**McCarty and Ritchie. 2002. Impact of soil movement on carbon sequestration in agricultural systems.**

*Introduction*

Potential causes for development of the source/sink transition include CO2 fertilization increasing the biomass accumulation of the biosphere due to increased atmospheric content, but the magnitude of the transition is considered too large for this mechanism (Joos and Bruno, 1998). Other possible causes include increased usage of fertilizer N in agriculture that may stimulate C sequestration in soil because of the need for N to stabilize soil C.

One noteworthy occurrence, however, during the period of apparent source to sink transition (1930s & 1940s) was massive soil erosion associated with agriculture, which resulted in major redistribution of surface soil resources within the continental ecosystem. It is noteworthy that the current IPCC global C budget (Fig. 1) contains a term for export of terrestrial C to the ocean which is approximately equal to the net terrestrial uptake indicating that the terrestrial ecosystem is at steady state relative to total C storage. This implicates soil erosion as an important process influencing terrestrial C cycling via terrestrial C movement and ultimate export to oceans.

Stallard (1998) estimated annual soil erosion to be 9.6 t ha−1 year−1 (3.4 t ha−1 year−1 water and 6.2 t ha−1 year−1 wind) with total soil erosion of about 7.5 Gt year−1 within the United States. Lal et al. (1998) estimated that erosion from cultivated cropland in the US has decreased from 1.9 Gt year−1 in 1982 to 0.6 Gt year−1 in 1995.

A recent high profile debate over accuracy of the commonly used erosion models has brought attention to the concern about validity of current estimates of soil erosion in the United States (Trimble, 1999, Pimentel et al., 1999, Nearing et al., 2000, Trimble & Crosson, 2000). This concern is based on an argument that current erosion models measure soil detachment and not the amount exported from the watershed. With this argument much of the eroded soil predicted by these models is redeposited within the watershed and as a result the estimated “soil loss” is largely accounted for by redistribution on landscapes (Trimble and Crosson, 2000).

The expectations for increased greenhouse gas emissions due to erosion are based on (1) the decrease in the capacity of eroded soils to produce biomass; (2) the breakdown of soil structure that exposes C locked in aggregates to oxidation; and (3) the mineralization of exposed C by microbial decomposition and other oxidative processes. Some have estimated that 20% of organic C associated with erosion is mineralized to CO2 because of increased biodegradation with loss of soil structure (Lal, 1995). The magnitude of C loss from a land surface due to erosion can be substantial and the dominant loss mechanism. For example, Harden et al. (1999) found at a Mississippi site cropped for more than 100 years that nearly 100% of the original organic C in the agricultural soil had been lost. They attributed as much as 80% of the reduction in organic C to soil erosion.

Typically only 10% of eroded soil is exported from a watershed (Lal et al., 1998), and therefore, in large part the eroding soil represents redistribution of soil resources on the landscape.

*Results*

To explore the potential impact of terrestrial sedimentation on C sequestration consideration can be given to influence of soil resource redistribution in a typical agricultural watershed as may be represented by our agricultural study site, where soil C contents vary from roughly 1% on hilltops to 20% in the histosol bordering the stream (areal extent of histosol shown in Fig. 4). Within the agricultural field, C contents vary from roughly 1 to 2.5% (Fig. 5). Spatial patterns of soil C are highly related to topography and are usually functions of soil water relations.

Typical erosion patterns will result in movement of soil down slope with deposition in concave and toe slope positions or further into the adjoining riparian wetland. This type of redistribution will generally result in depositions with C content below the pedogenic equilibrium for the zone of deposition. For example, sediment containing 1% C may become deposited on a down slope zone which supports 2.5% soil C. The pedogenic processes also promote formation of new organic C in zones of soil loss as observed by Harden et al. (1999) and likely will also promote active sequestration within the zone of deposition.

Other zones of deposition may also have high productivity but a lower pedogenic equilibrium for C storage. Assessing the influence of soil resource redistribution on C sequestration in an ecosystem requires the ability to track both the movement of sediment in the ecosystem and the dynamics of soil C within the zones of erosion and deposition.

Based on the mineral sediment deposited in the wetland and the apparent limit on soil C content, it is estimated that the overall capacity of this ecosystem to store C has been increased by 200–300 t C ha−1. This represents a substantial increase in storage capacity of the watershed as a whole.