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Assessing the required additional organic inputs to soils to reach the 4 per 1000 objective at the global scale: a RothC project

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The 4 per 1000 Initiative underlines the role of soil organic matter in addressing the three-fold challenge of food security, adaptation of the land sector to climate change, and mitigation of human-induced GHG emissions. It sets an ambitious global target of a 0.4% (4/1000) annual increase in top soil organic carbon (SOC) stock.

The present collaborative project between the 4 per 1000 research program, INRA and IIASA aims at providing a first global assessment of the translation of this soil organic carbon sequestration target into the equivalent organic matter inputs target. Indeed, soil organic carbon builds up in the soil through different processes leading to an increased input of carbon to the system (by increasing returns to the soil for instance) or a decreased output of carbon from the system (mainly by biodegradation and mineralization processes).

Here we answer the question of how much extra organic matter must be added to agricultural soils every year (in otherwise unchanged climatic conditions) in order to guarantee a 0.4% yearly increase of total soil organic carbon stocks (40cm soil depth is considered). We use the RothC model of soil organic matter turnover on a spatial grid over 10 years to model two situations for croplands: a first situation where soil organic carbon remains constant (system at equilibrium) and a second situation where soil organic matter increases by 0.4% every year. The model accounts for the effects of soil type, temperature, moisture content and plant cover on the turnover process, it is run on a monthly time step, and it can simulate the needed organic input to sustain a certain SOC stock (or evolution of SOC stock).

These two SOC conditions lead to two average yearly plant inputs over 10 years. The difference between the two simulated inputs represent the additional yearly input needed to reach the 4 per 1000 objective (input_eq for inputs needed for SOC to remain constant; input_4/1000 for inputs needed for SOC to reach the 4 per 1000 target). A spatial representation of this difference shows the distribution of the required returns to the soil. This first tool will provide the basis for the next steps: choosing and implementing practices to obtain the required additional input.

Results will be presented from simulations at the regional scale (country: Slovakia) and at the global scale (0,5° grid resolution). Soil input data comes from the HWSD, climatic input data comes from AgMERRA climate dataset averaged of a 30 years period (1980-2010). They show that, at the global scale, given some data corrections which will be presented and discussed, the 4 per 1000 increase in top soil organic carbon can be reached with a median additional input of +0.89 tC/ha/year for cropland soils.