Tropentag, September 10-12, 2025, hybrid conference

"Reconcile land system changes
with planetary health"

Comparison of global soil databases with measured soil data across western Germany and northern Ghana

Sanghyo Moon, Thuy Huu Nguyen, Dominik Behrend, Thomas Gaiser

University of Bonn, Inst. Crop Sci. and Res. Conserv. (INRES), Germany

Abstract

Soil is an indispensable input for agro-ecosystem models in simulating soil-plant processes and yield. The recent publication of several global gridded soil databases with varying spatial resolutions offers possibilities for modelling at different scales. Despite the high spatial heterogeneity of soils and the availability of measured data, the accuracy of these databases remains uncertain. This study aimed to evaluate and compare the uncertainty of soil information – bulk density, soil organic carbon (SOC), total nitrogen (TN), and soil texture (sand, silt, and clay) – in North Rhine-Westphalia (NRW, Germany) and Northern Ghana provided by two global gridded data sources: SoilGrids and FAO's Harmonized World Soil Database 2.0. Measured profile data were used as a reference. We proceeded in three main steps: 1) retrieving global gridded soil data in locations equivalent to those where soil profile properties were measured; 2) harmonising the three data sources by aligning locations, units, names of variables, and depth layers; and 3) statistically comparing soil properties of the harmonised data with three soil layers (0–30 cm, 30–60 cm, and 60–100 cm). The harmonised data includes, in total, 230 locations with 2053 layers from NRW, Germany, and 32 locations with 277 layers from Northern Ghana. There were four notable key findings: 1) ANOVA results show statistically significant differences ($p < 0.05$) among datasets across two countries, except for bulk density in Ghana; 2) spatial clay content maps reveal high local variation in measured data, whereas SoilGrids and HWSD provide generalised distributions; 3) SoilGrids data exhibits stronger correlations among all soil properties in Germany with the higher correlation coefficient (r^2) values, while both databases show inconsistent differences in r^2 values in Ghana; 4) Overall, both databases exhibit negative r^2 values – except for sand, silt, and clay content in Germany – where greater measured data availability for map creation can be expected. These findings highlight the local soil heterogeneity, the importance of measured soil data availability, and the uncertainty of global soil databases when applied to specific point locations. Investigating uncertainties in ecosystem service simulations is essential for agro-ecosystem modelling that relies on global soil databases.

Keywords: Data harmonisation, global soil databases, soil data scarcity, soil properties

Contact Address: Sanghyo Moon, University of Bonn, Inst. Crop Sci. and Res. Conserv. (INRES), Auf dem hügel 6, 53121 Bonn, Germany, e-mail: moon.sanghyo@gmail.com