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Impact Analysis on Natural Cutoff Formation in Jingjiang River under Water and Sediment Condition -- A Case of Natural Cutoff at Shatanzi

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Objectives

Based on hydrological observation data of the upstream and downstream control stations of the cutoff river section, this paper analyzes the characteristics of water and sediment transport and ratio variation in such three stages as before, during, and after the natural cutoff of Shatanzi, and studies how the water and sediment conditions affect the formation and development of the natural cutoff at Jingjiang River.

Methods

The lower Jingjiang River bank is distributed with dual soil structure composed of clay soil and sand layer, resulting in poor anti-scouring. Before its natural cutoff, long duration floodplain flow scours the narrow neck area of bend in flood season, forming several large series of gullies. Based on the hydrological data of the control stations on both upper& lower reaches of the cutoff river section, the dates when the water level (Z) are higher than the lowest elevation of the gullies (30m) and lower than the lowest elevation of the narrow neck beach (33m) during the study period are statistically distinguished as per three periods in 1955-1966 (before artificial cutting), 1967-1971 (during artificial cutting) and 1972 (during natural cutting). Besides, annual variation of corresponding days, average water level, average water discharge, average sediment discharge, and average water gradient of cutoff section are compared under such three conditions as water level Z≥30m, 30m≤Z＜33m, and Z≥33m.

Results

Comparison of over-floodplain days shows that the average days of 30m≤Z < 33m before artificial cutoff in Xiajingjiang River account for about 2/3 of the days when Z≥30m, and this value rises to 0.75 during artificial cutoff, while the day when Z≥30m is 0 in the year when natural cutoff at Shatanzi, and the value reaches 1. Comparison of average annual water level, water discharge and sediment discharge in the three periods shows that the average annual water discharge and sediment discharge of 30m≤Z < 33m during artificial cutoff at Xiajingjiang River and natural cutoff at Shatanzi are greater than that before the artificial cutoff, while the average annual water level is smaller than that before the artificial cutoff, especially in 1971 and 1972. Comparison of annual water surface gradient on cutoff river section shows that the water gradient of 30m≤Z < 33m during artificial cutoff in Xiajingjiang is greater than that of Z≥30m and Z≥33m, and the gradient increases significantly compared with the same period before artificial cutoff. It indicates that the great energy of flood flow concentrates in the series gullies within the narrow neck area during artificial cutoff period, which undoubtedly creates favorable conditions for the subsequent natural cutoff. When natural cutoff occurred at Shatanzi in 1972, the flood peak level was only 31.96m, which was lower than the beach surface elevation. When water of cutoff section flowed over bottom of the gullies in end of May, the water surface gradient reached about 0.500×10^{4}. Water flow with large gradient directly cut through the gullies and formed natural cutoff during flood season, which greatly increased the water surface gradient in the cutoff section in that year.

Conclusions

It can be seen from the above results that under the premise of poor impact resistance of the Lower Jingjiang River bank, several large series gullies formed by the long duration of scouring on narrow neck area have laid the foundation for the cutoff before the natural cutoff at Shatanzi bend. Two artificial cutoff works result in water level drop and increase of water surface gradient in the river section where Shatanzi bend located, further guiding the water and sand conditions to the direction favorable to natural cutoff of the bend. Natural cutoff occurred in low-flow year, floodplain flow during flood season has a large energy and most of the time concentrates in the gullies, which has more intense scouring to the narrow neck area, until finally achieves the condition to form natural cutoff. This result shows that the formation of natural cutoff in lower Jingjiang River is not an overnight process, but a gradual process from quantitative change to qualitative change. Only when certain conditions are fulfilled can cutoff be realized.

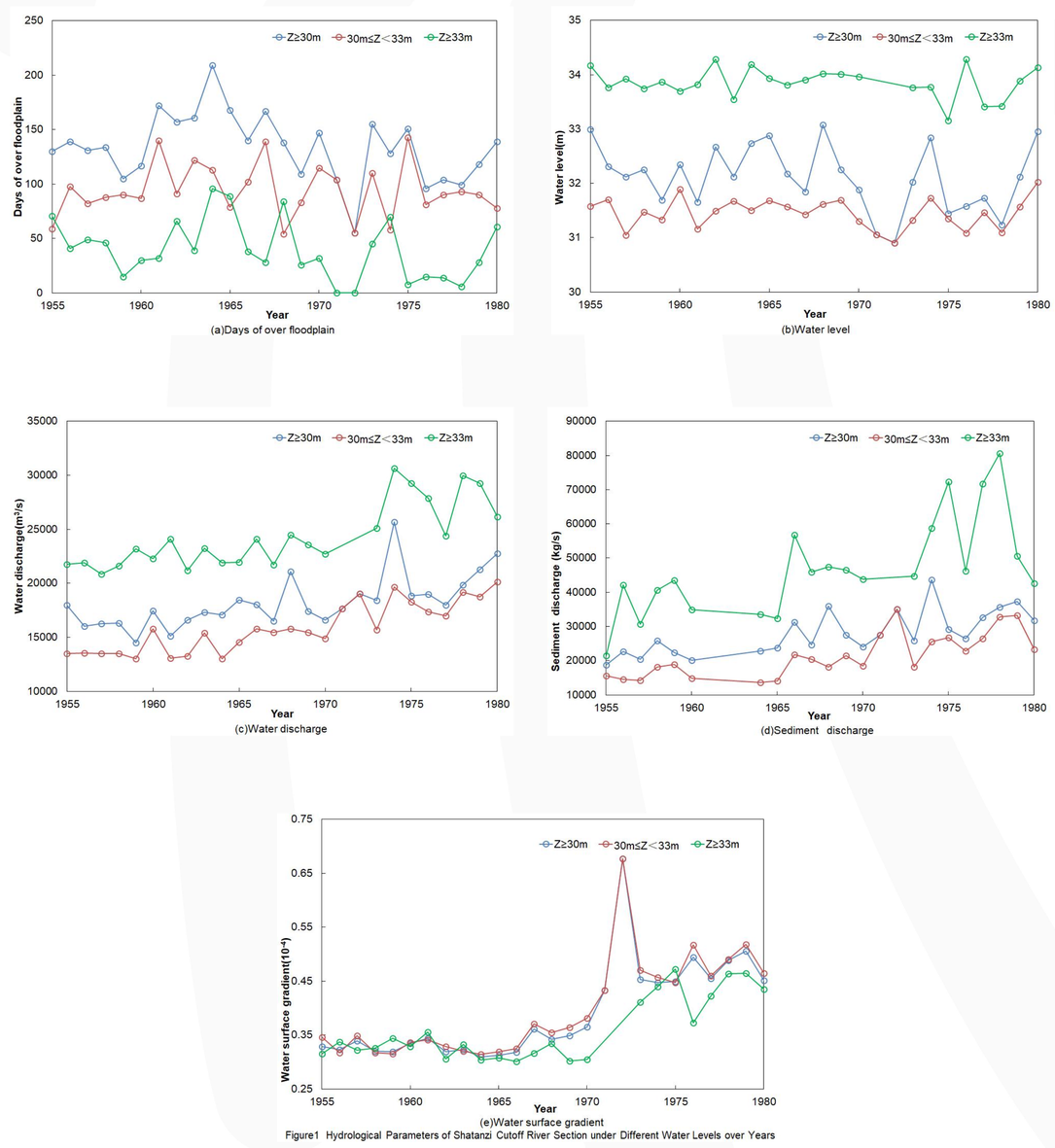

Figure1 Hydrological Parameters of Shatanzi Cutoff River Section under Different Water Levels over Years