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A quasi-steady model for morphological change of a stream following a weir removal

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ABSTRACT. According to the National Fishery Information System, the number of weirs installed on rivers in Korea as of 2025 is approximately 34,000. Each year, approximately 150 weirs are newly constructed, and 100 weirs are decommissioned due to urbanization and declining agricultural water demand. Many of the abandoned weirs remain instream, blocking sediment transport to the downstream reach, disrupting ecological connectivity, and deteriorating upstream water quality. Over 90% of weirs are more than 30 years old, and 5,900 are structurally damaged, underscoring the need to remove abandoned, aged, and damaged weirs. However, previous studies on morphological changes after dam or weir removal are rare. This study presents numerical simulations for morphological changes following the removal of Gongneung Weir-2 using a quasi-steady flow model. The quasi-steady model assumes steady-flow conditions over short time intervals, based on the premise that flow changes much faster than stream morphology. The quasi-normal flow assumption by Cui et al. (2006) is adopted to compute post-removal bed evolution, particularly to address discontinuities formed by upstream sediment deposits. Total sediment load was estimated using the Engelund-Hansen's formula, and morphological changes were calculated using the Exner equation. Gongneung Weir-2 is a 1.5 m high instream installation constructed in the 1970s on the Gongneung-cheon Stream, a tributary of the Han-gang River. The weir was removed on April 14, 2006, due to a land-use change in the nearby area. The study reach is a 1.0 km section that includes the location of the removed Gongneung Weir-2. Topographic survey data are used for initial conditions and model validation. The simulation was conducted to evaluate the time required for the bed to reach morphological equilibrium. After the weir removal, the bed slopes in both upstream and downstream reaches changed abruptly at the beginning. A comparison with measured data reveals that the numerical model successfully simulates the morphological change after weir removal. Even considering field conditions, it takes less than a month to reach equilibrium, in which the slope upstream of the dam equals the slope downstream. The quasi-steady model successfully reproduced morphological changes following weir removal, indicating its utility for river restoration and for predicting sediment transport.

This work was supported by Korea Environment Industry & Technology Institute(KEITI) through「Research and Development on the Technology for Securing the Water Resouces Stability in Response to Future Change(RS-2024-00335281)」Program, funded by Korea Ministry of Climate, Energy, Environment(MCEE)