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Soil Erosion and Terrestrial Carbon Sequestration

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This study contributes to a better understanding of the role of soil erosion in the global carbon cycle, including important questions surrounding the magnitude, significance, and sustainability of the erosion-induced terrestrial carbon sink in naturally eroding watersheds.

Soil erosion and terrestrial sedimentation play important roles in modifying the dynamics of the biosphere's most stable carbon pool—soil organic matter—and fluxes associated with it. Most carbon transported by erosion never leaves the watershed. Consequently, replacement of eroded carbon by new organic carbon produced by photosynthesis and reduced rates of decomposition in some depositional settings constitute an important terrestrial carbon sink that was not previously accounted in most global carbon cycle models.

Proper understanding of the role of soil erosion in carbon sequestration is important because accelerated erosion is a very serious environmental problem that is responsible for about one third of all soil degradation. Projected changes in climate are expected to stimulate the hydrologic cycle, increasing the intensity, amount, and seasonality of precipitation in many parts of the world, and thus accelerating soil erosion. Also, soil erosion is a significant method by which otherwise stable, mineral-associated soil organic carbon can be relocated in large quantities and its decomposition rate altered during transport or after deposition.

Using new data from an undisturbed, naturally-eroding, zero-order watershed in northern California and by reanalyzing data for a cultivated watershed in central Mississippi, the scientists investigated conditions for which soil erosion might constitute a terrestrial sink or source for atmospheric CO_2.

FINDINGS OF THE STUDY

This study showed that only about one percent of net primary productivity and 16 percent of eroded carbon contribute to carbon sequestration in eroding watersheds. Combining these results with global estimates from previous studies, the erosion-induced terrestrial carbon sink can potentially offset as much as 10 percent of the global fossil-fuel emissions of carbon dioxide in 2005.

Up to 80 percent of the carbon in the eroding/depositional toposequence is in stable, mineral-associated forms. Higher stocks of iron and aluminum oxides in the depositional settings provide protective surfaces for the stabilization of soil organic matter.

Conversely, up to 20 percent of carbon stored in depositional basins is either unprotected or temporally protected by aggregation and/or burial. By conserving lands that are storing this eroded carbon, it may be possible to prevent some of that carbon from re-entering the atmosphere as CO_2.

These results demonstrated that the fate of carbon in hillslope settings is primarily controlled by geomorphology. Plant productivity and microclimate exert significant control on the amount and composition of organic matter near the soil surface, while the fate of deeper soil carbon is primarily controlled by the extent of physical protection and chemical stabilization.

IMPACT

This study provides conceptual clarification for how soil erosion can result in carbon sequestration and data showing the forms and ages of carbon pools in various hillslope settings. These results will contribute to the proper accounting of the contribution of terrestrial biosphere in future global carbon cycle models.

Figure 1. Schematic diagram of an ideal eroding toposequence along with the important fluxes of carbon from the soil.

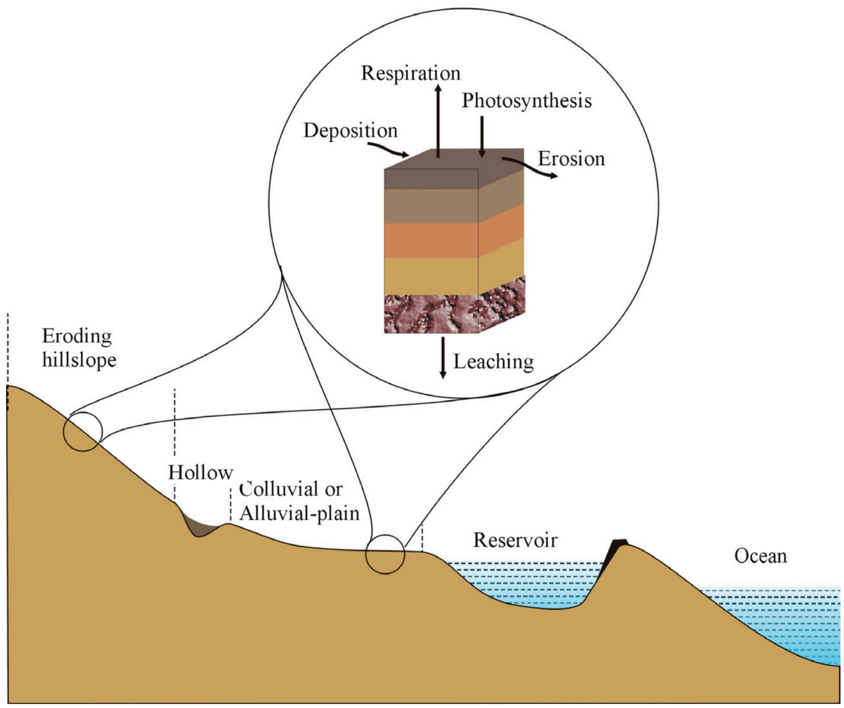

Figure Credit - Berhe et al., 2007

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