Geophysical Research Abstracts
Vol. 17, EGU2015-14929, 2015
EGU General Assembly 2015

Regional estimation of soil C stocks and CO_2 emissions as influenced by cropping systems and soil type

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Soil organic matter (SOM) is of crucial importance for agricultural soil quality and fertility. At global level soil contains about three times the carbon stored in the vegetation and about twice that present in the atmosphere. Soil could act as source and sink of carbon, influencing the balance of CO_2 concentration and consequently the global climate. The sink/source ratio depends on many factors that encompass climate, soil characteristics and different land management practices. Thus, the relatively large gross exchange of GHGs between atmosphere and soils and the significant stocks of carbon in soils, may have significant impact on climate and on soil quality.
To quantify the dynamics of C induced by land cover change and the spatial and temporal dynamics of C sources and sinks at regional and, potentially, at national and global scales, we propose a methodology, based on a bio-physical model combined with a spatial explicit database to estimate C stock changes and emissions/removals. The study has been conducted in a pilot region in Italy (Apulia, Foggia province), considering the typical cropping systems of the area, namely rainfed cereals, tomato, vineyard and olives.
For this purpose, the model RothC10N (Farina et al., 2013), that simulates soil C dynamics, has been modified to work directly in batch using data of climate, soil (over 290 georeferenced soil profiles), annual agriculture land use (1200 observations)
The C inputs from crops have been estimated using statistics and data from literature. The model was run to equilibrium for each point of soil, in order to make all the data homogeneous in terms of time. The obtained data were interpolate with geostatisical procedures, obtaining a set of 30x30 km grid with the initial soil C. The new layer produced, together with soil and land use layers, were used for a long-term run (12 years).
Results showed that olive groves and vineyards were able to stock a considerable amount of C (from 0.4 to 1.5 t ha-1 y-1). The continuous wheat lead to a reduction of C stock, ranging from 0.1 to 0.2 t ha-1 y-1, in sandy and clayey soils respectively. When the cereal rotation included irrigated tomato the C stock decline was about 0.4 t ha-1 y-1.
In terms of emissions of CO_2 the release to atmosphere was in average 6.5, 4.4, 3.6 and 3.3 t ha-1 y-1 for wheat-irrigated tomato rotation, continuous wheat, vineyards and olive groves respectively.
The method proposed to estimate at regional level the C stocks and emissions has proved to be efficient and could be used to supply key information for climate and agricultural policies.