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Challenges in linking agricultural soil erosion studies to landscape scale processes

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Soil erosion studies are usually implemented to collect data for specific processes, surface conditions or treatments. The ease of conducting the proposed erosion study, the associated quality of the data, and the confidence level of the findings, are generally related to the degree of the control on the experimental variables. With a proper experimental design, the collected erosion data and interpretation are valid within the realm of the study setting, which can be at any spatial and temporal scale. Simply, erosion data reflect the detachment-transport-deposition processes that occurred under the forcing function and conditions of the soil exposed for the duration of the observation. Scaling becomes an issue when one intends to make erosion assessments outside the range which the data support, both spatially and temporally. This issue is further aggravated by the misuse of physical models to simulate erosion processes at different scales beyond the original intent of the model formulation. Sometimes, processes and conditions controlling sediment detachment and deposition at meter scale areas are extrapolated to hectare or kilometer square areas without considering changes in boundary conditions and driving forces as the scale is increased.

In the US, we have seen the evolution from collecting natural runoff plot data that led to the development of Universal Soil Loss Equation (USLE) to the emergence of process-based erosion science using erodibility parameters derived from small-scale controlled plot experiments. These efforts are intended for assessing erosion at the field scale for implementing conservation practices. The nationwide usage of the Revised Universal Soil Loss Equation (RUSLE) in USDA Field Offices demonstrates the successful development of a field scale erosion assessment technology.

Recently, we have been challenged to assess conservation effects at the watershed scale. From the standpoint of erosion assessment in agricultural watersheds, we have to shift from the annual cycle of crop management and rotation, i.e., a field scale process, to a much longer time scale as sediment transport and deposition processes in the landscape have a very long response time. Agricultural management practices have different response times depending on where the focus is. Crop yield and water conservation can usually be observed in annual cycles. Changes in aggregate stability and soil erodibility can take several years or even decades. It is often observed that sediments eroded from a field are deposited within the field boundary and sediments transported in stream channels may have been those already deposited decades ago in stream banks and flood plains. Without knowing the transient nature of the sediment movement, or a distribution of travel time for the sediments from fields to stream channels, it can be very difficult to assess the conservation or management effects at the watershed scale where geomorphic processes become dominant.

In this presentation, we will provide a cursory review of US agricultural soil erosion research and development, which was intended for developing field scale erosion prediction technology. We will then discuss how we propose to address the scaling issue in assessing conservation effects at the watershed scale for sediments.