Feedback Mechanism in Bifurcating River Systems: the Effect on Water-Level Sensitivity

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Abstract

Accurate and reliable estimates of water levels are essential to assess flood risk in river systems. In current practice, uncertainties involved and the sensitivity of water levels to these uncertainties are studied in single-branch rivers, while many rivers in deltas consist of multiple distributaries. In a bifurcating river, a feedback mechanism exists between the downstream water levels and the discharge distribution at the bifurcation. This paper aims to quantify the sensitivity of water levels to main channel roughness in a bifurcating river system. Water levels are modelled for various roughness scenarios under a wide range of discharge conditions using a one-dimensional hydraulic model. The results show that the feedback mechanism reduces the sensitivity of water levels to local changes of roughness in comparison to the single-branch river. However, in the smaller branches of the system, water-level variations induced by the changes in discharge distribution can exceed the water-level variations of the single-branch river. Therefore, water levels throughout the entire system are dominated by the conditions in the largest branch. As the feedback mechanism is important, the river system should be considered as one interconnected system in river maintenance of rivers, flood-risk analyses, and future planning of river engineering works.

Keywords: river bifurcation; discharge distribution; sensitivity analysis; main channel roughness; hydraulic modelling; Rhine river; flood risk management

Water 2020, 12, 1915; doi:10.3390/w12071915 www.mdpi.com/journal/water