EGU21-7836, updated on 28 May 2022
https://doi.org/10.5194/egusphere-egu21-7836
EGU General Assembly 2021

BIS-3D: high resolution 3D soil maps for the Netherlands using accuracy thresholds

Anatol Helfenstein[1,2], Vera Leatitia Mulder[1], Gerard B.M. Heuvelink[1], and Joop Okx[2]
[1]Wageningen University, Soil Geography and Landscape, Environmental Sciences Group, Wageningen, Netherlands (anatol.helfenstein@wur.nl)
[2]Soil, Water and Land Use Team, Wageningen Environmental Research, Droevendaalsesteeg 3, 6708 RC Wageningen, The Netherlands

Since the establishment of Digital Soil Mapping (DSM) as a research field, the main focus has been on implementing new methods to improve the predictive performance of soil maps. However, considerably less effort has been invested in investigating the best way to communicate the quality of soil mapping products with users. This is essential for soil maps to be adopted by a broader community, future research guidance and most importantly, to ensure that they are used correctly. We introduce a high-resolution 3D soil modelling and mapping platform for the Netherlands (BIS-3D) using a quantile regression forest (QRF) for spatial interpolation approach that includes an assessment of the map quality using GlobalSoilMap (GSM) accuracy thresholds. Our objectives are twofold: a) providing accurate and high-resolution (25m) soil pH, soil organic carbon, and soil texture (clay, silt, and sand) maps over 3D space including prediction uncertainty; and b) providing an intuitive way to communicate accuracy of soil maps for users by means of accuracy thresholds. In this work, the first outputs of the modelling and mapping platform BIS-3D are being presented.

QRF models were trained and validated, yielding average predictions for each target location and depth as well as the 90% prediction interval. Predicted soil maps were evaluated using an independent validation data set based on a stratified random sampling design covering the entire Netherlands (1151 locations). Furthermore, at every validation location, predictions were assessed as A, AA or AAA quality using the GSM specifications.

First results for soil pH (KCl) using 15887 soil observations between depths 0-2 m and 180 covariates reveal a mean square error skill score (SS_{mse}) = 0.88, RMSE = 0.49 and bias = 0.01 for out of bag predictions. Model evaluation using the independent validation set resulted in SS_{mse} = 0.66, RMSE = 0.81 and bias = 0.12 across all depths. Prediction accuracy was highest for depths between 0-15 cm (SS_{mse} = 0.66, RMSE = 0.76) and 60-100 cm (SSmse = 0.69, RMSE = 0.78) and lowest for 100-200 cm (SSmse = 0.61, RMSE = 0.86). The soil measurement (observation) was within the 90% prediction interval of model predictions in 83% of the cases, indicating that QRF is slightly over-optimistic in quantifying the prediction uncertainty. 61% of predictions that were independently validated over all depths were within the highest GSM accuracy threshold (AAA = +/- 0.5 pH), 23% were AA (+/- 1.0 pH), 9% were A (+/- 1.5 pH) and the remaining 7% were below A. A categorical

physical geography map was the most important covariate, although other covariates associated with relief, geomorphology, land use and temperature were also effective. However, such variable importance measurements are merely indications and should be handled with care. The BIS-3D can easily be extended for predicting additional soil properties and it may provide a basis for decision makers to easily assess to what extent and in which areas soil maps can be used for their applications.