Characteristics of Bedload Transport in Republic of Korea - Using the Hydrophone Monitoring System -

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INTRODUCTION

Predicting sediment yield depending upon watershed characteristics is important in disaster prevention and soil erosion control works. Recently, large scale debris flows frequently occur in Korea due to heavy rainfall caused by extreme weather or climate change. So, clarifying watershed condition is one of key efforts to mitigation of such a debris flow disasters. In this study, we conducted sediment discharge monitoring for six watersheds in Korea, to monitor sediment discharge condition for future erosion control works and comprehensive management of soil.

There are two types of methods to measure bedload transport; direct and indirect. Direct measurements for bedload transport is relatively accurate, though it requires human resources, time and cost, whereas the indirect method uses some hydrological data for calculation of the amount of sediment, which is less accurate, but more efficient in terms of human resources, time and cost. In Korea, we combined two of methods to establish monitoring systems using acoustic sensors developed in Japan.

MATERIAL AND METHOD

In this study, we used Japanese acoustic pipe sensors (hydrophones), slot sampler, water level gauges, current meters, rain gauges, CCTVs and turbidity meters installed in the bedload monitoring systems.

There are two objectives of monitoring. The first object is the test of effects of forest disasters on sediment discharge. So, we installed the system at watersheds damaged by forest fires and landslides, and watersheds covered by undamaged forest. Second objective is the test of role of bedrock geology on sediment discharge. So, the systems were installed at three typical rock type areas, including igneous, metamorphic and sedimentary rocks.

RESULTS

Figure 1 shows the comparison of the water level at the bedload transport started (BRS) in a landslide-damaged forest and a undamaged forest as a control. As a result of comparison, the water level at the BRS point was 16.7cm (control 1), 12.0cm (control 2) and 10.9cm (landslide-damaged forest). Compared to the control site, the landslide-damaged forest, showed a higher bedload transport rate, even with the lower water level.

In the dry season having small cumulative rainfall, the bedload transport occurred only when the duration of rainfall was long (Landslide 1). Cumulative rainfall, duration of rainfall and rainfall intensity have a large impact on the bedload transport, but it was difficult to pinpoint the most effective factor in this study. **Figure 2** shows the rainfall characteristics of the cases where bedload transport occurred and the cases where it did not occur. It is considered that a larger database is needed to obtain clearer analysis results.

In the landslide-damaged forest, the bedload transport rate showed a positive correlation with the water level (R^2 = 0.4009) in the range between BRS ~ BR90 (Bedload transport rate 90%), and the bedload transport rate decreased to the peak water level after BR90. This phenomenon might have occurred because most of the movable bedload were transported during the rainfall. It was observed that most of the bedload transported around the highest water level during rainfall.

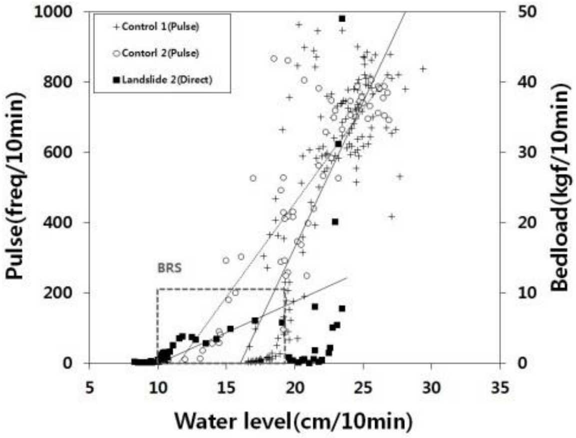

Fig. 1 Relationship between pulse water level when bedload transport

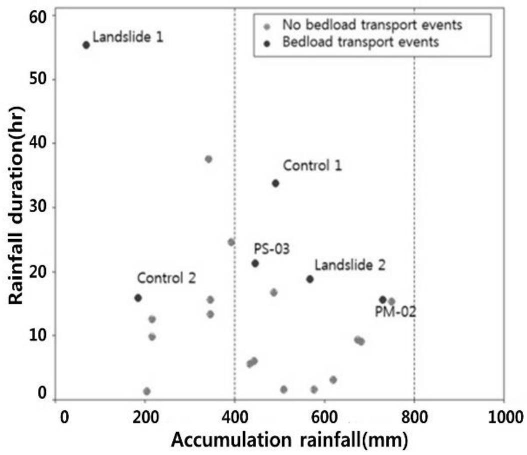

Fig. 2 Relationship between rainfall duration accumulation rainfall when bedload transport

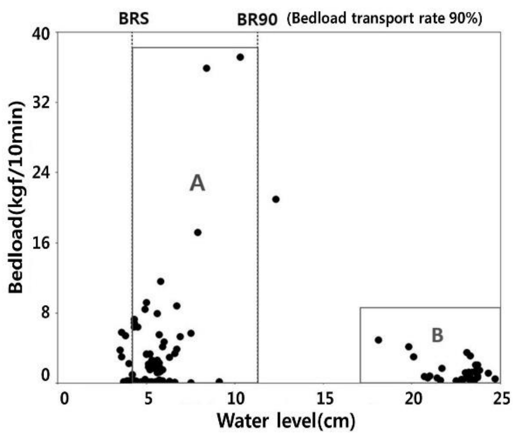

Fig. 3 Relationship between bedload water level in landslide-damaged forest

CONCLUSIONS

The bedload transport characteristics of the forest watershed by rainfall events were analyzed through the hydrophone monitoring system using acoustic sensors. An important result obtained by this study was that the bedload transport rate occurred in landslide-damaged forests, with less rainfall and lower water level than those in the control forests. Therefore, an urgent soil erosion control works seems to be required to prevent the second damages in landslide-damaged forests. It is expected that a larger database will increase the reliability of this result, and will help better understanding of the soil erosion control works and the bedload transportation mechanism.

Keywords: Hydrophone, Landslide-damaged, Bedload transport rate, Water level, Rainfall