Prolonged Effects on Catastrophic Sediment Yield on Catchment-scale Sediment Dynamics

Taro UCHIDA[1*], Hiroaki IZUMIYAMA[1] and Katsuya HORIE[2]

[1] National Institute for Land and Infrastructure Management, Japan
[2] IDEA Consultants, Tokyo, Japan
[*]Corresponding author. E-mail: uchida-t92rv@mlit.go.jp

INTRODUCTION

Heavy rainfall and huge earthquake often induced catastrophic sediment yield. For example, a huge earthquake "Hietsu earthquake" occurred in 1858 in the central part of Japan induced huge landslide "Tonbi Kuzure" at the headwater of Joganji River in Toyama Prefecture. The volume of the sediment yield due to the landslide was estimated as more than hundred million m^3. Previous studies showed that the frequency of flood was dramatically increased at the lower reach of Joganji river after the catastrophic sediment yield due aggradation of riverbed (e.g., Ikeda, 2011). Moreover, the riverbed at the lower reach of Joganji river continuously increased. Consequently, the high frequency of flood was continued until more than 50 years after the catastrophic sediment yield. So, it can be considered that we have to manage sediment discharge during not only the huge single events, but also the following period after the huge event for sustainable development. Several case studies have been conducted about this issue (e.g., Koi et al., 2008). However, information about sediment dynamics in the following period after the catastrophic event are still limited. Here we compiled 18 sediment yield events data to clarify prolonged effects on catastrophic sediment yield on catchment-scale sediment dynamics.

DATA AND METHODS

In this study, we surveyed 11 catchments in Japan. Areas ranged between 19 and 471 km^2. We focused 18 sediment yields events. Thirteen events were triggered by rainfalls and 5 were induced by earthquake. Volumes of sediment yield ranged from 0.6 to 130 million m^3. The largest sediment yield event was the Hietsu earthquake. We compiled rainfall, stream flow and sediment discharge data. We mainly used annual deposited sediment volume at the water reservoirs for clarifying sediment discharge. We also compiled annual deposited sediment volume at Sabo dam for few sites. Moreover, we used aerial photographs to clarify spatial and temporal patterns of landslide. We estimated landslide volume through empirical scaling functions between landslide area and landslide volume.

Then, we defined "affected period" as the following period after the extreme sediment yield which sediment discharge was elevated. To remove effects of rainfall amounts, we used the ratio of sediment discharge volume to annual maximum daily rainfall amount, since we found relatively good correlation between sediment discharge volume and maximum daily rainfall during the each observation period. So, if the ratio sediment discharge volume to the annual maximum daily rainfall had been declined at the same level before the sediment yield events, we considered affected period was finished.

RESULTS

We found elevated sediment discharge in the following period after sediment yield events in 16 events (**Fig. 1**). While, two events are occurred during the affected periods of previous events. Although these two events yielded a lot of sediment, an increase of sediment discharge was not obvious after sediment yield event. These two events occurred in the following period after the extremely large sediment yield events, i.e., Hiestu earthquake (V=130 million m^3) and Kanto earthquake occurred in 1923 (V=40 million m^3). Koi *et al.* (2008) already argued that the effect of rain storm in 1972 was masked by extra ordinal event induced by Kanto earthquake in Nakgawa river. In Jouganji river, as similar to Nakgawa river, effects of rain storm in 1968 might be masked by prolonged effect of Hietsu earthquake, although sediment yield volume was relatively large 13 million m^3.

Length of affected periods ranged from 1 year to more than 100 years. The affected periods were shorter than 10 years, except for three seismic events yielded more than 30 million m^3 of sediments. While, affected periods of three extra ordinal events became longer than 20 years. So, the affected period length was related to sediment yield volume, suggesting that the effected period can be roughly estimated by sediment yield volume.

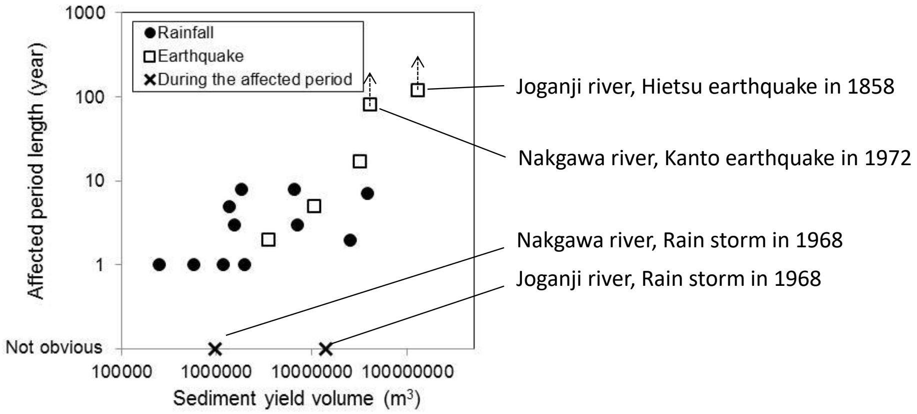

Fig. 1 Relationship between sediment yield volume and affected period length

CONCLUSIONS

Here we argued prolonged effects of catastrophic sediment yields on catchment scale sediment dynamics. Once catastrophic event yielded more than 30 million m^3 of sediments, sediment discharge can be elevated more than few decades.

References

Ikeda, A. (2011) Sediment discharge from large-scale collapse and its countermeasure－A Case History of the Sabo Works at Joganji River－, Journal of the Japan Society of Erosion Control Engineering, 64(3), 57-63.

Koi, T. et al. (2008) Prolonged impact of earthquake-induced landslides on sediment yield in a mountain watershed: The Tanzawa region, Japan, Geomorphology 101 692–702

Keywords: Catastrophic sediment yield, Earthquake, Landslide, Heavy rainfall. Sediment discharge