

High SOC stocks under sugarcane crops on volcanic soils of Reunion Island

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Abstract

Volcanic soils of Reunion Island with high carbon (C) contents highlight the importance of 'carbon hotspots' to face the challenges of climate change and food security through C sequestration. In addition, the '4 per mille' initiative demonstrated that agricultural soils can play a crucial role for these global issues. Reunion, a young tropical volcanic island in the Indian Ocean, 700km east of Madagascar, presents a wide range of tropical soils on a volcanic rock-weathering gradient. Here, our work focused on the dynamics of soil organic carbon (SOC) contents in the different types of volcanic soils under sugarcane crops.

A large soils database consisting of information from more than 40 000 soil samples collected predominantly from sugarcane plots over the past 20 years was accessed for this study. Long-term diachronic series of SOC contents were extracted from the database. Georeferenced data combined with GIS tools were used to create a SOC map of Reunion. Data mining tools, such as boosted regression trees (BRT), were used to prioritize the drivers of SOC contents and evaluate the storage capacity of these young volcanic soils.

Soil type was the main driver of SOC content, ahead of climatic conditions and agricultural practices. As expected, Ferralsols, mostly located on the west and north coast, exhibited the lowest SOC content, whereas Andisols, at higher altitudes, showed the highest SOC contents for the 0-30cm layer. The long-term diachronic series also showed almost constant SOC under sugarcane crops over the full range of soils. In fact, sugarcane cropping systems produce high organic C inputs (residues and roots, 1.2 Mg C ha⁻¹y⁻¹) that are returned to the soil. This, combined with the C conservation practices in Reunion (no burning, mulching, one tillage every ten years on average), suggested that soil C saturation occurs under sugarcane crops for all soil types.

However, even though no more SOC storage is possible, several factors, such as land use change, could decrease the SOC that is stored in these soils. Preliminary results showed higher SOC stocks under sugarcane crops and pastures than in gardening plots for different soil types. Agricultural soils with high SOC stocks need to be preserved and agro-ecological practices need to be implemented in order to maintain/improve productivity and ecological resilience in farming systems.

Keywords: soil organic carbon, tropical volcanic soils, long-term diachronic series, sugarcane, soil analyses, database, data mining.