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A regional field-based assessment of organic C sequestration and GHG balances in irrigated agriculture in Mediterranean semi-arid land

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In a context of global change and increasing food demand, agriculture faces the challenge of ensuring food security making a sustainable use of resources, especially arable land and water. This implies in many areas a transition towards agricultural systems with increased and stable productivity and a more efficient use of inputs. The introduction of irrigation is, within this framework, a widespread strategy. However, the C cycle and the net GHG emissions can be significantly affected by irrigation. The net effect of this change needs to be quantified at a regional scale. In the region of Navarra (NE Spain) more than 22,300 ha of rainfed agricultural land have been converted to irrigation in the last years, adding to the previous existing irrigated area of 70,000 ha. In this framework the project Life+ Regadiox (LIFE12 ENV/ES/000426, http://life-regadiox.es/) has the objective of evaluating the net GHG balances and atmospheric CO_2 fixation rates of different management strategies in irrigated agriculture in the region.

The project involved the identification of areas representative of the different pedocllimatic conditions in the region. This required soil and climate characterizations, and the design of a network of agricultural fields representative of the most common dryland and irrigation managements in these areas. This was done from available public datasets on climate and soil, and from soil pits especially sampled for this study. Two areas were then delimited, mostly based on their degree of aridity. Within each of those areas, fields were selected to allow for comparisons at three levels: (i) dryland vs irrigation, (ii) soil and crop management systems for non-permanent crops, and (iii) soil management strategies for permanent crops (namely olive orchards and vineyards).

In a second step, the objective of this work was to quantify net SOC variations and GHG balances corresponding to the different managements identified in the previous step. These quantifications will allow for evaluating the most suitable strategies for developing sustainable irrigation agrosystems in the region. The quantification of SOC stocks was done within equivalent soil units in each area, and for each level of comparison. Soil organic C stocks were quantified using the area-frame randomized soil sampling protocol (Stolbovoy et al., 2007), in the tilled layer (0-30 cm). GHG balances were calculated from inputs information obtained from farmers, using tools developed by the regional agricultural research institute (INTIA), adapted to the local characteristics of agriculture.

The results corresponding to the comparison between dryland and irrigated agrosystems showed differences both in terms of SOC storage and GHG balances in the two studied areas. Irrigated fields had significantly greater stocks of SOC on average, although net organic C storage was significantly affected by soil and crop type. Also, organic fertilization in dryland resulted in significantly more SOC stored in the soil. Net GHG balances were greatly affected by the type of crops and their management, in particular fertilization strategies. As a result, net balances in terms of GHG emissions and mitigation varied greatly among irrigated systems, and in comparison to dryland systems.