Parameter Scaling Of Hydrological, Soil-Erosion And Nutrient Parameters At Three Different Spatial Scales

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Abstract

Arid and semiarid desert ecosystems are characterised by considerable variability of key hydrological and soil-erosion parameters at a range of scales. This heterogeneity makes it particularly difficult to model the fluxes of water, sediments and nutrients and to scale up environmental models, which are typically defined at the plot scale, to the catchment scale.

The research question of this study is how to represent numerically the sub-pixel variability of model parameters derived from remotely sensed data, i.e. how to up-scale point measurements. In order to achieve this aim, this study combines field data collected within 60 $\times$ 60 m plots with aerial photography and remotely sensed data to obtain parameterisation data for catchment-scale models.

An extensive field study was undertaken in the Jornada Basin, a typical Basin and Range desert rangeland basin located in the Chihuahuan Desert, south-western United States, within four characteristic vegetation types (grassland and three different shrubland types). Parameters under investigation include vegetation and pavement cover, ponded infiltration rates, microtopography, the Darcy-Weisbach friction coefficient, soil moisture, particle size distribution, soil aggregate stability and nutrient content (ammonium, nitrate and phosphorus). A nested sampling strategy is used to obtain measurements at a range of different spatial scales (resolution of 3×3 m, 10×10 m, 30×30 m and 60×60 m). This approach enables the assessment of the short-range variations over several metres (plant-interspace scale) and the medium-range variations of several tens of metres (shrub patch size).

To obtain data at the catchment scale, aerial photography and two different types of remotely sensed data are used: aerial photography with a resolution of 1 m; multispectral ASTER data with a resolution of 15 m to 30 m, and Landsat 7 ETM data with a resolution of 30 m. Mixture modelling (also called spectral mixture analysis) is applied to these imageries to acquire data related to vegetation cover and soil properties.

Statistical and geostatistical analysis are used to establish relationships between the different types of data. The geostatistical analysis enables to estimate the deterministic length scales of these parameters at the various scales. The poster summarises the scaling behaviour of the key hydrological and soil erosion parameters for the four different vegetation types. Furthermore, it introduces numerical concepts derived from the geostatistical analysis and statistical modelling how to model the sub-pixel variability of remotely sensed data. These concepts permit the direct incorporation of the intrinsic small-scale variability of model parameters when used at the appropriate scale. The derived algorithms can then be employed to overcome the lack of parameterisation data of spatially distributed models at the catchment scale.