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SOC stock changes in Belgian Agricultural soils between 1960 and 2006

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Given the importance of soil organic carbon (SOC) as a pool in the global carbon cycle and an indicator for soil quality, there exits an urgent need to monitor this dynamic soil property. Here we present a modelling approach to analyse the spatial patterns and temporal evolution of organic carbon in mineral soils under agricultural land use in Belgium. An empirical model, predicting the SOC concentration in top 0.3 metres, as a function of precipitation, land use, soil type and management has been constructed and applied within a spatial context using data from different time slices. Furthermore, we conducted a detailed study considering SOC distribution with depth. The results show that SOC content is strongly correlated with precipitation and temperature under cropland and with texture and drainage under grassland. Total SOC stock increased with 1.3% from 6.18 $\pm$ 0.03 kg C m-2 in 1960 to 6.26 $\pm$ 0.07 kg C m-2 in 2006. Although this increase was not significant ($p>0.05$), a significant discrepancy between cropland (-8%) and grassland (+10%) was observed. Foremost, the grasslands in the hilly southern part of the country, under relatively wet climate conditions, acted as important sinks of CO_2. Under cropland, all soil types were characterized by a decrease in SOC, except for the clay soils in the north-west. Currently, croplands in the central loam region have SOC concentrations close to 10 g kg-1 indicating that these soils are at risk of a decline in aggregate stability. Temporal analysis of SOC depth distributions confirmed this trend by showing a significant decrease of carbon near the surface for dry silt loam cropland soils in the top 0.3 m (i.e. 1.02 $\pm$ 0.23 kg C m-2). The latter can be probably related to changed management, such as a remarkable increase in tillage depth calculated at 0.079 $\pm$ 0.031 m or a change in crop rotation. An overall strong SOC decrease in poorly drained soils is probably caused by artificial drainage. Detailed depth distribution information indicates that this decrease is restricted to the topsoil and that total loss of SOC in the top 1 m ranges from 3.99 $\pm$ 2.57 kg C m-2 in extremely wet silt loam soils to 2.04 $\pm$ 2.08 kg C m-2 in wet sandy soils. Further research is needed to gain more insight into the processes driving the observed SOC trends. Moreover, the use of updated drainage class information and land management history would improve the empirical models.