

Using Long-Term Measurement to Enhance Regional Disaster Prevention through Monitoring of Small Rivers

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Abstract: This study promotes regional disaster prevention using Long-Term Measurement (LTM) of small rivers. Continuous monitoring of water level and vibration revealed correlations, and experiments confirmed detection of “goro-goro” rumbling from moving boulders. By quantifying local traditional knowledge, this approach enhances community awareness and provides a practical, low-cost early warning framework for sediment-related disasters in mountainous regions.

Keywords: LTM (Long-term measurement), Traditional knowledge, Landslides.

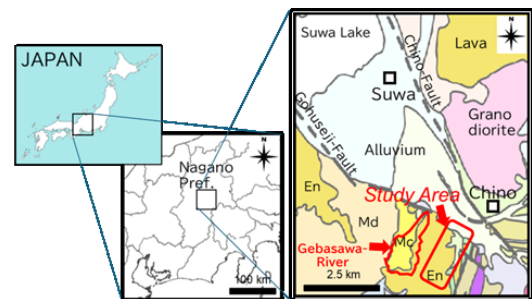


Figure 1, Study area.

Introduction

Due to climate change, the likelihood of unprecedented heavy rainfall has increased. Regions such as Nagano Prefecture, which usually receive little rainfall, now face a higher risk of slope failures during extreme rain events. In 2021 Takabe debris flow in Chino City, 64 houses were destroyed, but no casualties occurred thanks to early evacuation based on local traditional knowledge. Water level data showed a sudden drop just before the event, suggesting that water decreases prior to flash floods. Since small and medium-sized rivers often lack monitoring due to cost constraints, this study reports the initial trial of installing measurement instruments in the Suwa region to promote long-term, community-based monitoring.

Study area

The study area covers the Ankokuji District of Chino City in Nagano Prefecture. This area is located on the western side of the Miya-River basin, which drains into Lake Suwa. It lies on the northern slope of the Tsuetsuki-Pass, at the northern end of the Akaishi Mountains. Rivers in this region are 2–5 km in length, with channel gradients ranging from 10° to 30° in their upper and middle reaches. Geologically, the area is situated along the western margin of the Itoigawa–Shizuoka Tectonic Line and the northern end of the Median Tectonic Line (Figure 1). The main geological formations consist of the Takabe Conglomerate of the Miocene Moriya Formation (Mc), overlain unconformably by the Moriya acidic volcanic rocks (Md), and further unconformably covered by the Enrei volcanic rocks (En).

Methodology

In the 2021 debris flow disaster at the Gebasawa River in Takabe, Chino City, residents evacuated approximately 30 minutes before the event. Interviews revealed that their decision was based on traditional local cues such as “when the river rumbles” or “when the river gives off an odor.” In addition, water level sensors installed before the disaster recorded a decrease in water level immediately prior to the debris flow. This study focused on two such precursory phenomena:

1. The rumbling sound from the river, and
2. The drop in water level before the debris flows.

Previous studies have shown that the riverbed contains Enrei lava deposits acting as valley fills, which may produce rumbling sounds prior to slope failure (Kikuchi et al., 2023). Interviews with residents indicate that this sound can be heard during rainfall exceeding 50 mm/hour. Moreover, the water level drop is believed to indicate the temporary formation of a dammed section before a debris flow occurs. Based on these observations, we hypothesized that precursory phenomena could be detected by:

1. Continuous microtremor monitoring (Figure 2), and
2. Multi-point water level measurement.

A gravel-dragging experiment was conducted on July 21, 2025, at the confluence of the Dodo-River and the Miya-River in Chino City (Figure 3). Five boulders, weighing from 1 to 37 kilograms, were manually dragged

about 10 meters along a concrete river channel to simulate vibrations caused by moving gravel (Figure 4). The test aimed to identify vibration patterns associated with pre-disaster phenomena (Figure 5). Local residents observed the experiment and confirmed that the sound from the 37-kilogram boulder was very similar to the “goro-goro” rumbling heard during heavy rainfall.

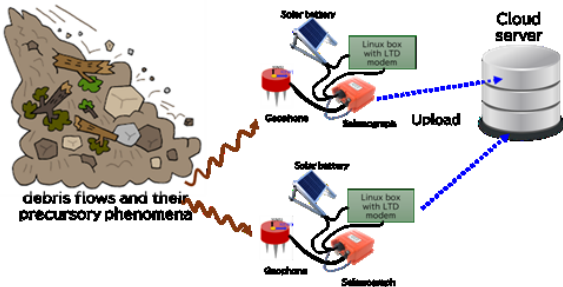


Figure 2, Measurement instruments and detection method.

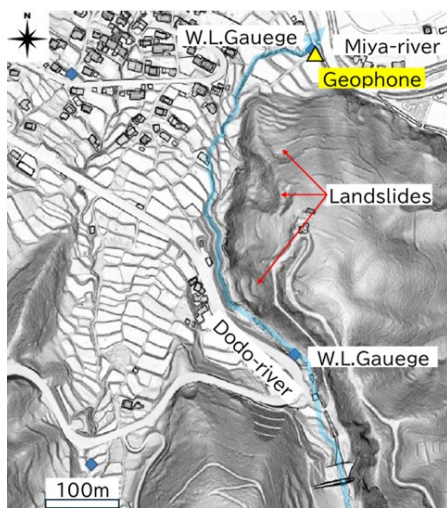


Figure 3, Locations and Slope Map.



Figure 4, Dragging test and gravel of schist (37kg).

Results and discussion

The data are still being organized; therefore, only preliminary results are presented here. A one-minute sampling interval was used, and vertical ground acceleration (in gal) was recorded together with water level observations. During ordinary rainfall, as shown in Figure 6, water level and vibration amplitude showed a similar trend vibration increased as the river discharge rose, reflecting normal hydraulic behavior. In contrast, Figure 7 shows results from the gravel-dragging test, conducted under no-rain conditions. Distinct vibration

waveforms were recorded, differing clearly from those during rainfall. This indicates that the vibrations generated by gravel dragging can be distinguished from rainfall-induced river vibrations as anomalous signals.

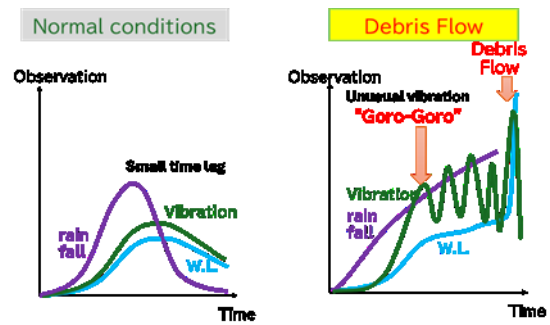


Figure 5, Concept of the early detection system of debris flow occurrence in mountain streams.

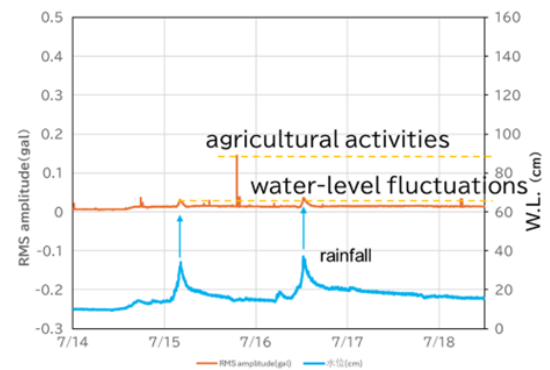


Figure 6, Normal condition and water-level noise.

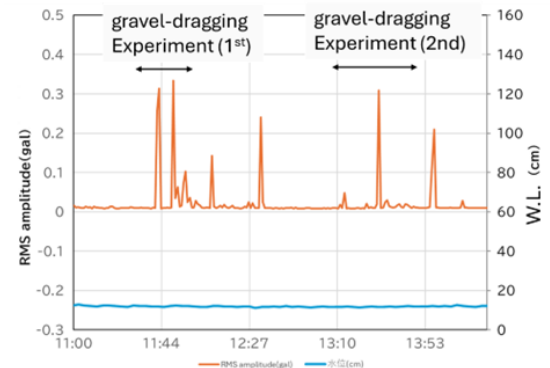


Figure 7, Gravel dragging experiment results.

Acknowledgement

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Reference

Kikuchi, T., and Kobayashi, S. (2023). A brief study on sediment and flood hazards in the Gebasawa River Basin, Chino City, during the September 2021 event. Proceedings of the 2023 Annual Meeting of the Japan Society of Engineering Geology (in Japanese).