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Terrestrial laser scanning of cliff face at Kegon Falls

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Mechanisms of bedrock erosion at waterfalls have been studied so far for several cases, but there remain some uncertainties in erosional processes with regard to detailed form of rocks composing a waterfall. In this study, detailed form of cliffs around Kegon Falls in Nikko, Japan is examined using a terrestrial laser scanner (TLS). Kegon Falls has a total hight of 97 m, with a vertical drop of surface water and outflows of underground water at the lower portion of the cliff. The form of cliffs around the waterfall was measured using a TLS (Topcon GLS-1500) from an observatory facing the waterfall, and the obtained point cloud was georeferenced using a GNSS-based position coordinates of measurement targets. The point cloud was then rotated in order to create a digital elevation model (DEM) on a vertical plane. Longitudinal and transverse profiles were then extracted from the vertical DEM. The stability of the collapsed portion in the cliff indicates that the collapse in 1986 could have likely occurred with crack propagation along joints within the former cliff. The stability analysis also suggests that catastrophic collapse of whole of the waterfall face seems to hardly occur, because the igneous rock composing the cliff is strong enough to keep its current overhanging shape. Actually smaller-scale collapses of the cliff face have occurred in recent years. Whereas, frequent occurrence of freeze-thaw weathering seems to be responsible for the formation of a depression at the bottom of the uppser cliff of lava. The load and tractive force by surface water flow (up to 100 t/s when flooding) may support faster removal of rock blocks behind the water drop. Multiple processes are thus responsible for the erosion of the cliff face of Kegon Falls.

Keywords: waterfall, erosion, bedrock, cliff, terrestrial laser scanning