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Fractality of drainage networks in a tectonically active region of North-West Himalaya

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Drainage network as a skeletal framework of landscape is well established to display fractal behavior. This is largely due to the complex interactions amidst the forcings. However the process-form relationship has not been widely studied by quantifying variability of their fractal behavior. Tectonics among other external forcings influences the temporal evolution of the drainage network configuration. In our current work, we have analyzed this fractal behavior of drainage network under active tectonic condition. Drainage basins have been selected around the out-of-sequence Jwalamukhi thrust (JMT) in the Kangra reentrant, which accommodates a substantial Indo-Eurasian convergence over the Holocene timescale in the NW Himalaya. The fractal dimension has been estimated using box counting method (Box Dimension) and stream frequency-stream length ratio method (Branching Dimension). For calculation of branching ratios, we have used both Horton and Tokunaga classification of drainage network streams. Since higher vertical displacement (in the absence of any substrate heterogeneity) would result in higher channel activity, our null hypothesis is that the drainage network dimensions for the Hanging Wall of JMT will be higher than those for the Foot wall. Fractal Dimensions for both HW and FW regions were found to be much less than 2 indicating constrained growth of drainage networks around this neotectonically active region. Further, comparison among the drainage networks crisscrossing through the HW and FW regions showed a subtle but discernibly higher values of fractal dimension estimates for the HW. Average Box Dimensions were found to be 1.39 and 1.35 for the HW and FW region respectively, whereas average Branching Dimensions were 1.35 and 1.33 for the two regions. The findings of our work favors our working hypothesis and presents a simple and objective methodology to study the effect of tectonics on drainage network fabric.