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Use of proximal soil sensing to improve the thematic accuracy of a soil-polygon map

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The thematic accuracy, defined as the degree to which the attribute information in a map agrees with reality, is often found to be low in classical polygon-based soil maps compiled from national soil surveys. This is especially relevant for soil attributes for which the variability cannot be accurately inferred using the methodology employed in conventional soil survey. The use of such soil data bases to aid sustainable land use decision making can lead to false land use decisions resulting irreversible environmental damages. Therefore, improvement of thematic accuracy of national soil maps is required for their credible use. Soil investigation by intensive soil sampling is not suitable for this due to cost and time constraints. Therefore, exploring cost effective techniques are needed.

This study was conducted to investigate the utility of apparent electrical conductivity (EC_a) measured with an EM38DD sensor to improve the thematic accuracy of the Belgian national soil map published at a 1:20000 cartographic scale. The depth to a tertiary clay layer (D_{cl}) was considered as the target variable for thematic accuracy improvement. The soil map of the 14-ha study area revealed a presence of this layer at deep ($>$ 1.25 m). In contrast, auger observations revealed a presence of the Tertiary clay layer at a shallow (0.4 m – 1.25 m) to deep ($>$ 1.25 m). The EC_a measured with vertical dipole mode (EC_a-V) of the EM38DD sensor showed a strong exponential relationship with D_{cl} (R^2 = 0.80). Therefore, we used the hybrid interpolation technique, regression kriging to estimate D_{cl} in the entire study area by incorporating sparse D_{cl} observations with densely measured EC_a. These estimations were validated using a

set of independent observations of D_{cl} and a higher prediction accuracy was found (r = 0.95 and mean estimation error = 0.02 m). Therefore, the boundaries of the mapping units of the 1:20000 map were reallocated according to its map legend using the predicted D_{cl}. The resulted map partitioned the study area into six soil series variants. The thematic accuracy of the resulted map was investigated by calculating the measure of overall accuracy (θ_1) and the kappa index of agreement (κ) using 46 ground truth D_{cl} observations. The outcome showed an excellent agreement of improved map with the reality (θ_1 = 0.90 and κ = 0.82) in comparison to the original 1:20000 map (θ_1 = 0.60 and κ = 0.0). Also, the result was slightly superior to the 1:5000 soil map specifically compiled for the study area (θ_1 = 0.80 and κ = 0.7). We concluded that EC_a-V measurement from EM38DD can be used to improve the thematic accuracy of the national soil map of Belgium by reallocating the map unit boundaries in relation to D_{cl}.