Critical Rainfall Thresholds for Hydrological Processes Leading to Debris Flow due to Torrent Bed Material Scouring

Yasushi SANO[1*], Takashi YAMADA[2], Tsuyoshi IKESHIMA[3] and Sadakazu MATSUMOTO[3]

[1] Nippon Koei CO.,LTD,Japan (former Graduate School of Bioresources,Mie University,Japan)

[2]Graduate School of Agriculture,Hokkaido University,Japan(former Graduate School of Bioresources,Mie University,Japan)

[3]Nippon Koei CO.,LTD,Japan

*Corresponding author. E-mail: a8359@n-koei.co.jp

INTRODUCTION

11 Debris flows due to torrent bed material scouring occurred at the Nishinokaito River of Mount Fujiwara in Inabe City of the Mie Prefecture, Japan between 1999 and 2012. Our hydrological observations including runoff of subsurface flows from the torrent bed material, aim to reveal the mechanism of hydrological processes(pipe flow, clogged pipe exit, and debris flow) leading to debris flow and to propose a method to predict the timing and magnitude of debris flow. Due to high-intensity rainfall, hydrological processes including pipe flow and clogged pipe exits induce debris flow at the Nishinokaito River (*YAMADA et al*.,2017). We employ the 10-minute rainfall intensity and the effective rainfall with a half-life period most similar to the characteristics of torrent bed material water storage in the storage type model to calculate and evaluate the critical rainfall thresholds for hydrological processes leading to the generation of debris flow due to torrent bed material scouring

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METHODS

The basin in the upstream of the No. 6 Sabo Dam(study area) has an area of 0.75 km^2, a mean gradient of 24.3°, and the geological setting is mainly composed of Paleozoic and Mesozoic lime rocks. At the No. 6 Sabo Dam, we observed the subsurface flow discharge using 2 ultrasonic water level gauges at weep hole s of the dam. In August 2015, we also set an interval camera at the lower of the dam to observe of the night-time subsurface flow discharge from weep holes of the dam.

In this study, the hydrological processes leading to debris flow were defined as pipe flow, clogged pipe exits, and debris flow, based on our observation s conducted since 2008. Both the 10-minute rainfall and the effective rainfall were employed as rainfall indices. The half-life period of effective rainfall, which is equivalent to the changes in a tank's water storage in the storage type model (first tank and second tank) on a 10-minute scale was determined using the similarities between the water storage of each tank and the effective rainfall or the mean value of their absolute difference.

RESULTS

On a 10-minute rainfall scale, the characteristics of the changes in the water storage of the first tank and sum of first and second tanks in a storage type model were similar to those for effective rainfall with a half-life period of 360 minutes and that with a half-life period of 720 minutes, respectively.(**Fig. 1**). Critical rainfall thresholds (effective rainfall with a half-life period of 360 minutes) for hydrological processes leading to debris flow since 2008 were effective rainfall of 41.2 mm and 10-minute rainfall of 6 mm for pipe flow without generating a debris flow, effective rainfall of 129.1 mm and 10-minute rainfall of 8 mm for a clogged pipe exit without generating debris flow, and effective rainfall of 126.8 mm and 10-minute rainfall of 19 mm for debris flow generation (**Fig. 2**). These results suggest that a pipe flow has a small possibility of debris flow generation. For a clogged pipe exit, the amount of water stored in the torrent bed material meets the quantitative conditions required to generate a debris flow, indicating that a 10-minute rainfall of 19 mm or more may increase the possibility of a debris flow occurrence.

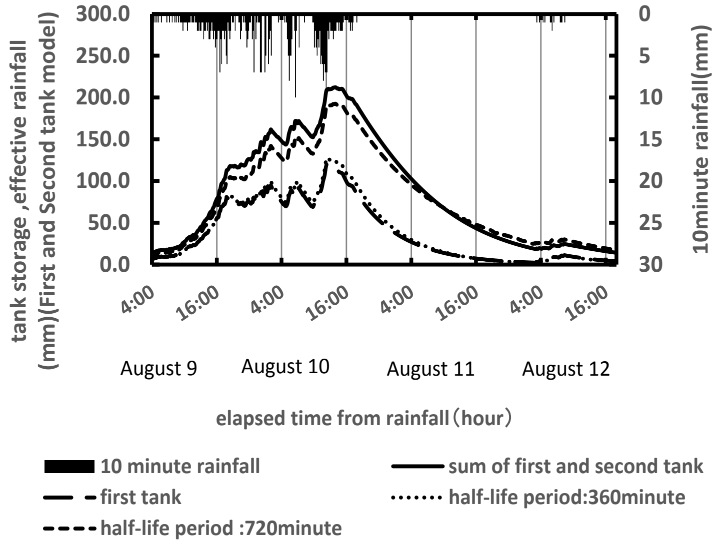

Fig.1 Half-life period of the effective rainfall equivalent to the first tank and the sum of first and second tank (Case on August 9, 2014)

CONCLUSIONS

1) Half-life period of the effective rainfall equivalent to the first tank and the sum of first and second tank were 360 minutes and 720 minutes, respectively.
2)Critical rainfall thresholds (effective rainfall with a half-life period of 360 minutes) for hydrological processes leading to debris flow since 2008 were revealed.
3)Possibility of debris flow generation during pipe flow is small, but a clogged pipe exit increases the possibility of debris flow generation with a 10-minute rainfall of 19 mm or more at the Nishinokaito River

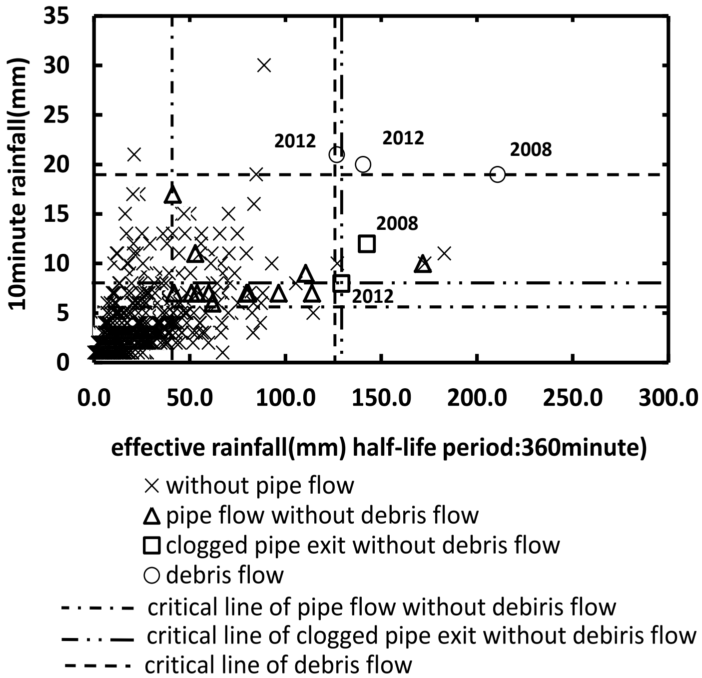

Fig.2 Critical rainfall thresholds(effective rainfall with a half-life period of 360minutes) to generate a hydrological processes

REFERENCE

Takashi YAMADA, Hirofumi SATO, Shingo YAMADA, Hideaki KIKUCHI (2017). Hydrological Observation of Subsurface Flows Spouting from Pipe Exits in Torrent Bed Material and its Triggering Rainfall Conditions of the Nishinokaito River in Mount Fujiwara, Mie Prefecture, Japan. International Journal of Erosion Control Engineering. Vol. 10, No. 1

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