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Estimating Soil Organic Carbon stocks and uncertainties at the regional scale following a legacy sampling strategy - a case study from southern Belgium

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The quantification and the spatialisation of reliable SOC stocks (Mg C ha-1) and total stock (Tg C) baselines and associated uncertainties are fundamental to detect the gains or losses in SOC, and to locate sensitive areas with low SOC levels. Here, we aim to both quantify and spatialize SOC stocks at regional scale (southern Belgium) based on data from one non-design-based nor model-based sampling scheme. To this end, we developed a computation procedure based on Digital Soil Mapping techniques and stochastic simulations (Monte-Carlo) allowing the estimation of multiple (here, 10,000) independent spatialized datasets. The computation of the prediction uncertainty accounts for the errors associated to the both estimations of i) SOC stock at the pixel-related area scale and ii) parameters of the spatial model. Based on these 10,000 individuals, median SOC stocks and 90% prediction intervals were computed for each pixel, as well as total SOC stocks and their 90% prediction intervals for selected subareas and for the entire study area. Hence, a Generalised Additive Model (GAM) explaining 69.3 % of the SOC stock variance was calibrated and then validated (R^2 = 0.64). The model overestimated low SOC stock (below 50 Mg C ha-1) and underestimated high SOC stock (especially those above 100 Mg C kg-1). A positive gradient of SOC stock occurred from the northwest to the center of Wallonia with a slight decrease on the southernmost part, correlating to the evolution of precipitation and temperature (along with elevation) and dominant land use. At the catchment scale higher SOC stocks were predicted on valley bottoms, especially for poorly drained soils under grassland. Mean predicted SOC stocks for cropland and grassland in Wallonia were of 26.58 Tg C (SD 1.52) and 43.30 Tg C (2.93), respectively. The procedure developed here allowed to predict realistic spatial patterns of SOC stocks all over agricultural lands of southern Belgium and to produce reliable statistics of total SOC stocks for each of the 20 combinations of land use / agricultural regions of Wallonia. This procedure appears useful to produce soil maps as policy tools in conducting sustainable management at regional and national scales, and to compute statistics which comply with specific requirements of reporting activities.