学　位　論　文　内　容　の　要　旨

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学　位　論　文　題　名

Study on the effect of upstream water and sediment discharge conditions to the alternate bar dynamics in gravel-bed rivers

(上流からの流量と給砂条件が礫床河川の交互砂州動態に与える影響に関する研究 )

Flow and sediment supply are two main roles affecting river morphology and lots of research has been done on these two aspects, giving us a comprehensive understanding. In both fields, water and sediment supply from the upstream reach have been assumed constant in time to understand fundamental characteristics of river morphology, providing important insights in terms of geological and engineering perspectives. In other words, for example, simplification of the discharge variability (i.e., hydrograph) to a single, steady formative (or dominant) discharge does not generally affect the fundamental physics of river morphologies. However, the specific impact of flow and sediment supply on river morphology is not apparent since the unsteadiness of water discharge and nonequilibrium sediment supply conditions do affect the downstream river morphologies. Due to the limitation of experiment and observation means, it is difficult to observe the general response of river morphology to changes in flow and sediment supply conditions and quantify and specify the scale of the response. In this research, the long-term behaviors of migrating alternate bars subject to repeated unsteady flow and sediment supply conditions are investigated. To do so, this research contains mainly two parts, expounds on the influence of unsteady flow and sediment transport on migrating alternate bars under long-term hydrograph.

Regarding the effect of imbalanced sediment supply on rivers morphology, we apply the hydrograph boundary layer (HBL) concept, which indicates upstream riverbed changes caused by the imbalance of sediment supply to the capacity can propagate only a limited length and have a negligible effect on the riverbed beyond such a short length. We performed a two-dimensional morphodynamic calculation to test the concept of HBL, which was proposed under a one-dimensional simulation, meaning whether the concept of HBL is still valid for plane changes in river morphology. We employed an unsteady flow with equilibrium or constant sediment supply in a straight, modeled gravel-bedded channel with an unerodable bank to simulate alternate bar morphodynamics. The results show that regardless of the sediment supply condition, the alternate bar features formed downstream of the HBL are considerably similar. This suggests that sediment disturbance at the upstream end has a large impact on the bed evolution within the HBL but has a negligible effect on the mobile-bed dynamic processes, including alternate bar formation and development downstream of the HBL.

In the study of the sediment supply above, a unique alternate bar behavior is found, that is, even under unsteady flow conditions, a specific combination of hydrograph cycles and discharge variations results in an equilibrium state of migrating alternate bars (i.e., non-time dependent wavelength and migration period). To investigate this equilibrium behavior of alternate bar dynamics in the long-

term for unsteady discharge conditions, we obtain repeated, simple triangle hydrographs to the upstream boundary condition for movable bed numerical simulations, to understand the long-term morphodynamic behaviors of migrating alternate bars. This may be a unique feature of the alternate bar morphodynamics, as a dynamic equilibrium state arising from steady discharge counterparts shows time-dependent features. The hydrograph cycle that achieves this equilibrium state must be moderately long such that the timescale of the hydrograph is similar but slightly smaller than the bar growth. Therefore, in the time scale, the effect of the duration of the hydrograph cycle on river morphology is significant.

Meanwhile, some unique morphodynamic properties have been put forward, suggesting unfair erosion/deposition exists under the condition of morphodynamics equilibrium, which might be significant for the study of river disasters.

In conclusion, alternate bars show different morphodynamics properties when facing changes in discharge or sediment supply. For the imbalance of sediment supply, the response of the riverbed has limited within HBL, which suggests sediment disturbance at the upstream end has a negligible effect on the mobile-bed dynamic processes, including alternate bar formation and development downstream of the HBL. For unsteady flow, the different response times of migration and elevation variation make the duration of the hydrograph cycle a dominant factor affecting alternate bars morphodynamics. The hydrograph cycle that achieves this equilibrium state must be moderately long so that the timescale of the hydrograph is similar but slightly smaller than the bar growth timescale, but not too small to allow equilibrium bar behaviors caused by steady discharge conditions, or too long to provide sufficient time for the deformation and development of alternate bars.