Sediment discharge and flow discharge observations in mountain rivers to contribute to general sediment management

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1. Introduction

In order to resolve various problems related to dam sedimentation, aggradation and degradation of riverbeds, shoreline erosion, and other sediment movement, it is necessary to perform general sediment management as part of a sediment transport system. Therefore, it is important to clarify the quantities and the characteristics of flow discharge and sediment discharge from the mountains where sediment is produced.

The Ministry of Land, Infrastructure, Transport and Tourism has been performing nationwide sediment discharge and flow discharge observations and improving this observation system since 2009. The Erosion and Sediment Control Division provides technological support for observation methods, has developed a method of converting observed data to sediment discharge rate, and has developed a database system.

2. Outline of sediment discharge and flow discharge observations

Flow rate, suspended sediment discharge, and bedload discharge are observed. Flow rate is obtained by measuring the water level with a water level gauge and solving a water level – flow rate relational equation. The suspended sediment discharge is obtained by multiplying flow rate by suspended sediment concentration measured by a turbidity meter. The bedload discharge sensor is described in the next section.

3. Method of analyzing observed data obtained by a bedload discharge sensor (hydrophone)

The device used as a bedload discharge sensor, which is a steel pipe containing a microphone, is called a hydrophone (Photo 1). The sound pressure value is calculated from the impact sound wave of the bedload, then converted to sediment discharge rate[1)]. The sound pressure value is the averaged value of the amplitude of the impact sound waves and it can be used in much the same way as the sound volume. When a sand or gravel particle impacts the hydrophone individually, the sound pressure value is proportional to the volume of a particle. When a group of particles impact it, the more particles, the larger the sound pressure value. However it is not proportional to the total volume. This is because the sound pressure value is reduced due to the destructive interference of sound waves. The reduction rate is large when the number of particles per unit of time is large. For example, even if particles with the same volume impact the hydrophone, the smaller each particle, the more the sound pressure volume decreases because the number of particles becomes larger (Fig. 1). Bedload discharge is calculated based on these relationships by a numerical calculation.

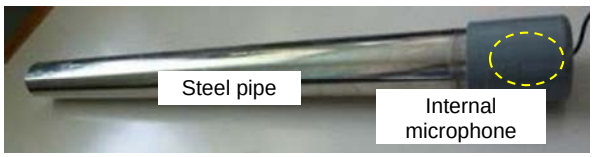

Photo 1. Hydrophone

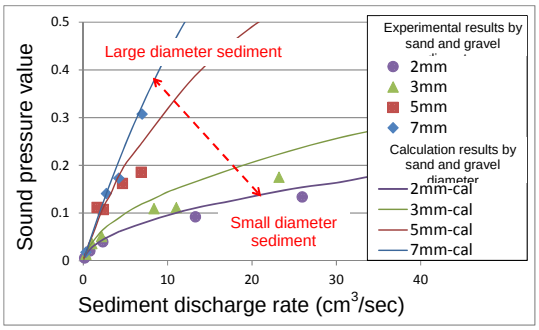

Figure 1. Sediment Discharge Rate - Sound Pressure Value Relationship (Experimental Results and Calculation Results)

4. Future plans

The observed data will be used for general sediment management and crisis management. And it is stored in a data base system. The improvement of the method of converting observed data to bedload discharge rate is planned, through the verification of measurement accuracy in field observations.

[Reference]

1) T. Suzuki, H. Mizuno, N. Osanai, R. Hirasawa, Y.

Hasegawa (2010): Basic study on sediment rate measurement with a hydrophone on the basis of sound pressure data, Journal of the Japan Society of Erosion Control Engineering, Vol. 62, No. 5, p. 18-26, 2010.