Features and controlling factors of drainage networks in the Tibetan Plateau

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Tibetan Plateau is the source of many major rivers in Asia. Drainage networks of these rivers vary in shapes and features due to complex climatic and geomorphic conditions. In this study, we extracted drainage networks in the source area of Yellow River, Yangtze River and Yarlung Zangbo River from 90-m-resolution SRTM DEM. We chose 62 sub-basins in the Yellow River, 96 sub-basins in the Yangtze River and 120 sub-basins in the Yarlung Zangbo River and tested self-similarity of drainage networks in two ways. First, we tested self-similarity for traditional Horton laws. Based on Horton-Strahler order, the results indicate that rivers with low levels generally obey Horton laws while rivers with high levels show deviation. Second, we tested statistical self-similarity in the topology of river networks. Random self-similar networks (RSN) model which combines self-similarity and randomness shows topological features of river networks statistically. Real networks were decomposed into generators that produce the network. The results demonstrate that the generators of RSN model obey a geometric distribution and the parameter \( p \), which describes the distribution of generators, ranges from 0.401 to 0.587. Self-similarity holds in a statistical sense in the selected basins in the Tibetan Plateau. Motivated by the need to understand the controlling factors of drainage networks in Tibetan Plateau, these sub-basins were divided into groups according to possible controlling factors, such as climate, tectonic and geology. Analysis shows that Horton ratios and generators of low-level rivers are affected by precipitation, but the relationship between these parameters of high-level rivers and these factors is not obvious. In order to further explore the controlling factors, we analyzed three typical rivers (Tao River, Yalong River and Lasa River) in more details. For Yalong River, Tao River and Lasa River, bifurcation ratios are 4.46, 5.00 and 4.37 while the length ratios are 2.35, 2.71 and 2.30 respectively. The Normalized Concavity Index for Tao River, Lasa River and Yalong River are -0.129, -0.082 and 0.009 respectively, indicating that the profiles of the first two rivers are concave-up and that of Yalong River is convex-up. The influence of climate is well reflected in the structure and longitudinal profiles of the drainage network in the Tibetan Plateau. Strong tectonic activities in the eastern margin of the Tibetan Plateau destroy the network of Yalong River, resulting in river capture to maintain equilibrium.