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Interdecadal trends of sediment discharge in mountain watersheds in Japan

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After sediment production, such as by a landslide, some sediment immediately discharges from the basin outlet. However, part of the sediment remains in the basin, to be removed and re-deposited by subsequent rainfall and flooding before finally being discharged. Such sediment dynamics occur at various timescales, depending on the frequency and magnitude of sediment production and the various agents of sediment transport. Thus, interdecadal trends of sediment discharge differ by watershed. Understanding sediment dynamics over longer timescales is important for studies of geomorphological processes and for basin management. This study examined factors associated with interdecadal sediment discharge by comparing two mountain watersheds in Japan. The study sites were the Nakagawagawa watershed (39 km^2) in the Kanto district, where widespread landslides were induced by a catastrophic earthquake (M 7.9) in 1923, and the Dogawa watershed (81 km^2) in the Kyushu district, where heavy rainfall events (continuous rainfall of over 1000 mm) have repeatedly triggered landslides. Long-term reservoir sedimentation data were available for both watersheds, covering 25 years in the Nakagawagawa watershed and 53 years in the Dogawa watershed. Although both watersheds had high sediment yield (10^3 $m^3km^{-2}year^{-1}$ order) for their decadal averages, the interdecadal time series showed different waveform trends. The waveform of the Nakagawagawa watershed was nearly constant over 25 years. The waveform of the Dogawa watershed showed interdecadal fluctuation over 50 years. These waveforms were distinguished according to the difference between maximum and minimum sediment yields of the N-year moving average. Annual sediment discharges roughly corresponded with the rainfall magnitude, yet rainfall was not a main factor controlling interdecadal variability of sediment discharge. These sediment dynamics can be discussed from the perspective of temporarily stored sediment. In the Nakagawagawa watershed, the abundant temporarily stored sediment produced by earthquake-triggered landslides was discharged with rainfall and, consequently, high sediment discharges continued for a long time. On the other hand, in the Dogawa watershed, high sediment discharges were concentrated only after landslide occurrences; in other periods sediment discharge was moderate, regardless of rainfall magnitude. When temporarily stored sediment abounded in the watershed, high sediment yields corresponded with rainfall events. In contrast, when temporarily stored sediment was not abundant, sediment yield was moderate, regardless of rainfall magnitude. Hence, the interdecadal variability of sediment discharge was dictated not only by rainfall but also by the amount of temporarily stored sediment. This study shows that temporarily stored sediment was closely associated with sediment dynamics on the interdecadal timescale and that waveforms of sediment discharge reflect fluctuation of the temporarily stored sediment.