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Erosion Modeling in Central China - Soil Data Acquisition by Conditioned Latin Hypercube Sampling and Incorporation of Legacy Data

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The Three Gorges Dam at the Yangtze River in Central China outlines a prominent example of human-induced environmental impacts. Throughout one year the water table at the main river fluctuates about 30m due to impoundment and drainage activities. The dynamic water table implicates a range of georisks such as soil erosion, mass movements, sediment transport and diffuse matter inputs into the reservoir. Within the framework of the joint Sino-German project YANGTZE GEO, the subproject “Soil Erosion” deals with soil erosion risks and sediment transport pathways into the reservoir.
The study site is a small catchment (4.8 km^2) in Badong, approximately 100 km upstream the dam. It is characterized by scattered plots of agricultural landuse and resettlements in a largely wooded, steep sloping and mountainous area.
Our research is focused on data acquisition and processing to develop a process-oriented erosion model. Hereby, area-covering knowledge of specific soil properties in the catchment is an intrinsic input parameter. This will be acquired by means of digital soil mapping (DSM). Thereby, soil properties are estimated by covariates. The functions are calibrated by soil property samples.
The DSM approach is based on an appropriate sample design, which reflects the heterogeneity of the catchment, regarding the covariates with influence on the relevant soil properties. In this approach the covariates, processed by a digital terrain analysis, are outlined by the slope, altitude, profile curvature, plane curvature, and the aspect.
For the development of the sample design, we chose the Conditioned Latin Hypercube Sampling (cLHS) procedure (Minasny and McBratney, 2006). It provides an efficient method of sampling variables from their multivariate distribution. Thereby, a sample size n from multiple variables is drawn such that for each variable the sample is marginally maximally stratified. The method ensures the maximal stratification by two features: First, number of strata equals the sample size n and secondly, the probability of falling in each of the strata is n^{-1} (McKay et al., 1979). We extended the classical cLHS with extremes (Schmidt et al., 2012) approach by incorporating legacy data of previous field campaigns. Instead of identifying precise sample locations by CLHS, we demarcate the multivariate attribute space of the samples based on the histogram borders of each stratum. This widens the spatial scope of the actual CLHS sample locations and allows the incorporation of legacy data lying within that scope. Furthermore, this approach provides an extended potential regarding the accessibility of sample sites in the field.