quality Index (TQI) calculation across ISRIC, ESDAC and Greek Soil Map datasets 1.0 High quality soils with medium textures, 1.2-1.6 moderate-quality soils with sandy-clay or clay-loam, 2.0 low-quality soils with very sandy or very heavy clay textures, **(b)** classification of K soil erodibility factor across ISRIC, ESDAC and Greek Soil Map datasets, which influences RUSLE soil erosion estimation model **(c)** Over- and underestimation of CN by ISRIC and ESDAC compared to the Greek Soil Map dataset.

Soil erodibility factor (K) a significant influencing factor of RUSLE soil erosion estimation model

$$K=[(0.043\times pH)+(0.62\div OM)+(0.0082\times S)-(0.0062\times C)]\times Si$$

pH=pH of the soil
OM = Organic Matter in percent
S = Sand content in percent
C = Clay ratio (%clay / %sand + %silt)
Si = Silt content = %silt / 100

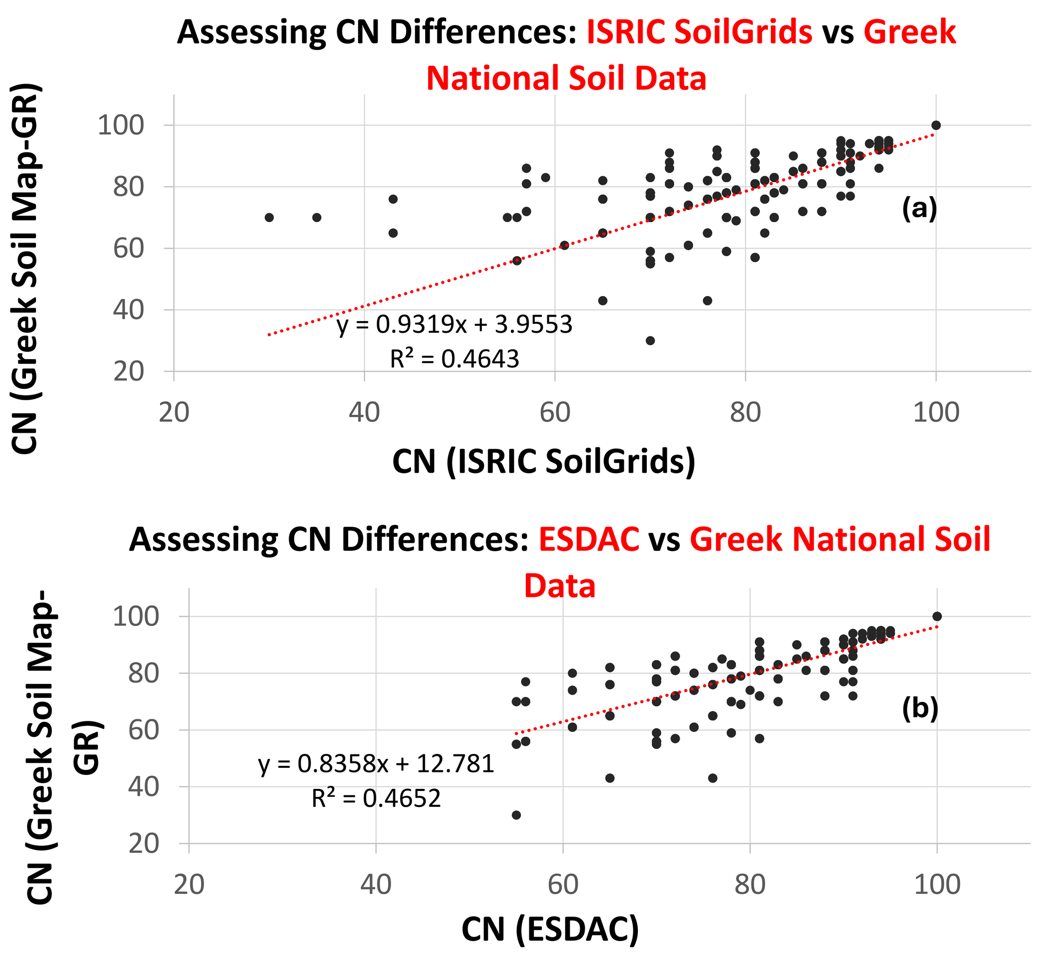


Figure 3: Scatterplot comparing predicted Curve Numbers (CN) from the **(a)** ISRIC SoilGrids dataset and **(b)** ESDAC dataset with observed CN values from the Greek National Soil Map.

Results and Discussion

- **Soil property comparisons**: Significant discrepancies found in texture (sand, silt, clay), between ISRIC, ESDAC, and the Greek Soil Map.
- **Texture Quality Index (TQI - MEDALUS):** Evaluation regarding whether global datasets (ESDAC, ISRIC) classify texture quality differently from the national map (Figures 2a, 4a, b), potentially altering desertification risk maps.
- **K-factor (RUSLE):** Both ISRIC and ESDAC datasets showed deviations in K-factor values, resulting in differentiated erodibility (Figure 2b).
- **Curve Number (CN):** CN values from global and European datasets often over- or underestimated observed values; spatial variability of errors was high (Figure 2c, 3a,b).
- **Spatial patterns:** Discrepancies were not uniform—larger errors occurred in regions with distinct soil characteristics and complex terrain.
- **Overall finding:** Dataset uncertainties can significantly influence soil erosion predictions, underlining the need for integrating national data into global products.

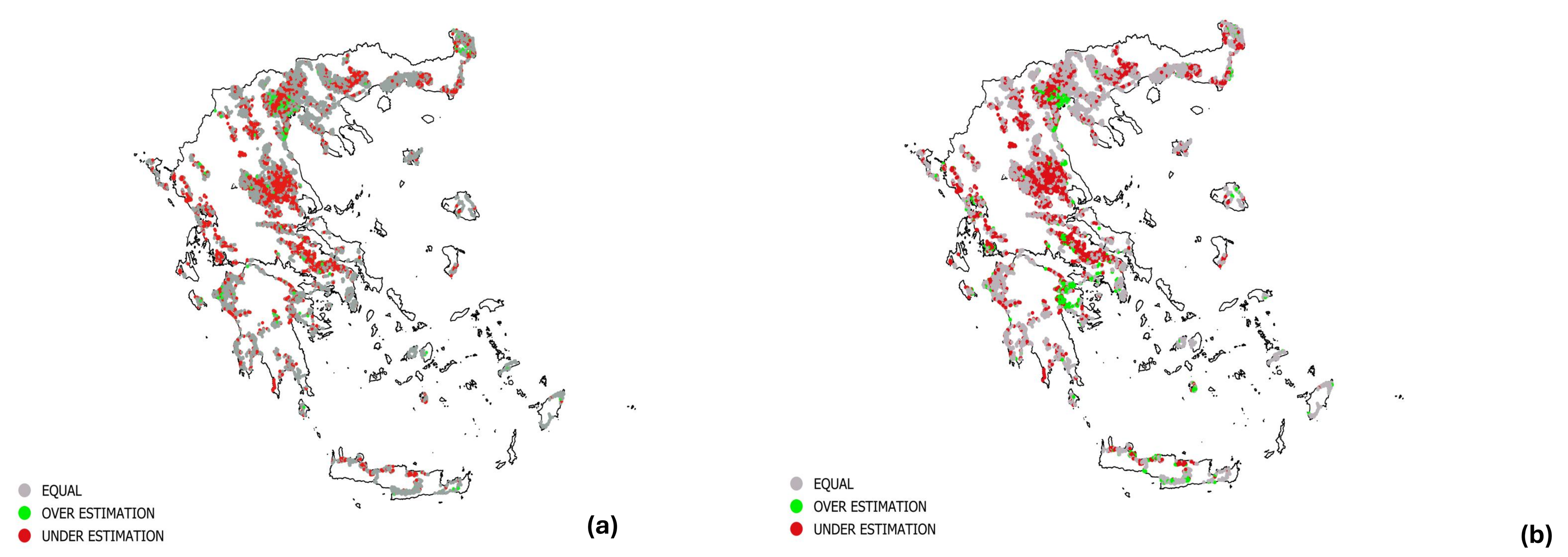


Figure 4: Map of texture quality index over- or underestimation versus Greek Soil dataset using (a) ESDAC (b) ISRIC

References

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[2]: Ghosal, K., Das Bhattacharya, S. A Review of RUSLE Model. *J Indian Soc Remote Sens* **48**, 689–707 (2020). https://doi.org/10.1007/s12524-019-01097-0

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