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Soil erosion increases soil microbial activity at the depositional position of eroding slopes

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Soil erosion is the most widespread form of soil degradation. Estimation of the impact of agricultural soil erosion on global carbon cycle is a topic of scientific debate, with opposing yet similar magnitude estimates of erosion as a net source or sink of atmospheric carbon. The transport and deposition of eroded agricultural soils affects not only the carbon cycle but other nutrient cycles as well. It has been estimated that erosion-induced lateral fluxes of nitrogen (N) and phosphorus (P) could be similar in magnitude to those from fertilizer application and crop removal (Quinton et al., 2010). In particular, the dynamics of soil N in eroding slopes need to be considered because the management of soil N has profound influences on the functioning of soil microorganisms, which are generally considered as the main biotic driver of soil C efflux. Carbon dioxide (CO_2) emissions tend to increase in deposition positions of eroded slopes, diminishing the sink potential of eroded soils C (. As the global warming potential of nitrous oxide (N2O) is 310 times relative to that of CO_2, the sink potential of agricultural erosion could easily be negated with a small increase in N2O emissions. Therefore, an investigation of the potential emissions of greenhouse gases, and especially N2O from soils affected by agricultural erosion, are required.

In the present study, a field experiment was established with contrasting cultivation techniques of a C4 crop (Zea mays; δ13C = -12.2‰ to introduce 13C-enriched SOC to a soil previously cropped with C3 plants (δ13C = -29.3‰. Soils sampled from the top, middle, bottom and foot slope positions along a distinct erosion pathway were analyzed using 13C-phospholipid fatty acid (PLFA) analysis and incubated to investigate the responses of microorganisms and associated potential emissions of greenhouse gases (GHG). The total C and N contents were greatest in soils at the top slope position, whereas soil mineral N (NO_3–N and NH4+-N) contents were greater at the bottom and foot slope positions. The biomarker PLFAs for Gram positive bacteria and fungi were relatively 13C-enriched, indicating the incorporation of C from Zea mays residues compared with 13C-depletion in biomarker PLFA in Actinobacteria indicating utilization of SOC. An average of 72% C incorporated by the all microbial groups was derived from SOC at the slope foot, suggesting a large amount of SOC was mineralized at the depositional position. We observed the highest emissions of N2O and CO_2 from the incubated soils sampled from the bottom slope position. We conclude that the conditions in the depositional positions of eroding slopes can promote GHG emissions reducing the previously reported sink capacity of soil erosion.

Quinton et al (2010) The impact of agricultural soil erosion on biogeochemical cycling. Nature Geoscience 3, 311 – 314.