

Effects of the decontamination activity on the characteristics of the sediment transport on hillslope in Fukushima Prefecture

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The decontamination activity in Fukushima has been conducted to remove radioactive substances released from Fukushima Daiichi Nuclear Power Plant accident. Topsoil (several centimeters thick) was removed and then, uncontaminated coarse sand was overlaid. However, it is not clear how the decontamination activity can affect the sediment transport on hillslope. Recently, UAV-SfM (Unmanned Aerial Vehicle - Structure from Motion) photogrammetry and soil particle tracing with RFID (Radio Frequency IDentification) tag were applied to study soil erosion process. However, the accuracy of UAV-SfM method depends on the conditions where the photos were taken. And it takes much time to determine the location of the RFID tags with total station. Therefore, this study aimed following three points; 1. to assess the accuracy of the UAV-SfM method at the plot scale. 2. to determine the location of the RFID tags with Orthomosaic imagery and assess the accuracy of this method. 3. to clarify the effect of the decontamination activity on the characteristics of the sediment transport using these new techniques.

Three soil erosion plots; before decontamination farmland, decontaminated farmland, and not decontaminated farmland were established. They were 5 m wide and 22.1 m long and have no vegetation by scattering weed killer. Comparing the dense point cloud between UAV-SfM technique and TLS (Terrestrial Laser Scanning) one, the geometric mean of the error was only 6.4 mm. The location of the RFID tag could be determined using Orthomosaic imagery and its accuracy was evaluated with total station. The geometric mean of the error was about 27 mm. The particle size analysis resulted in the decrease in silt (0.06-0.002 mm) and increase in sand (2-0.06 mm) and aggregate analysis resulted in decrease in mean weight-diameter value of water-stable aggregate because of the decontamination activity. The hydrological measurements showed that the amount of soil loss from the decontaminated farmland was less than from the before decontamination farmland. No rill erosion was observed from the analysis of the ground surface changes, so interrill erosion would be the main erosion process at the decontaminated farmland. Transport distance of the RFID tags in interrill area was small. So, the flow energy in interrill area would be small and the soil loss can be less at the decontaminated farmland.

The experiment was carried out under simulated rainfall at intensities of 100 and 200 mm h⁻¹ using large-scale rainfall simulator. Two plots; decontaminated and farmland plot were established. Larger sediment discharge and large amount of rill erosion were observed from the analysis of ground surface changes at the decontaminated plot.

Consequently, the decontamination activity caused the increase in grain size and decrease in soil aggregate, and the formation of crust would not easily occur. Therefore, the infiltration rate was higher and soil loss was smaller in decontaminated area. However, these changes of soil characteristics reduce the soil shear strength and the amount of soil erosion would increase because of rill erosion at heavy rainfall event.

Keywords: Decontamination Activity, Soil erosion, Radio-frequency identification (RFID), Unmanned Aerial Vehicle (UAV), Structure from Motion (SfM), Artificial rainfall simulation