Combining UAV-SfM survey, soil particle tracing with RFID tag to study the plot-scale sediment transport processes.

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A substantial quantity of radiocesium was deposited on the Fukushima prefecture, Japan in 2011 because of the Fukushima Daiichi nuclear power plant accident. On farmland, contaminated surface soil was removed to reduce the radiation dose rate because radiocesium is strongly attached to fine soil particles. Instead of the removed soil, decomposed granite, which has larger soil particles and less organic materials, was added. Such large-scale land use change can affect the sediment transport system. Soil erosion plot is generally applied to quantify the soil erosion, but this method cannot reveal how the sediment is detached, transported and deposited. In order to understand soil particle movement and soil redistribution, Unmanned Aerial Vehicle – Structure from Motion (UAV-SfM) method, which enables to obtain 3D data of the soil surface and detect soil surface changes, can be used. Radio Frequency Identification (RFID) tag can also be applied to trace soil particle movement (Parsons et al., 2014). It can show how the sediment transport system is different in the plot. However, it takes so much time to locate the RFID tag with a total station. This issue would be solved by means of high-resolution orthomosaic image derived with UAV-SfM method.

This research has two objectives: (1) assessing the accuracy of UAV-SfM measurement and the survey of the RFID tag location with the orthomosaic image. (2) applying UAV-SfM method and soil particle tracing with the RFID tag to study the sediment transport processes on decontaminated slope farmland. Study sites were located in Kawamata town (decontaminated) and Date city (not decontaminated), Fukushima prefecture, Japan. USLE plots (22.13 m × 5 m) were installed on each slope farmland. These plots were kept with no vegetation and no cultivation. Water and sediment discharge were measured at the outlet of each plot. The accuracy of 3D data derived from the UAV-SfM method was assessed by comparing the data with those derived from 3D laser scanning. Locations of RFID tags were determined by using Orthoimage derived from UAV-SfM method and were compared with those measured with a total station.

We found that the accuracy of UAV-SfM can be minimized as 3.3 mm (S.D.). RFID tags also can be located with an accuracy of 28 mm (RMSE). The results of UAV-SfM surveys showed no rill erosion in the decontaminated plot (DP) and the development of micro-terraces, and the result of RFID tracing showed a short transport distance in inter-rill zones at DP. After the decontamination works, the runoff and sediment yield decreased in DP. Our results suggest that the combination of these methods can provide new insights to understand sediment transport processes, and the decontamination works affected the water and sediment discharge.