Study on a simplified measurement of water depth and reconstruction of the riverbed form by using SfM and MVS.

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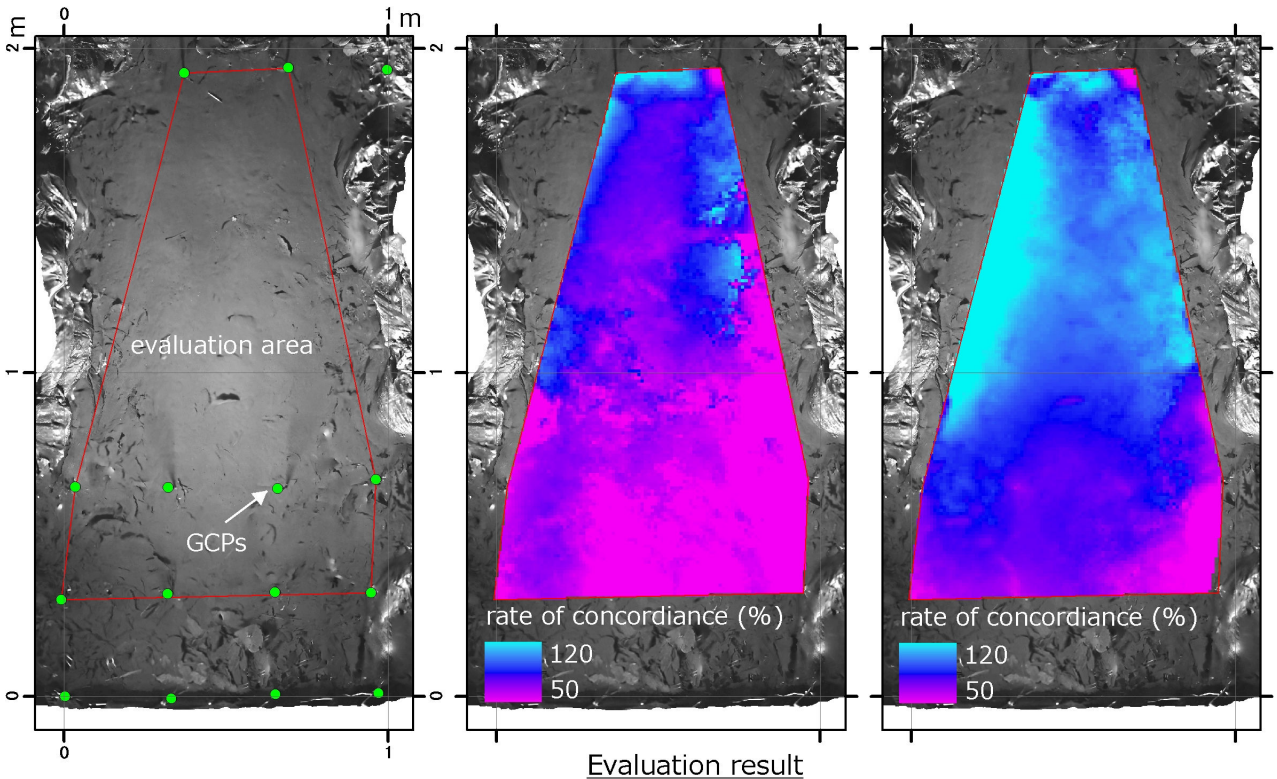
Primary outflow process of radiocesium, which is released by the TEPCO’ s Fukushima Dai-ichi Nuclear Power Plant accident, from a forested hillslope to a mountain stream is a particulate-bond state transport. A detailed estimation of the riverbed form and sediment volume changing with time is a key issue to assess the radiocesium distribution in the forested environment. Changes in the sediment volume can be calculated from the water depth and the difference between measured water surface and reference water surface levels setting up at the initial. Conventional method for a water depth determination is a direct measurement of the stream water depth by using a scale. But it requires a lot of time and labor to evaluate the change of riverbed form and water depth in detail.
In this study, we attempted an accurate and labor-effective method to evaluate the water depth and three-dimensional (3D) structure of underwater riverbed form by applying the SfM (Structure from Motion) /MVS (Multi View Stereo) techniques and the optical image data collected on consumer-grade-camera. These images were photographed beside of the small stream located at southern part of the Abukuma Mountains, Fukushima. Light propagation properties such as attenuation or reflection influence precise reconstruction of 3D model using underwater images. This was done to reduce influence of light propagation in two steps: 1) to reduce the influence of reflection, photographing at the time of twilight using LED light and Circular PL filter. 2) to reduce the influence of attenuation, installing blue colored film on the LED light and omitting band R, G for SfM/MVS analysis. And we also photographed at the day time and reconstructed 3D model (Day Model: DM) to compare and confirm the model applying two steps (Twilight Model: TM). As a criterion for evaluation of these models, we carried out the direct measurement of water depth. Rate of estimation concordance was calculated by dividing analytical water depth by the direct measurement depth, then convert to percentage.
Discrepancy between measured and analytical results increased with depth, the rate of estimation concordances were 46 % (DM) and 73 % (TM) in the water depth of 20-25 cm, and 62 % (DM) and 93 % (TM) in 10-15 cm, respectively (Figure). Next step is an improvement of the correction and image-capturing methods to reduce the estimation errors by elimination of the light refraction on the stream water surface.

Keywords: SfM/MVS, measurement of water depth, riverbed form



Evaluation result

Left: Orthographic Image, Evaluation area (red polygon) and location of GCPs (green dot),
Center: Discrepancy between measured and analysis (DM),
Right: Discrepancy between measured and analysis (TM)

