Effect of EU's Common Agricultural Policies on Erosion and Soil Organic Carbon Balance, Italy

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Soils are the third largest global reservoir of carbon and the largest terrestrial ecosystem sink or source of atmospheric CO_2 depending on land-use and management. The French authorities ahead of COP21 proposed the 'four per mil' initiative aimed at offsetting most global agricultural CO_2 emissions by increasing global soil organic carbon (SOC). Since, the Common Agricultural Policies (CAP) reform in 2003, many efforts have already been made at the European level to promote a more environmentally friendly agriculture and increase SOC stock. In order to encourage farmers to manage their land sustainably, the GAEC (Good Agricultural and Environmental Conditions) were introduced as part of the Cross Compliance mechanism. Among the standards indicated, the protection of soils against erosion and the maintenance of soil organic matter and soil structure were two pillars to protect and enhance the soil quality and functions. However, today there is still a substantial lack of knowledge about i) the effects of this policy on erosion prevention and soil organic carbon (SOC) change and ii) the role of soil erosion in the global C cycle.

To move toward filling these knowledge gaps, we coupled a high resolution erosion model based on the Revised Universal Soil Loss Equation (RUSLE; Renard et al., 1997) with the CENTURY (Parton et al., 1988) biogeochemical model, with the aim to incorporate the lateral carbon fluxes occurring with the sediment transportation (Borrelli et al., 2016). Three scenarios were simulated on the whole extent of arable land in Italy: i) a baseline without the GAEC implementation; ii) a current scenario considering a set of management related to GAEC and the corresponding area of application derived from land use and agricultural management statistics and iii) a technical potential where GAEC standards are applied to the entire surface.

Figure 1. Example of the outcomes of RUSLE model applications in the Southern Tuscany (Magliano: 2163500E/4421500N).

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The annual average soil loss predicted by RUSLE for the baseline scenario totaled 67.59 x 10^6 Mg yr^{-1} with an average area-specific soil loss potential of 8.33 Mg ha^{-1} yr^{-1}. The average soil surface level change totaled 0.065 mm yr^{-1} with a long-term average change of 19.4 mm (over 30 years). During this period the application of conservation practices was not mandatory. The high soil erosion rates reflected the heterogeneity and propensity of the landscape to erosion, where locally the annual average rainfall erosivity can be as high as 6,200 MJ mm ha^{-1} h^{-1} yr^{-1} and the slopes on cultivated land considerably exceed 15%. From the modelling prospective, the compulsory standards proposed within the GAEC regulation (current scenario) proved to be somewhat effective in reducing soil erosion. At the national level, the decline of soil loss potential totaled 10.8%. The current average area-specific soil loss is 7.43 Mg ha^{-1} yr^{-1}, totaling a potential loss of 60.28 x 10^6 Mg yr^{-1}. With regard to the technical potential scenario, it showed a 50.1% decrease in the soil loss potential (soil loss average 4.1 Mg ha^{-1} yr^{-1}). Figure 1 illustrates a tangible example of the modelling results for a location in Tuscany notoriously prone to soil erosion processes.

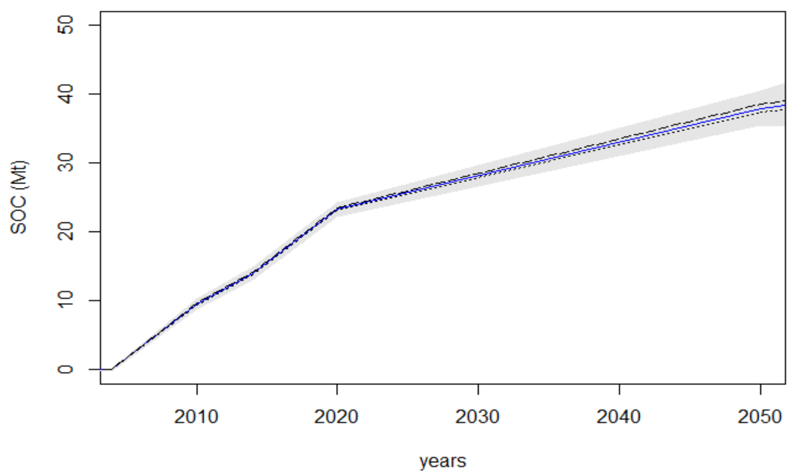

Figure 2. Cumulative values of soil organic carbon by 2050 (technical potential scenario). Thin and thick dotted lines correspond to HAD3_A1FI and PCM_B1 scenarios, respectively. The blue line is the average, while the grey region delimited the 2σ confidence interval.

The GAEC application resulted in overall SOC gains, with different rates depending on the hectares covered and the agroecosystem conditions. About 17% of the SOC change was attributable to avoided SOC transport by sediment erosion in the current scenario, while a potential gain of up to 23.3 Mt of C by 2020 is predicted under the full GAEC application (Figure 2).

References

Borrelli, P., K. Paustian, P. Panagos, A. Jones, B. Schütt, and E. Lugato. 2016. Effect of good agricultural and environmental conditions on erosion and soil organic carbon balance: A national case study. Land Use Policy 50: 408-421.

Parton, W.J., J.W. Stewart, and C.V. Cole. 1988. Dynamics of C, N, P and S in grassland soils: a model. Biogeochemistry 5: 109-131.

Renard, K.G., G.R. Foster, G.A. Weesies, D.K. McCool, and D.C. Yoder. 1997. Predicting soil erosion by water: A guide to conservation planning with the Revised Universal Soil Loss Equation (RUSLE). Agriculture Handbook No. 703, U.S. Department of Agriculture, Washington, D.C.