78 Monitoring and predicting trail erosion in Daisestuzan National Park in Japan

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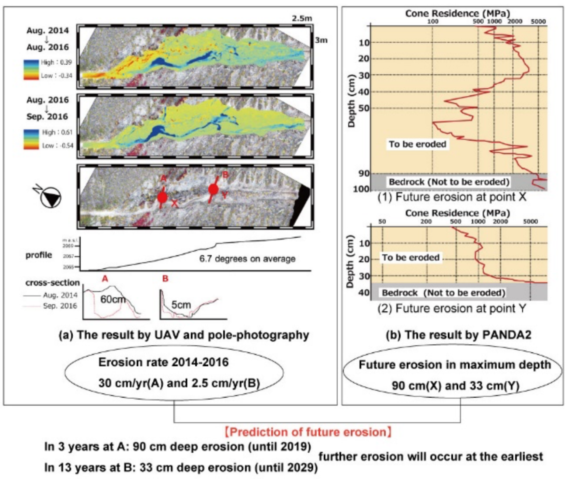
Mountain trail erosion is one of the geomorphological phenomena, which is generally caused by surface water and human trampling. Mountain trail erosion is one of the most serious problems in many national parks of Japan. Such examples are observed on trails in Mt. Rausu-take (Shiretoko National Park), Mt. Rishiri-san (Rishiri Rebun Sarobetsu National Park), Mt. Daisetsuzan (Daisetsuzan National Park), and Mt. Miyanoura-take (Yakushima National Park). Volcanic ashes cover trails in most of these mountains, and snow remains until the time when many trekkers come. For these reasons, trails in these mountains are eroded rapidly and deeply. Therefore, it is important to conduct studies to predict further erosion.



Mountain trail erosion has been traditionally studied by surveying cross-sectional changes at certain sites. The method of surveying cross section can be conducted quickly and simply for park managers to understand changing magnitudes of mountain trail erosion for a long period. In Japan, this method has been used mainly in Daisetsuzan National Park, and numerous data have been already accumulated in some trails. However, magnitudes of mountain trail erosion are understood in just two dimensions by this method. Furthermore, the largest limitation of this method is that the eroded/deposited area is understood only at the measured sites and does not produce the eroded/deposited volume of the entire trail segment with a certain length, which is more important for trail management.

This study, conducted in Daisetsuzan National Park (DNP), Japan's largest national park, has three objectives: (1) to show digital elevation models (DEMs) of the mountain trails including the surrounding ground surface, and to estimate the change of the eroded volume from 2014 to 2021; (2) to predict further erosion in the near future; and (3) to understand a relationship between the trail erosion and the number of trekkers.

DNP is located in central Hokkaido, northern Japan. The total length of the trails in the park is more than 300 km. Statistical data from the Japan's Ministry of the Environment show that the number of visitors to DNP in the 2017 summer attained approximately 97,000.

The investigated trail is located near Mt. Hokkai-dake (2149 m a.s.l.) in DNP. Seven segments with the soil erosion from a starting site to an ending site were selected. The length of the segments varied from 32 m to 195 m. The seven segments are located in the most seriously damaged trail in the entire park. This study employed the use of UAV (often called a drone) and pole photography (a method to take photographs by a camera attached to a long pole) to make digital surface model (DSM) to resolve the above limitation. Before flying UAV or conducting pole photography, ground controlling points (GCPs) were set and precise distance among the GCPs was measured using a total station and Trimble Geo7X.

Depending on the length of the distance of the surveyed trail segments, 300 to 500 photographs were taken in each segment by using UAV and pole photography. For an analysis of the photographs taken by UAV or by pole photography, Agisoft which is one of the Structure from Motion (SfM) software, was used, and DSMs and orthophotographs were made with the photographs. In addition, PANDA2, a soil compaction penetrometer, was employed to estimate the thickness of the unconsolidated volcanic materials from the trail surface to the top of the bedrock to predict the depth to be eroded in the near future at 14 points in each of the seven segments.

The result of the analysis shows that the most eroded volume in one of the segments was 274.67 m^3 in 2014, and 282.37 m^3 in 2016. This erosion was caused by extremely heavy rain in the 2016 summer.
Figure (a) shows that sites B and A had erosion of 5 cm and 60 cm thick soil from 2014 to 2016. Figure (b) shows that potentially further eroded soil depth will be 90 cm (point X = site A) and 33 cm (point Y = site B). If any measures against trail erosion will not be taken, such further erosion will potentially occur at these sites.

Another result obtained is the occurrence of lateral erosion. Running water welled up from the underground was observed on the eroded trail surface in the end of August. The water triggered lateral erosion in August 2017, making a situation to force trekkers to step on the fragile small-scale periglacial landforms with vegetation cover along the designated trail. This suggests that relocation of the trail segments should be taken in consideration to avoid further degradation.
All trekkers are requested to submit a hiking registration at the trailhead in DNP. Counting the number of the hiking registrations, the number of trekkers who hiked on the studied trail was only 2,000 in 2016 although the number of annual visitors in the national park was approximately 300,000 in the same year. However, about a half of 2,000 trekkers were concentrated in September because they came to enjoy fall colors. This result indicates that the number of trekkers is not likely to decide the volume of the trail erosion in the case of the study area.