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Modelling soil carbon flows and stocks following a carbon balance approach at regional scale for the EU-27

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Soil Organic Carbon (SOC) is a key parameter to many soil functions and services. SOC is essential to support water retention and nutrient buffering and mineralization in the soil as well as to enhance soil biodiversity. Consequently, loss of SOC or low SOC levels might threaten soil productivity or even lead to a collapse of a farming system. Identification of areas in Europe with critically low SOC levels or with a negative carbon balance is a challenge in order to apply the appropriate strategies to restore these areas or prevent further SOC losses. The objective of this study is to assess current soil carbon flows and stocks at a regional scale; we follow a carbon balance approach which we developed within the MITERRA-Europe model.

MITERRA-Europe is an environmental impact assessment model and calculates nitrogen and greenhouse emission on a deterministic and annual basis using emission and leaching factors at regional level (NUTS2, comparable to province level) in the EU27. The model already contained a soil carbon module based on the IPCC stock change approach. Within the EU FP7 SmartSoil project we developed a SOC balance approach, for which we quantified the input of carbon (manure, crop residues, other organic inputs) and the losses of carbon (decomposition, leaching and erosion). The calculations rules from the Roth-C model were used to estimate SOC decomposition. For the actual soil carbon stocks we used the data from the LUCAS soil sample survey. LUCAS collected soil samples in 2009 at about 22000 locations across the EU, which were analysed for a range of soil properties. Land management practices are accounted for, based on data from the EU wide Survey on Agricultural Production Methods in the 2010 Farm Structure Survey. The survey comprises data on the application of soil tillage, soil cover, crop rotation and irrigation.

Based on the simulated soil carbon balance and the actual carbon stocks from LUCAS we now can identify regions within the EU that are at risk. We further present results of the potential soil carbon sequestration by land management practices, such as cover crops, zero and reduced tillage, crop residue management and additional input of organic carbon. These results will be relevant for defining region specific strategies to reach the policy target on preventing loss of soil organic matter as stipulated in the Roadmap to a Resource Efficient Europe.