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Evaluation of Sediment Transport Mechanics Using Lanthanide Tracers and Radiometric Fingerprinting

A fully integrated hill-slope scale hydrologic monitoring project has been initiated to evaluate sediment transport mechanisms by combining a network of surface runoff sensors monitoring the temporal and spatial occurrence of runoff with lanthanide (rare earth element (REE) oxides) tracer analysis and radiometric (Be-7, Pb-210, Cs-137) fingerprinting. These methods have been combined on a hill-slope with a Plano silt loam soil at Arlington, WI under two tillage orientations and data were collected from a series of three rainfall-runoff events. The objectives are to: (i) determine the spatial patterns of runoff and sediment movement for different agricultural management systems, and (ii) link sediment source areas to phosphorus export dynamics. The runoff sensor operates in a current loop calibrated to be 4 mA when no water is present and 20 mA when water bridges a section of the circuit mounted on precision laser-cut steel mounts located in critical areas in the field. Characterization of areas of soil erosion is being performed by monitoring the migration of REE oxide-tagged soils. An optimal hillslope length (36 ft from edge-of-field) has been divided into three segments within which different types of soil-REE (Gd, Nd, Pr) oxide mixtures were placed. The redistribution of REE-tagged soils and the REE concentration in suspended sediments are being used to delineate source regions and determine characteristic transport distances. Preliminary data indicate a good correspondence between the sedigraph peaks and contributions from the downslope REE segment during the initial runoff event. The contributions from the upslope REE segments become more pronounced during the second and third runoff events in the storm series. Our results suggest the suitability of using REE-tagging technique to acquire information on spatial and temporal patterns of sediment movement in agricultural fields. Radiometric fingerprints using concurrent measurements of multiple environmental isotopes will be used to determine relative areal extents of the hillslope subjected to interrill vs. rill erosion.

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