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Fluvial drainage networks: the fractal approach as an improvement of quantitative geomorphic analyses

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Drainage basins are primary landscape units for geomorphological investigations. Both hillslopes and river drainage system are fundamental components in drainage basins analysis. As other geomorphological systems, also the drainage basins aim to an equilibrium condition where the sequence of erosion, transport and sedimentation approach to a condition of minimum energy effort. This state is revealed by a typical geometry of landforms and of drainage net. Several morphometric indexes can measure how much a drainage basin is far from the theoretical equilibrium configuration, revealing possible external disarray. In active tectonic areas, the drainage basins have a primary importance in order to highlight style, amount and rate of tectonic impulses, and morphometric indexes allow to estimate the tectonic activity classes of different sectors in a study area.

Moreover, drainage rivers are characterized by a self-similarity structure; this promotes the use of fractals theory to investigate the system. In this study, fractals techniques are employed together with quantitative geomorphological analysis to study the Upper Tiber Valley (UTV), a tectonic intermontane basin located in northern Apennines (Umbria, central Italy). The area is the result of different tectonic phases. From Late Pliocene until present time the UTV is strongly controlled by a regional uplift and by an extensional phase with different sets of normal faults playing a fundamental role in basin morphology.

Thirty-four basins are taken into account for the quantitative analysis, twenty on the left side of the basin, the others on the right side.

Using fractals dimension of drainage networks, Horton's laws results, concavity and steepness indexes, and hypsometric curves, this study aims to obtain an evolutionary model of the UTV, where the uplift is compared to local subsidence induced by normal fault activity. The results highlight a well defined difference between western and eastern tributary basins, suggesting a greater disequilibrium in the last ones. The quantitative analysis points out the segments of the basin boundaries where the fault activity is more efficient and the resulting geomorphological implications.