Geophysical Research Abstracts, Vol. 7, 03871, 2005
SRef-ID: 1607-7962/gra/EGU05-A-03871

The Role of Erosion and Deposition in Soil Carbon Sequestration in an Undisturbed Watershed

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It has been hypothesized that erosion can lead to up to 0.9 Pg C/yr soil carbon (C) sink globally if eroded C is replaced by new photosynthate and preserved by burial in depositional basins. In an undisturbed, zero-order coastal watershed we set up a study to answer three questions: (1) How much of the eroded soil C is replaced by photosynthesis; (2) Is buried C significantly more stable than C in other parts of the watershed; and (3) What variables control accumulation and stabilization of C in depositional basins? We determined C input, storage, and turnover rate, as well as the inventory of iron and aluminum extractable by sodium pyrophosphate, ammonium oxalate, and citrate dithionite in multiple positions of an eroding hillslope and two types of depositional basins - terrestrial depression/hollow and floodplain. We found that eroded C is completely replaced by photosynthesis (C input to SOC = 1.06 * C loss from eroding slopes); turnover time of buried C is three times longer than for C in eroding slopes, and that a combination of higher soil thickness, clay content, metal ion inventory, and moisture content contribute to the stabilization of eroded C in depositional basins. Our study shows that organo-metal complexes (pyrophosphate extractable) explain most of the variability in stabilization of C overall while inventory of pedogenic Fe (dithionite extractable) is most closely correlated with long-term storage of C and non-crystalline minerals are closely associated with high inventory and stabilization in the upper- and lower-most positions in our watershed. In this study we provide compelling empirical evidence that erosion and terrestrial sedimentation constitute a soil C sink in this temperate grassland watershed.