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Catchment scale soil erosion modeling using GIS and soft computing techniques

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Soil erosion by water is considered as one of the major threats for sustainable land management. Effective land management to prevent soil loss requires prediction for large areas. However, although erosion models (e.g., the USLE and its successors) do exist, attempts to apply them over large regions have been unsuccessful in many cases due to insufficient factor calibration, low input resolution and vast temporal and spatial uncertainty in the erosion processes.

We suggest a new erosion model, based on the fuzzy logic approach. The potential of fuzzy logic in environmental modeling has long been recognized, and its ability to use objects with indeterminate boundaries can be most useful to erosion modeling. The model predicts soil erosion potential over wide regions with spatial cell resolution of 30 m. It is temporally and spatially explicit, based on detailed meteorological and environmental factors derived from GIS and remote sensing techniques. The potential erosion is predicted for each rainfall event in the database, considering the time elapsed from a previous event and rainfall intensity. Unlike most single-event models, this model accumulates the potential erosion to seasonal and annual predictions.

The model advantages are the temporally dynamic structure and the soft fuzzy methods, eliminating the need for accurate coefficient calibrations, and reducing errors resulting in the uncertainty associated with erosion process. The temporally dynamic structure of the model expresses the changes in the soil moisture content and vegetation cover. Both are critical factors in erosion processes.

The model input includes vegetation parameters drawn from multi-temporal Landsat TM images, physical soil parameters based on soil maps and published data, daily

rain data from 10 meteorological stations presented in a geostatistical interpolation, topographic parameters calculated from a DEM and land use factors classified from multi-temporal Landsat TM images.

The model was tested on the Shiqma Basin ($760 km^2$) in central Israel and was compared to a series of validations using several sources and techniques: (1) published sediment yield measurements at sites scattered throughout the basin; (2) an existing semi-empirical soil erosion model (SEMMED- Soil Erosion Model for MEDiterranean regions); and (3) remote sensing and image processing techniques applied to Landsat TM images for mapping erosion phenomena from spectral signatures.