The Effects of Hydraulic Structures on Streams Prone to Bank Erosion in an Intense Flood Event: A Case Study from Eastern Hokkaido

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INTRODUCTION

Rivers in Japan are often equipped with various types of hydraulic structures to control sediment delivery for disaster prevention. In an intense flood, channel responses should differ between rivers due to their types and the arrangement, for they are supposed to alter the intrinsic pattern of sediment delivery not only for the vicinity of the structures but also through a fluvial network considering the continuity of sediment and water flux. In this study the manner of channel responses to an intense storm are compared for two neighboring rivers of the Tokachi River Basin, Pekerebetsu and Kobayashi Rivers, in the eastern Hokkaido Island (**Fig. 1**). In particular, the study presents the effects of the structures, which work for either trapping sediment (dams) or protecting erosion (groundsills and revetments), on the changes in channel forms in the rivers prone to bank erosion.

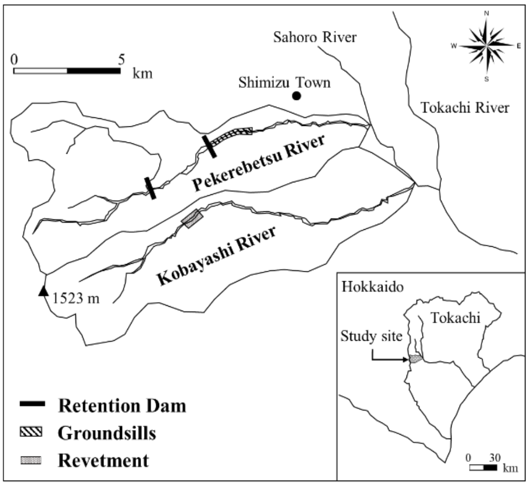

Fig. 1 Study site

Tab. 1 Geomorphological and geological features of the study rivers

River	Catchment area (km^2)	Channel slope (°)	Geology	Installed structures
Pekerebetsu	46.6	3.58	Granite, Granodiorite, Periglacial slope deposits, Pelitic hornfels, Alluvial deposits	・2 retention dams ・Groundsills
Kobayashi	41.9	3.49	Granite, Granodiorite, Periglacial slope deposits, Alluvial deposits	Revetments

STUDY SITE and METHODS

The study rivers are geomorphologically and geologically resembled but installed structures differed (**Tab. 1**). Active channel width of both were narrower than 10 m prior to the event, running through incohesive materials derived from periglacial deposits, debris flow, or fluvially transport. Typhoon Lionrock brought an intense storm over the region in August 2016, drastically changing the entire channel features by mostly widening. Change in active channel width was measured on aerial photographs and Landsat Images every 100 m. At the same time, channel plan forms were traced. Airborne LiDAR data for Pekerebetsu River were used to evaluate change in elevation. Because the data did not cover Kobayashi River, 20 cross section lines set about every 500 m were instead measured to estimate channel changes caused by the typhoon.

RESULTS and DISCUSSION

It was common for both the rivers that debris flow occurred in the event scoured the channel beds along the course steeper than 6.5 degrees in Kobayashi river and 8.2 degrees in Pekerebestu River (**Fig. 2**). Then, debris flow started depositing in the downstream. Field observation and cross sectional survey presented that the deposits triggered channel aggradation and bank erosion in the successive reaches. In Kobayashi River, the process continued through to the 16.6 km. On the other hand, in Pekerebetsu River, No.2 dam trapped sediment and contributed to bed aggradation and channel widening up to 200 m their upstream, (8 - 9 km, **Fig. 2**). In turn, the reduction of the amount of sediment travelled resulted in channel degradation in the downstream from groundsills (11-13 km, **Fig. 2**). Nevertheless, bank erosion occurred to widen the beds there too. Sediment provided from the banks then aggraded and widened further downstream (13-15.6 km). The average width of the downstream section from the groundsills, 11-15.6 km, was 69.7 m. The value was, in fact, almost the same for the course with similar bed slope (< 1 degree) in Kobayashi River, 70.6 m (12-16.6 km).

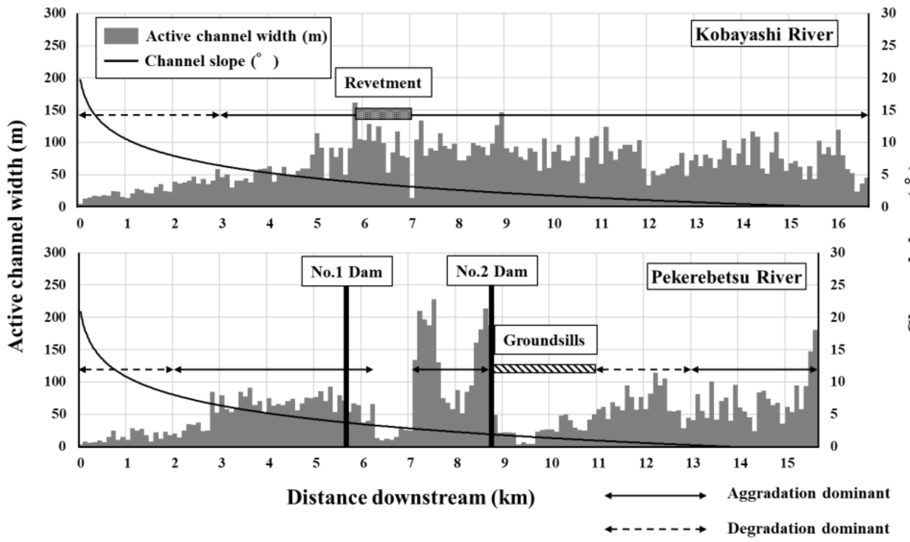

Fig. 2 Active channel width and channel slope of the study rivers after the event.

CONCLUSIONS

This study demonstrated that in laterally erosive environment, hydraulic structures affected on channel forms in their vicinities. After all, the channel courses could expand to the same degree in their downstream, seemingly irrespective of the types of hydraulic structures installed. The results provide an opportunity to rethink the way of designing hydraulic structures in those river systems, to prevent from unwanted changes in channel forms that possibly cause disasters.

Keywords: Channel widening, Bank erosion, Hydraulic structures