THEME 2

Losses and redistribution of organic carbon by erosion in fragile agricultural and restored catchments

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INTRODUCTION

Fluvial systems constitute large sediment stores and have the potential to store large amounts of organic carbon associated to the sediments.

However, redistribution of organic carbon by lateral flows in catchments can be affected by fluvial processes, complex erosion patterns (gully, channel and bank erosion) and by transport and post-depositional processes in sediments. Although large efforts are being made to understand the flow paths of OC at the catchment scale, studies quantifying global redistribution of organic carbon by lateral flows at this scale are still scarce. Particularly, little is known on how organic carbon is redistributed in fragile environments with a variety of lithologies, land uses patterns (large agricultural areas adjacent to large reforested areas) and ephemeral hydrological and sedimentological processes, typical of Mediterranean conditions.

The catchment scale research on this matter could identify organic carbon sinks providing insight on opportunities for carbon sequestration through sediments management.

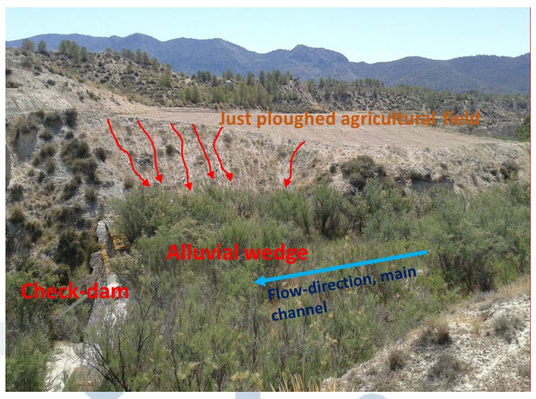

Fig. 1 : Project location

OBJECTIVES

The objective of this work was to estimate the organic carbon redistributed by lateral flows in 2 representative Mediterranean catchments, highly disturbed by agricultural terraces, land levelling for agriculture, reforestation and construction of check-dams, with erodible lithologies and shallow soils. Research was carried out in two catchments with different climatological conditions (Cárcavo, precipitation of 285 mm year^{-1} and Rogativa, 530 mm year^{-1}) in SE Spain, representing medium mountain Mediterranean environments with a variety of land uses. A carbon budget within the erosional cycle was estimated for each catchment taking into account carbon mineralized during erosion processes, carbon deposited at channel sinks and carbon exported downstream.

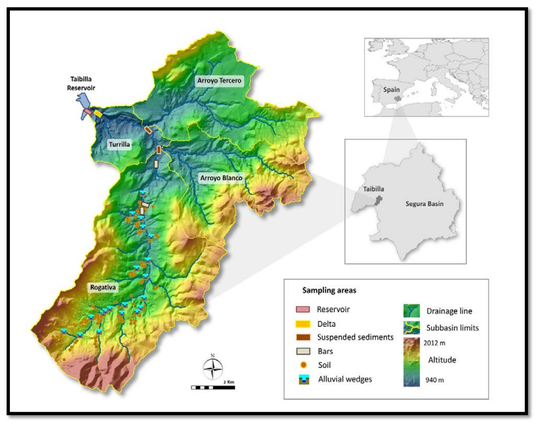

Fig. 2: High connectivity between agricultural fields and channels at the Cárcavo catchment.

Fig. 3: The alluvial wedge behind the check-dam creates a sediment sink and thus an opportunity to sequester carbon. Protection of soils through proper management is important to decrease connectivity

Fig. 4: Photos of sampling

MAIN RESULTS

In both catchments, organic carbon concentration of sediments in the fluvial system is significantly lower than the soil organic carbon concentration of forest and shrubland soils (Table 1). On average, sediments in both catchments contain a 43% of the organic carbon of forest soils (first 5 cm). However, organic carbon concentration is higher in sediments than in agricultural soils. The specific soil carbon yield estimated at the catchment scale is similar for both areas. Total organic carbon removed by erosion processes represented a 9,68 % of the superficial 5 cm soil stock in 21 years for the Cárcavo basin, and a 9.09 % of that for the Rogativa basin in 27 years. From the organic carbon redistributed by lateral fluxes, 76.6 % and 67.4 % (alluvial wedges + footslopes) was redeposited within the fluvial system in Cárcavo and Rogativa, respectively.

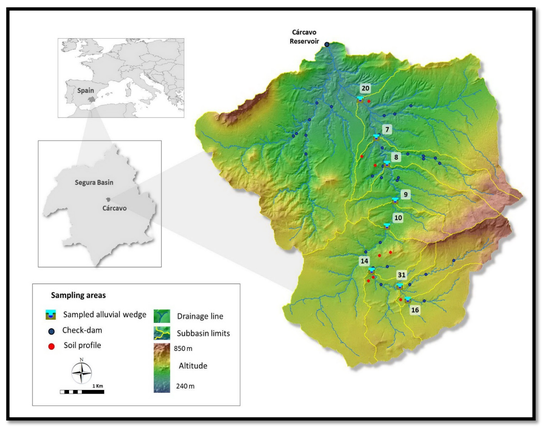

Fig. 4: Upper Taibilla catchment and subcatchment of La Rogativa with subhumid climatological conditions

Fig. 5: Cárcavo catchment with semiarid-arid climatological conditions. Both have suffered reforestation of their catchment areas and land abandonment in the last 40 years

Tab. 1: Indicators of the Total Organic Carbon concentration, stored and exported in the Cárcavo and Rogativa catchments.

Catchment	TOC forest soils (g kg^{-1})	TOC agricultural soils (g kg^{-1})
Cárcavo	15.2 ± 9.35	4.4±1.06
Rogativa	18.82 ± 5.37	8.12 ± 3.20
	TOC Sediments 0-100 cm (g kg^{-1})	Soil TOC stock 5 cm (tn ha^{-1})
Cárcavo	6.6	7.3
Rogativa	11.7	9.31
	TOC buried check-dams (21 years) (tn)	TOC exported downstream check-dams (27 years) (tn)
Cárcavo	677.65	45.156
Rogativa	1654.18	502.29
	Specific soil carbon yield (SCY) catchment (tn ha^{-1} yr^{-1})	
Cárcavo	0.040±0.047	
Rogativa	0.037±0.045	

CONCLUSION

In fragile Mediterranean environments with active geomorphological processes, despite restoration activities (reforestation and hydrological control works), erosion processes caused the loss of more than 10% of the superficial soil carbon stock during the studied period (20-30 years). At this catchment scale, sediments flowing within the fluvial system have similar concentrations of organic carbon than agricultural soils of the catchments. Losses of soil organic carbon due only to lateral fluxes represent a rate of at least 0.4% per year in both studied catchments, without taking into account losses of organic carbon due to other processes (as land use conversions and land management practices). Those results point out the need to protect soil organic carbon resources in active fluvial environments of those fragile ecosystems, for instance with measures for stabilizing organic carbon in soils and sediments and decreasing connectivity of rich-carbon soils with fluvial channels.