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Planform geometries and controlling factors of river networks in the Yellow River source zone

Minhui Li and Baosheng Wu

Tsinghua University, River Research Institute, China

The Yellow River source zone is located in the northeast of the Qinghai-Tibet Plateau. The landform of this zone is diverse, leading to various river network patterns. To explore the planform geometries and controlling factors of the river networks in this zone, 83 representative sub-basins are selected for the study. Based on the definitions and descriptions of different river network types, these sub-basins can be divided into four types, namely, dendritic, pinnate, rectangular, and symmetrical pinnate patterns. Using river network parameters, the classification trees are established to automatically classify river networks. The results show that the aspect ratio, drainage density and maximum frequency of flow directions play important roles in classification. Aspect ratios of basins characterize basin shapes, and the more elongated the basin is, the smaller the aspect ratio is. Thus, aspect ratios of pinnate and symmetrical pinnate patterns are lower than that of dendritic and rectangular patterns. The mean aspect ratios of dendritic, pinnate, rectangular and symmetrical pinnate patterns were 0.56, 0.29, 0.62, and 0.26, respectively. Drainage density reflects the relative spacing of drainage lines in a network. The tributaries of the pinnate pattern are long and concentrated, and the drainage density of this pattern is the largest, with an average of 1.92 km/km². Though the tributaries of the symmetrical pinnate pattern are also concentrated, most of the tributaries are short, and the drainage density is smaller than that of the pinnate pattern, with an average of 1.54 km/km². Mean drainage densities of dendritic and rectangular patterns are about 1.24 km/km² and 1.22 km/km². The maximum frequency describes flow direction distributions of river networks. The greater the value is, the rivers within the basin tend to flow in the same direction. The flow directions of tributaries in the dendritic pattern are free, and the mean maximum frequency is small, which is 2.48. For the rectangular pattern with lots of right-angle bends, the mean maximum frequency is 2.40. There is a dominant direction in the pinnate pattern. The mean value of the maximum frequency of this pattern is the largest, which is 8.11. Tributaries of the symmetric pinnate pattern are distributed symmetrically along the main trunk, and the mean maximum frequency is 3.36. To explore the controlling factors, correlation analysis is made between these river network parameters and topography (i.e. basin slope and relief) and climate (i.e. precipitation, temperature, and aridity). Compared with topography, climate is more strongly correlated with these river network parameters. In the Yellow River source zone, the pinnate pattern is mainly distributed in arid areas with little precipitation. Dendritic and symmetric pinnate patterns, the basin slopes of which are relatively larger, are more likely to occur in humid areas with more precipitation. The rectangular pattern is concentrated in the Ruogai basin, where the slope and relief are low and the climate is relatively humid.

