

## Meteorological observation at the Kakunezato, Mt. Kashima-yarigatake in the Japanese Alps

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Perennial snow patch is spreading in the straight valley extending northeast from the northern peak of Mt. Kashima-yarigatake, the northern Japanese Alps. This snow patch has been pointed out the possibility of glaciers. We installed an automatic weather station on the boulder at 1530 m altitude in the Kakunezato. Wind direction, wind speed, air temperature, humidity, solar radiation, and precipitation have been observed during from June 19, 2016 to October 20, 2016.

Keywords: perennial snow patch, heat balance, snow melt

## Distribution of Wetlands and Environment of Formation in South Hachimantai, NE Japan

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For the formation of a mountain wetland, an abundant supply of water and topography retaining water are necessary. This study examines wetland distribution with a focus on topography and snow accumulation in the South Hachimantai and Mt. Iwate, northeastern Japan.

We identified wetlands using color aerial photographs (scale 1:15,000 and 1:18,000) taken by the Geographical Survey Institute in 1976, and classified topography using them of scale 1:30,000 taken in 1988. The snow depth was calculated with ArcGIS 10.2.2 using a 5-m digital surface model measured on January 22nd, 2010 as an investigation of snow accumulation distribution at Mt. Iwate, and a 1-m digital elevation model measured in 2008.

Steep slopes of Mt. Iwate (2038 m asl.), conical-shaped stratovolcano, dominate the eastern study area, and moderate slopes are spread along the ridge of the Hachimantai Volcanic Groups in the western area. Many small scarps in the north-south direction, which are along the western marginal active fault zone of Shizukuishi basin as an east-dipping reverse fault, extend on the original volcanic surfaces.

Distribution of snow accumulation comprehensively shows that the East Asian winter monsoon brings heavier snow to the northeastern area of the mountain range and around the top of the Mt. Iwate. Snow depth on the west-facing (windward) slopes is less than 0.5 m because the strong monsoon from the north-west blows away snow deposit. In contrast, that on the east-facing (leeward) slope or under the east-dipping scarps is more than 5 m.

We identified 108 wetlands, of which 72 are on the original volcanic surfaces, and 35 are on landslide bodies. Wetlands on the original volcanic surfaces tend to be concentrated under the small scarps with much snow or in saddles of the mountain ridge where snowmelt from surrounding slopes maintains a moist environment. Wetlands could not be formed on the snow-rich and steep slopes dissected by channels. Few wetlands except for the crater lakes were formed on snow-rich surface on the Mt. Iwate, where melt-water quickly penetrates deep into the earth through scoria deposits. Wetlands on landslides lie at the foot of the scarps where spring water can be abundantly supplied, regardless of snow accumulation. Wetlands both on original volcanic surfaces and landslide are developed where can receive and keep water stably throughout a year.

Keywords: wetland distribution, original volcanic surface, landslide, snow accumulation, Ou Mountain Range

## Seasonal variations of supraglacial ponds on debris-covered glacier in the eastern Himalaya

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In the eastern Himalayas (eastern Nepal and Bhutan), large proglacial lakes have often developed gradually by connecting of small supraglacial ponds since 1950s-1960s (Ageta et al., 1998; Komori et al., 2004). The Tshojo Glacier flood of 2009 in Bhutan occurred at a debris-covered glacier without a proglacial lake (Komori et al., 2012). As characteristics of the sudden large drainage at the Tshojo Glacier, a large supraglacial pond disappeared after flooding. It is important to clarify the behavior of supraglacial lake for countermeasure of glacier lake hazards. To clarify the seasonal variations of supraglacial ponds, we investigated the area changes of supraglacial ponds on debris-covered glaciers in the Lunana region of Bhutan and Khumbu region of the eastern Nepal using Landsat8 OLI and ALOS-2 PALSAR-2 data.

Keywords: supraglacial pond, debris-covered glacier, eastern Himalaya, ALOS-2/PALSAR-2

## Recent variations of glacial lakes in Issyk-Kul Basin, the northern Tien Shan

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Several large drainages from glacial lakes occurred in the Issyk-Kul Basin (Kyrgyzstan), the northern Tien Shan. Although glacial lakes are small size, large drainages have caused serious damages to resident areas near the mountain sites. We investigated the current state of glacial lakes distributed in the Issyk-Kul Basin. Several satellite images were analyzed taken in 2013-2016, and classified the situations of glacial lakes of each year according to their variation pattern. We classified lakes into three types, continuous, recurring, transient. Our results showed that glacial lake of recurring type has a temporal ice-dam blockage of the drainage channel and high risk to drainage in this region.

Keywords: glacial lake, ALOS satellite data, Tien Shan

## Underground structure of glacier ice and snow using Ground Penetrating Radar(GPR)

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In the Teskey Range of the northern Tien Shan, a large drainage from west-Zyndan glacial lake on 24 July 2008 caused damages such as farmland, infrastructure, three victims. The lake was a short-lived glacial lake which appeared and drained for two and half month (Narama et al., 2010). The lake water was discharged through ice tunnel (cave) which developed into debris landform in glacier front. To know the development (location and size) of ice tunnel in other glacier fronts, we examined reflection characteristic of glacier ice, snow, firn, cave, debris, and bedrock in the southern Inylchek, Adygene, and Kara-Kungoy Glaciers (Kyrgyzstan) and Shirouma-Daisekkei (Japan) using Ground Penetrating Radar (GPR). The GPR data showed the reflection characteristic differed in size of ice tunnel.

Keywords: Ground Penetrating Radar(GPR), glacier ice and snow, reflection characteristic, ice tunnel

## The spatial distribution of mountain permafrost in northern Tien Shan, Central Asia using DInSAR analysis

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In the northern Tien Shan located in semi-arid area, glacier and mountain permafrost are important water resources that supply water to the city and irrigation farmland. Although the current state of glacier and mountain permafrost should be clarified as important tasks (Sorg et al., 2012), information about the mountain permafrost is limited in Ili Range (Marchenko et al., 2007). We investigated the spatial distribution of mountain permafrost in the Teskey, Kungoy, ili Ranges, the northern Tien Shan, based on satellite data analysis and field observation. As a topographic indicator of mountain permafrost, we classified rock glaciers into active/inactive or fossil using DInSAR (Differential SAR Interferometry) analysis with ALOS-2/PALSAR2 data.

Keywords: mountain permafrost, rock glacier, DInSAR, UAV, Tien Shan

## Slope failure events in Himalayan snow area due to Gurkha Earthquake

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On 25 April 2015, an earthquake (M7.8) occurred at Gurkha region located northwest of Kathmandu, the capital of Nepal. On 12 May, an earthquake of M 7.3 occurred at 80 km northeast from Kathmandu. Due to this series of large earthquakes, slope failure events (ice avalanche, snow avalanche, snow-rock avalanche, rock avalanche) occurred frequently in the snow mountain area of the Himalaya. In Langtang valley, a catastrophic snow-rock avalanche caused serious damages such as more than 100 victims at Langtang village. We investigated the distribution and characteristics of the slope failure events in snow area of the Himalaya using satellite data. In addition, we clarified the size and location of hanging glaciers which caused the failure in the Langtang Valley using the digital aerial images acquired in the field survey in the fall 2015.

Keywords: Gurkha earthquake, slope failure, hanging glacier, Langtang Valley

# Rockslide phenomenon occurred on the southern face of Mount Myojin and the origin of Myojin-ike Ponds in the Kamikochi Valley of the northern Japanese Alps, Central Japan

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We describe the geological and geomorphological features (e.g., distribution, morphology, and lithofacies) of boulder lobes in the Myojin-ike Pond area in Kamikochi Valley of northern Japanese Alps. Then we discuss the origin and cause of those boulders and Myojin-ike Ponds. Our main results are as follows: a) Boulders consisting of the lobes were supplied from the southern rock face of Mount Myojin, just north of Myojin-ike Ponds; b) Estimated transporting process of the rock debris was rockslide or rock avalanche from the rock wall composed of tuff-welded tuff layer; c) Myojin-ike Ponds were formed by river course obstruction by accumulation of rock debris; d) the rockslide probably occurred before AD1693 based on the old document written by the Hotaka Shrine founded on the shore of Myojin-ike Ponds.

Keywords: Boulder, Rockslide, Maehotakadake welded tuff, Mountain landforms, Slope disaster

# Development of a New Method for Rockfall Analysis using Schmidt Hammer

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Schmidt hammer was invented by Schmidt (1951) for the purpose of examining the strength of concrete non-destructively, and it is now applied to the fields of rock engineering, rock mechanics, and geomorphology. Many studies using Schmidt hammers in the field of geomorphology have been carried out measuring the strength (or hardness) of rocks that characterize the terrain, especially for areas where it is difficult to collect rock samples for strength measurement in the laboratory. The Schmidt hammer method records large differences in the rebound values obtained by the Repeated Hit Method (RHM) and the Single Hit Method (SHM). The SHM measurement is preferable to construct an index of weathering degree of the surface layer (Matsukura et al. 2004) as repeated hits corrupt the original surface. As per present, most of the studies in geomorphology have been performed to understand the formation of landforms, such as moraines using the variability in rebounds values to infer differential weathering (for example, Winkler, 2016), but there to the authors knowledge, no work has been done to characterize rockfall triggering conditions and movement process yet.

For the survey of rockfall, geological features such as cracks, rock joins, the slope in the triggering area, the weathering patterns and level, and various other data need to be set, but many are based on qualitative criteria, which makes comparisons between sites difficult. A few quantitative methods exist however, such as the stability assessment of rock mass using hammering sound measurement (Kanbara et al. 2013) and vibration measurement with U-Doppler (Uehan et al. 2012). Nevertheless those studies remain very marginal and it is still necessary to develop further low-cost methods to evaluate the stability of rock masses on slopes and terrains difficult to access. Therefore, in this study, we attempted to evaluate the factors, estimated occurrence time, place of occurrence, and geomorphological environment of rockfall using Schmidt Hammer, UAV, and laser data, which are easy to carry because they are compact and lightweight and because they offer data from a comfortable remote position.

The survey was conducted at Gunbarrel-tributary in the Fox Glacier Valley, located on the west coast of New Zealand, using a single hit method for a giant boulder of 5 to 6 m. The data collected show differences in the Schmidt Hammer rebound values, which we could relate to the difference in the degree of weathering. On the newly broken side of the rock, the rebound value tended to be slightly higher than on the sides that were exposed to erosion for a longer period. Additionally, examining the pattern of weathering based on the Schmidt Hammer data, we can also infer that the rock was partly connected to a non-weathered bedrocks while half of it had been subjected to various weathering processes. This finding also allows us to discard a glacial origin. Indeed as half of the block did not show any weathering, we can infer that the rockfall comes from a late detachment from the bedrock. It was not deposited first by the glacier as an erratic block. Further refinement of the method is certainly needed, but the present results are encouraging.

Keywords: rockfall, Schmidt hammer, SfM, UAV

## Constraining the Quaternary evolution of the Hida range of the Japanese Alps

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Japan is one of the most tectonically active locations on Earth, situated adjacent to two triple junctions between four tectonic plates. Within this convergent zone, the Hida, Kiso and Akaishi ranges of the Japanese Alps are thought to have been uplifted within the last 1 to 3 Myr. Whilst undoubtedly tectonically driven, this mountain-building may also have been coincident with the onset of the Quaternary period, and the associated global climatic transition to ice-house conditions. Extremely high rates of precipitation (>3,000 mm/yr) coupled with earthquake enhanced landsliding potentially make the Japanese Alps one of the most rapidly exhuming places on Earth. However the rate of exhumation and the topographic evolution of this significant tectono-climatic setting remain poorly constrained. Quantifying exhumation rates will provide insights into the tectonic evolution of the Japanese Alps as well as an improved understanding of the coupling between tectonics and climate through erosion processes. Thermochronometry enables exhumation rates to be determined from the measurement of rates of rock cooling, and the newly developed multi-OSL-thermochronometry system is sensitive to temperatures of as low as ~25 °C, enabling constraint of late-Quaternary exhumation histories at an unprecedented resolution. We collected 19 samples from the Hida range of the Japanese Alps for multi-OSL-thermochronometry analysis, including 4 samples from a high-temperature tunnel which has a present day temperature of ~40-50 °C, but experienced temperatures of up to 166 °C prior to excavation in the 1930s. The high-temperature samples should have an apparent age of almost zero when measured using OSL-thermochronometry, providing a local control on the performance of this recently established technique. Measurement of the remaining 15 samples will complement previous (U-Th)/He in Apatite (Ahadi et al., In Prep.), Zircon fission track (Yamada and Harayama, 1999; Ito and Tanaka, 1999) and Zircon U-Pb (Ito et al., 2013) measurements which have been made on the same sample suite. Once measurements are complete, we will be able to invert the different thermochronometric data together, to determine the exhumation of the Hida range over the past 3 Myr. In a second research phase, we plan to sample the Kiso and Akaishi ranges, applying a similar set of methods to constrain their recent exhumation histories. Temporally consistent changes in exhumation rates across all ranges may reveal the effects of global climatic changes.

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Keywords: Multi-OSL-thermochronometry, Japanese Alps, Quaternary exhumation