Influence of Sediment Particle Size Constituting Riverbed on Sediment Transport after Huge Sediment Supply

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INTRODUCTION

To understand long-term (years to decades) watershed sediment dynamics, it is important to clarify sediment transport mechanisms that may remain active for long periods following high-volume sediment supply events in upstream regions of the water basin. Horie et al. (2016) investigated 11 river basins that had experienced high-volume sediment supply events and used a time series analysis to quantify the influence period, i.e., that during which the amount of sediment transported becomes larger than usual. It is recognized that the influence period varies among river basins and is possibly affected by sediment particle size. However, the processes induced this difference have not been examined quantitatively. In this study, we analyzed the influence of temporal variation in sediment particle size on sediment runoff.

METHODS

To express sediment transport potential, Okumura (1991) proposed the parameter *ARI*, where *A* is river basin area, *R* is amount of precipitation, and *I* is channel slope. Moreover, to take sediment particle resistance against flow into account, we introduce ARI/d^3, where *d* is particle diameter. For a high-volume sediment supply event, we calculated *ARI* and ARI/d^3 for four periods; A) before the event, B) just (i.e. one year) after the event, C) during the influence period (defined such that the amount of sediment runoff is larger than usual amount seen in period A), and D) after the influence period. We also analyzed the relationship between these parameter and sediment runoff. In this study, we select average value of channel slope in watershed as *I*. We selected six watersheds, in the Imokawa River basin, the Kawabe River basin, the Koshibu River basin, the Otaki River basin, the Ibigawa River basin and Urakawa River basin. *A* are 38.4, 97, 288, 304, 471, 22 km^2, respectively and *I* are 0.017, 0.05, 0.029, 0.014, 0.017, 0.17, respectively. We collected as many sediment diameter values as possible from archives and conducted field surveys to obtain particle size distributions.

RESULTS AND DISCUSSIONS

Figure 1 shows the temporal variation of the average, maximum, 10, 30, 50 and 60% particle sizes at the same dam. Particle size became fine during period B and increased gradually thereafter. **Figure 2** shows the temporal variation in average particle size for all river basins, which follows the same trend. **Figure 3** shows the relationship between *ARI* and the amount of sediment runoff. In **Figure 3**, the data for period D are distinguished depending on whether the ratio between sediment runoff and sediment supply, which has been calculated by Horie et al.(2016), exceeds 0.7 or not.

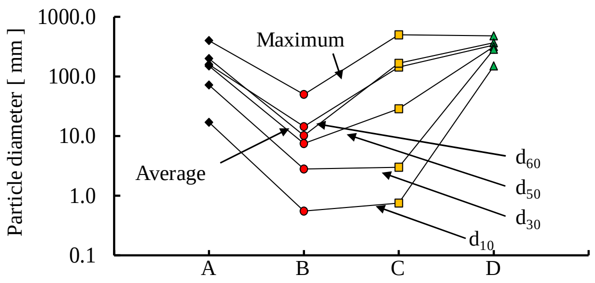

Figure 1. Sediment particle parameters before and after a high-volume sediment production event in the Kawabe River basin.

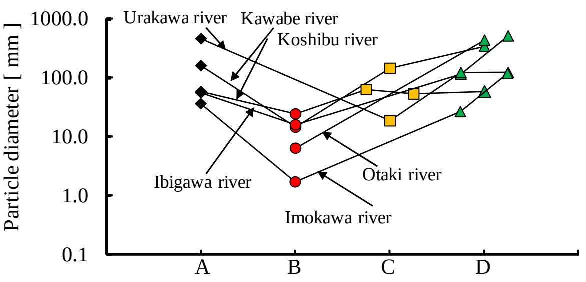

Figure 2. Average sediment particle diameter before and after a high-volume sediment production event.

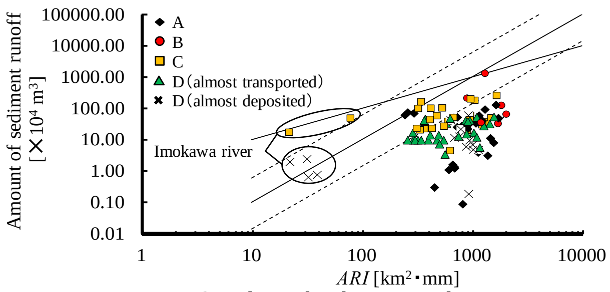

Figure 3. Relationship between sediment transport potential (*ARI*) and sediment runoff.

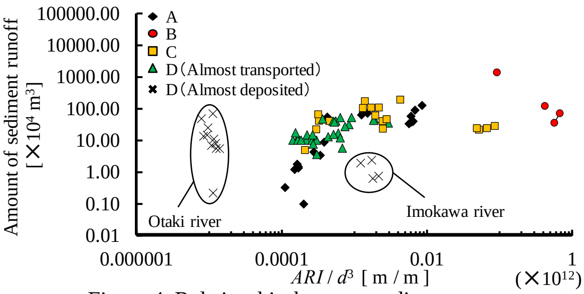

Figure 4. Relationship between sediment transport potential adjusted for particle size (ARI / d^3) and sediment runoff.

Adherence to the solid line indicates ample sediment in the basin available for transport by water flow. During periods B and C, the data clustered around the fitted line, whereas in periods A and D they did not. The data for periods C and D in the Imokawa River basin also followed the fitted line. We estimate that most of the sediment produced was composed of fine sand. **Figure 4** shows the relationship between ARI / d^3 and sediment runoff. ARI / d^3 and sediment runoff were positively correlated, indicating that sediment runoff is more precisely estimated using ARI / d^3 than *ARI*. The data for the Otaki River basin during period D appear on the left-hand side despite the large sediment runoff occurred. In the case of the Imokawa River basin, the data for period D plotted lower than all other data points. These anomaly may have occurred due to topographical influences.

CONCLUSIONS

Our findings confirm that sediment transport potential is more precisely estimated by incorporating sediment particle size during and after high-volume sediment supply events. However, this study must consider effects such as functions of check dam on sediment runoff and deserves further investigation.

REFERENCES

Horie et al. (2016): Abstracts of 2016 JSECE Annual Conference B, p. 32-33 (In Japanese)

Okumura (1991): Shin-SABO, Vol. 43, No.5, p. 19-26 (In Japanese with English abstract)

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