Territorial mapping to reduce the mismatch between soil organic carbon stocks and potential storage capacity

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Abstract

The ‘4 per 1000’ initiative aims to increase soil organic carbon stocks to offset carbon dioxide emissions. For a French case study, this graphic offers evidence of the links between carbon stocks and agricultural productions at the territorial level: stocks are positively associated to animal loads, whereas soils with arable crops have much lower stocks despite a higher storage potential. Territorial mapping of both storage capacities and organic resources is needed to optimize soil carbon storage.

The ‘4 per 1000’ initiative aims to increase soil organic carbon (SOC) stocks by 0.4% per year to offset carbon dioxide emissions from human activities. Understanding the determinants explaining the distribution of current SOC stocks is an important step towards achieving this target. Here, the Puy-de-Dôme department[1] was chosen as case study because of a wide diversity of soils and agricultural productions. The Limagne plain, specialising in arable crops, is surrounded by mountain ranges specialising in livestock breeding on grasslands.

Soil characteristics come from the SoilGrids project[2] [1], statistical data from the French agricultural census [2] and elevation from the French Digital Elevation Model BD ALTI ® [3]. Animal load was calculated as the ratio of livestock units to total agricultural area at municipality level. For municipalities where the herds were concentrated in a small number of farms, data on animal numbers were restricted to preserve anonymity and animal loads could not be calculated.

Figure 1 shows a clear difference in SOC stocks between the plain and the mountains, which can be partly related to agricultural productions. For the Limagne plain, it has already been shown that SOC stocks had decreased following the specialization in cereal production, which led to reduction in manure spreading and replacement of grassland with crops [4]. Consequently, it appears that there is a mismatch between potential SOC storage capacities and current stocks: while clay soils have the highest storage potential [5], they have the lowest stocks here. Beyond this case study, this trend can be observed in several territories, with the segregation of crop and livestock productions. Crops are mainly cultivated on soils with high storage potential, but with little organic inputs, such as manure. Mapping of both storage capacities and available resources is a first step to optimize soil carbon storage. The territorial level is a key scale for carrying out such work because of the constraints related to the transportation of organic inputs.

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[1] French departments are administrative entities of intermediate size, between municipalities and regions.

[2] SoilGrids combines soil observations, remote sensing and machine learning to create digital soil maps.

References

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Figure

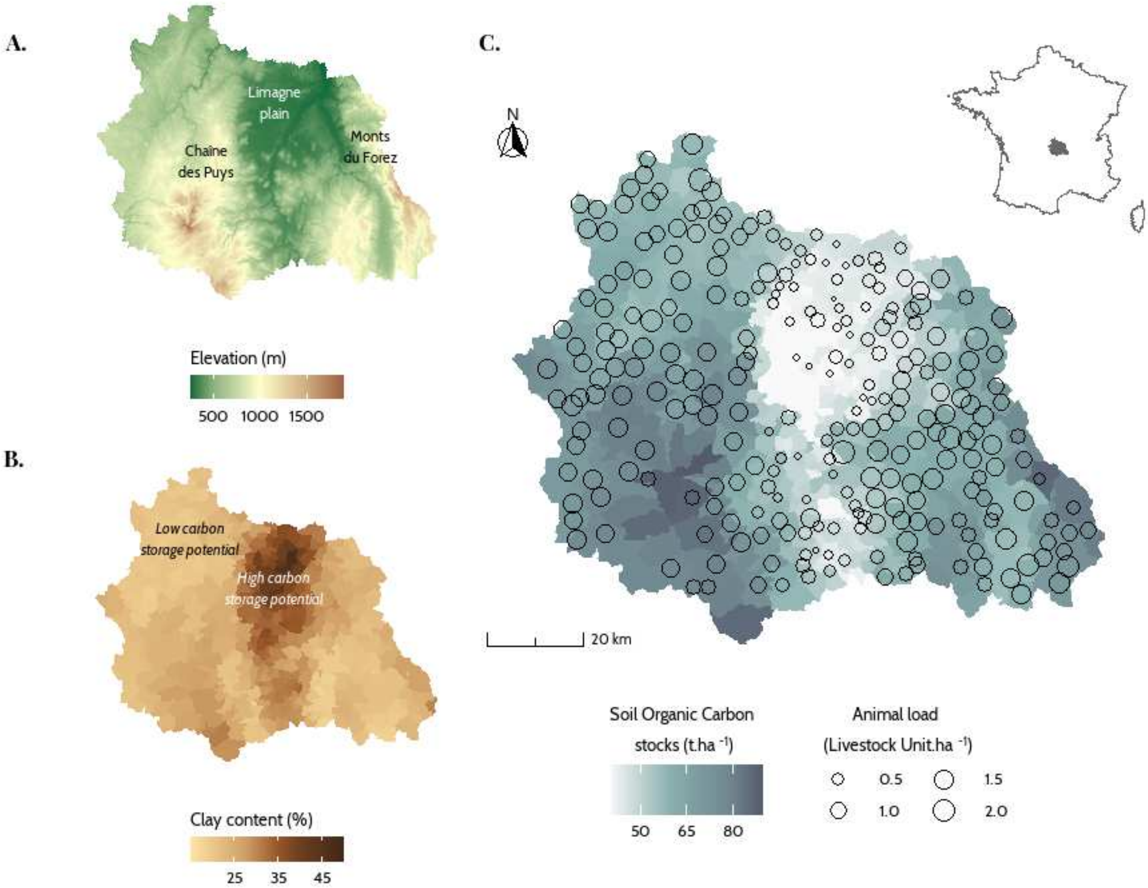

Figure 1 A: Elevation for the Puy-de-Dôme department (France). **B**: Clay content from 15 to 30cm depth. **C:** Soil organic carbon stocks from 0 to 30cm depth and animal load per municipality.