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Multifractal Model of Soil Water Erosion

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Multifractal Phenomena in Hydric Erosion: implications for soil mapping and management
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Breaking of solid surface symmetry during the interaction between the rainfall of high erosivity index and internally unstable volcanic soil/vegetation systems, results in roughness increasing as well as fertile horizon loosing. In these areas, the sustainability of management practices depends on the ability to select and implement the precise indicators of soil erodibility and vegetation capacity to protect the system against the extreme damaging precipitation events. Notwithstanding, the complex, non-linear and scaling nature of the phenomena involved in the interaction among the soil, vegetation and precipitation is still not taken into account by the numerous commonly used empirical, mathematical and computer simulation models: for instance, by the universal soil loss equation (USLE). The soil erodibility factor (K-factor) is still measuring by a set of empirical, dimensionless parameters and indexes, without taking into account the scaling (frequently multifractal) origin of a broad range of heterogeneous, anisotropic and dynamical phenomena involved in hydric erosion. Their mapping is not representative of this complex system spatial variability. In our research, we propose to use the toolbox of fractals and multifractals techniques in vista of its ability to measure the scale invariance and type/degree of soil, vegetation and precipitation symmetry breaking. The hydraulic units are chosen as the precise measure of soil/vegetation stability. These units are measured and modeled for soils with contrasting architecture, based on their porosity/permeability (Poroperm) as well as retention capacity relations. The simple Catalog of the most common Poroperm relations is proposed and the main power law relations among the elements of studied system are established and compared for some representative agricultural and natural Biogeosystems of Mexico. All resulted are related with the Mandelbrot′ Baby Theorem in order to construct the universal Phase Diagram which graphically represents the critical points of the dynamics of soil erodibility as function of the vegetation cover and precipitation parameters.