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Effect of tillage system and cumulative rainfall on multifractal parameters of soil surface microrelief

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Mathematical description of the spatial characteristics of soil surface microrelief still remains a challenge. Soil surface roughness parameters are required for modelling overland flow and erosion. The objective of this work was to evaluate the potential of multifractal for analyzing the decay of initial surface roughness induced by natural rainfall under different soil tillage systems. Field experiments were performed on an Oxisol at Campinas, São Paulo State (Brazil). Six tillage treatments, namely, disc harrow, disc plow, chisel plow, disc harrow + disc level, disc plow + disc level and chisel plow + disc level were tested. In each plot soil surface microrelief was measured for times, with increasing amounts of natural rainfall using a pinmeter. The sampling scheme was a square grid with 25 x 25 mm point spacing and the plot size was 1350 x 1350 mm, so that each data set consisted of 3025 individual elevation points. Duplicated measurements were taken per treatment and date, yielding a total of 48 experimental data sets. All the investigated microrelief data sets exhibited, in general, scale properties, and the degree of multifractality showed wide differences between them. Multifractal analysis distinguishes two different patterns of soil surface microrelief, the first one has features close to monofractal spectra and the second clearly indicates multifractal behavior. Both, singularity spectra and generalized dimension spectra allow differentiating between soil tillage systems. In general, changes in values of multifractal parameters under simulated rainfall showed no or little correspondence with the evolution of the vertical microrelief component described by indices such as the standard deviation of the point height measurements. Multifractal parameters provided valuable information for chararacterizing the spatial features of soil surface microrelief as they were able to discriminate data sets with similar values for the vertical component of roughness.