Development of Channel Design Techniques for Small and Medium-sized Rivers where a Large Amount of Sediment Flows in from the Upstream

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1. Introduction

In recent heavy rains, much damage has also been caused by what is called a "sediment and flood inundation," which refers to the inundation of sediment and flood in the downstream due to the inflow of sediment caused by a sediment disaster in the upstream into the river channel (e.g., Photo 1). This study strives to grasp phenomena through waterways experiment to examine channel design techniques for damage mitigation.

2. Grasp of phenomena by waterways experiment

In order to grasp the basic phenomena of sediment and flood inundation, we conducted a waterways experiment simulating a section from a place between mountain torrent part to a valley plain part. In the waterway upstream section corresponding to the mountain torrent, a large amount of sand is supplied to the extent possible. The waterway downstream into which the sand flows and which corresponds to the valley plain consists of (i) a channel with the same river width as the upstream section and small channel bed gradient and (ii) the flood plain where width expands as water flows down.

In the experiment case 1 where very coarse sand (mean diameter of 1.5 mm) corresponding to boulders in local scale conversion, deposition onto the channel bottom started when water flowed into the valley plain and when water flow was continued, the channel was clogged at spots where deposition proceeded and the deposition area rapidly expanded to the valley plain (Photo 2). This would be attributable to tractive force being reduced by thin flow expanding to the flood plain due to the clogged channel.

On the other hand, in the sediment and flood inundation that occurred in the Akatani River at the time of the 2017 Northern Kyushu Heavy Rain, the channel was clogged by the sediment mainly consisting of sand and small gravels carried in a floating form, considering the hydraulic quantity at flooding. In order to reproduce this phenomenon, we conducted experiment case 2 in which fine sand (mean diameter of 0.2 mm) whose grain size is smaller by 1 order than the case 1 was supplied. As a result, although there was some deposition of sediment on the channel or flood plain, clogging of the channel did not occur in the duration (about 40 seconds) in which water flow is possible with the relevant equipment (Photo 3).

Photo 1: Sediment and flood inundation in the July 2018 Heavy Rain

Photo 2: State after water flow in the experiment case 1 (grain size of 1.5 mm)

Photo 3: State after water flow in the experiment case 2 (grain size of 0.2 mm)

3. Future activity

At present, sand supply equipment that can continue supply stably a plenty of fine grain sediment for a long time is being manufactured and we continue to grasp the process of sediment and flood inundation.

In the recent events of sediment and flood inundation, there were sections of weathered granite and unconsolidated volcanic ash geology in the upstream, and some cases where a large amount of fine grain sediment was supplied were reported in recent years. We intend to study through experiments how to establish a channel design method where a large amount of fine grain sediment is supplied in rapid rivers where river bed consists of boulders etc.