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Large-extent digital soil mapping approaches for total soil depth

Titia Mulder (1), Marine Lacoste (2), Nicolas P.A. Saby (1), and Dominique Arrouays (1)

(1) INRA, US 1106 Infosol, F 45075, Orléans, France (vlmulder0@gmail.com, (2) INRA, UR 0272 Science du sol, F45075 Orléans, France

Total soil depth (SDt) plays a key role in supporting various ecosystem services and properties, including plant growth, water availability and carbon stocks. Therefore, predictive mapping of SDt has been included as one of the deliverables within the GlobalSoilMap project.

In this work SDt was predicted for France following the directions of GlobalSoilMap, which requires modelling at 90m resolution. This first method, further referred to as DM, consisted of modelling the deterministic trend in SDt using data mining, followed by a bias correction and ordinary kriging of the residuals. Considering the total surface area of France, being about 540K km2, employed methods may need to be able dealing with large data sets. Therefore, a second method, multi-resolution kriging (MrK) for large datasets, was implemented. This method consisted of modelling the deterministic trend by a linear model, followed by interpolation of the residuals. For the two methods, the general trend was assumed to be explained by the biotic and abiotic environmental conditions, as described by the Soil-Landscape paradigm. The mapping accuracy was evaluated by an internal validation and its concordance with previous soil maps. In addition, the prediction interval for DM and the confidence interval for MrK were determined. Finally, the opportunities and limitations of both approaches were evaluated.

The results showed consistency in mapped spatial patterns and a good prediction of the mean values. DM was better capable in predicting extreme values due to the bias correction. Also, DM was more powerful in capturing the deterministic trend than the linear model of the MrK approach. However, MrK was found to be more straightforward and flexible in delivering spatial explicit uncertainty measures. The validation indicated that DM was more accurate than MrK. Improvements for DM may be expected by predicting soil depth classes. MrK shows potential for modelling beyond the country level, at high resolution. Large-extent digital soil mapping approaches for SDt may be improved by (1) taking into account SDt observations which are censored and (2) using high-resolution biotic and abiotic environmental data. The latter may improve modelling the soil-landscape interactions influencing soil pedogenesis. Concluding, this work provided a robust and reproducible method (DM) for high-resolution soil property modelling, in accordance with the GlobalSoilMap requirements and an efficient alternative for large-extent digital soil mapping (MrK).