Climate change impacts on alpine ecosystems in the Daisetsuzan National Park in northern Japan

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Alpine ecosystems are the most sensitive nature against rapid climate warming. Thus, alpine ecosystem is a suitable system for the detection and prediction of the ecological impacts of climate change. So far, there are many reports on the physiological, phenological, and distributional responses of organisms inhabiting alpine ecosystems to climate change. Recent climate change may increase the risk of species extinction, decreasing population, diversity reduction, and vegetation changes in alpine ecosystems. However, long-term monitoring of climate, environment, and ecosystem changes in Japanese alpine regions are restricted. I introduce the evidence of climate change and its impacts on alpine ecosystems in the Daisetsuzan National Park in Hokkaido, northern Japan. As the major ecological responses to climate change, the modification of phenological events and the distribution shift of organisms are known in many ecosystems in the world. Warm summer temperature and early snowmelt accelerate the phenological progress of alpine plants that cause earlier and shorter flowering season of alpine plant communities. Rapid changes in plant phenologies may disturb the plant–pollinator interactions, resulting in the decrease in pollination service for plants and food resource for insects. Phenological mismatch between alpine plants and bumble bees was detected in unusually warm summer in this area. Major vegetation changes observed in the Daisetsuzan National Park are decreasing populations in alpine snow-meadows and expansion of dwarf bamboo. These changes may be caused by the recent warm summer temperature, longer snow-free period, and drier soil conditions. Expansion of bamboo distribution results in the decreasing species diversity of alpine plant communities due to strong shading effect by dwarf bamboos. On the other hand, alpine vegetation successfully recovered by the bamboo removal treatment. Thus, the bamboo removal may be a useful management to conserve biodiversity of alpine ecosystems. For the practical and effective conservation of alpine ecosystems under warming climate, long-term ecosystem monitoring and experimental approaches are necessary to construct the adaptive management protocol of the alpine ecosystem conservation.

Keywords: alpine ecosystem, climate change, alpine plants

Effects of climate change on flowering phenology of montane plants: a case study for a spring ephemeral and alpine plants

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Plant phenology, seasonal and periodic behavior shown by plants, is though to be largely affected by global climate change. Most studies on plant phenology have been carried out on the low-elevation sites in and/or near the urban area. Phenological observation has been rarely conducted in the montane area, especially in the alpine region, where global climate change would have a strong impact. In this presentation, I will show seasonal and yearly variations of flowering phenology in montane plants inhabiting in a secondary forest and alpine ecosystems having a snowy climatic regime. Target species are *Erythronium japonicum*, *Diapensia lapponica* var. *obovata*, and *Sieversia pentapetala*. I and co-researchers observed these flowering phenology from 2010 to 2015, and also measured air and soil temperatures, and recorded directly or estimated indirectly dates of snowmelt. According to an analyzing technique reported by Kimball et al. (2014), we could express temporal changes of the flowering rate as a logistic curve, using degree-day accumulations based on air and soil temperatures, day of year, and day from snowmelt as explanatory variables. I will show the species specific difference of significant variables against the flowering phenology, and the effectiveness using a logistic model for describing and predicting flowering phenology of montane plants.

Keywords: phenology, alpine plants, climate change

Monitoring of snowmelt in the Japanese alpine zone by using time-lapse cameras

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The vulnerability of alpine ecosystems to climate change, as pointed out by IPCC, and the necessity to conduct monitoring in the alpine zone have been recognized worldwide. The Japanese alpine zone is characterized by extremely heavy snowfall, and snowmelt is a key factor for the growth of alpine vegetation. National Institute for Environmental Studies has, therefore, launched long-term monitoring of snowmelt and ecosystems in the Japanese alpine zone since 2011 by using automated digital time-lapse cameras, and 18 monitoring sites are under operation currently. By comparing the photographs taken at the same time each year, we can determine the time for snow fall and melting and the spatial differences in their speed,
In this study, a new monitoring method by digital cameras was developed in order to detect yearly changes of snow-cover areas at high temporal and spatial resolutions. We used images derived from the cameras that we have installed at mountain lodges in Nagano Prefecture (at elevations around 2350–3100 m) and at around Mt. Rishiri in Hokkaido, and in addition, the live camera images that have already been operated by local governments in Tohoku area and Mt.Fuji. RGB digital numbers were derived from each pixel within the images. The snow-cover and snow-free pixels were automatically classified by statistic discriminate analysis based on the variance of gray-level histograms for each image.
The detected snowmelt dates showed site-specific characteristics and yearly variations.

Keywords: RGB, discriminate analysis method, ortho-rectify

Timing, magnitude and origin of seasonal rockfall activity in the Southern Japanese Alps: A multi-method approach

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Recent technological advances have enabled us to monitor bedrock micro-cracking at high time resolution and succeeding rockfall activity at high spatial resolution. Precise evaluation of the trigger of each rockfall event, however, requires a combination of multiple methods that detect cracking and falling activities and provide data on their controlling environmental parameters. Long-term monitoring is also necessary to evaluate the contribution of each trigger to the rockwall erosion.
Multi-method monitoring has been conducted to detect the timing and trigger of rockfall activity on an alpine rockslide cliff composed of Cretaceous sandstone and shale in the southern Japanese Alps (Aresawa rockslide, 2900 m ASL). The monitoring programme includes manual measurements of peeling from painted rockface and collection of fallen debris (4-5 times per year) and thermography of rockface (yearly), and data logging of time-lapse photography of rockface (daily), crack opening, rock temperature and moisture (3-4 hr intervals) and meteorological elements (air temperature and precipitation at 10-min intervals). A stereographic pair of sequential photographs allow us to visually identify the location of new erosion at daily resolution. Combined with precipitation data, the photographs also indicate the type of precipitation (rain or snow).
Five years (2010-2015) of debris trapping show major rockfall activity in winter (between November and May) and occasional activity associated with heavy rains in summer. Highly active areas of the rockwall experience retreat by >1 mm per year. Time-lapse photography displayed at least eight rockfall events within the shot area in the 2014-2015 period. The integration of multiple data enables understanding of a sequence of natural processes towards rockfalls, suggesting that at least three types of rockfall processes recur annually (Fig. 1A). (1) In summer and early autumn, heavy rainfalls (>100 mm/day) raise the rock moisture content close to the saturation level, often triggering significant rockfalls, probably due to raised water pressure in rock joints or lubrication of joints. (2) In late autumn and late spring, light or intermediate rainfalls are sometimes followed by high moisture, shallow freezing, rapid thawing and eventually by small-scale rock peeling. (3) In early winter and early spring, the same process occurs as in the second case but rainfall is replaced by snowfall (Fig. 1B).

Keywords: Rockfall , Monitoring, Time-lapse photography, Freeze-thaw, Japanese Alps

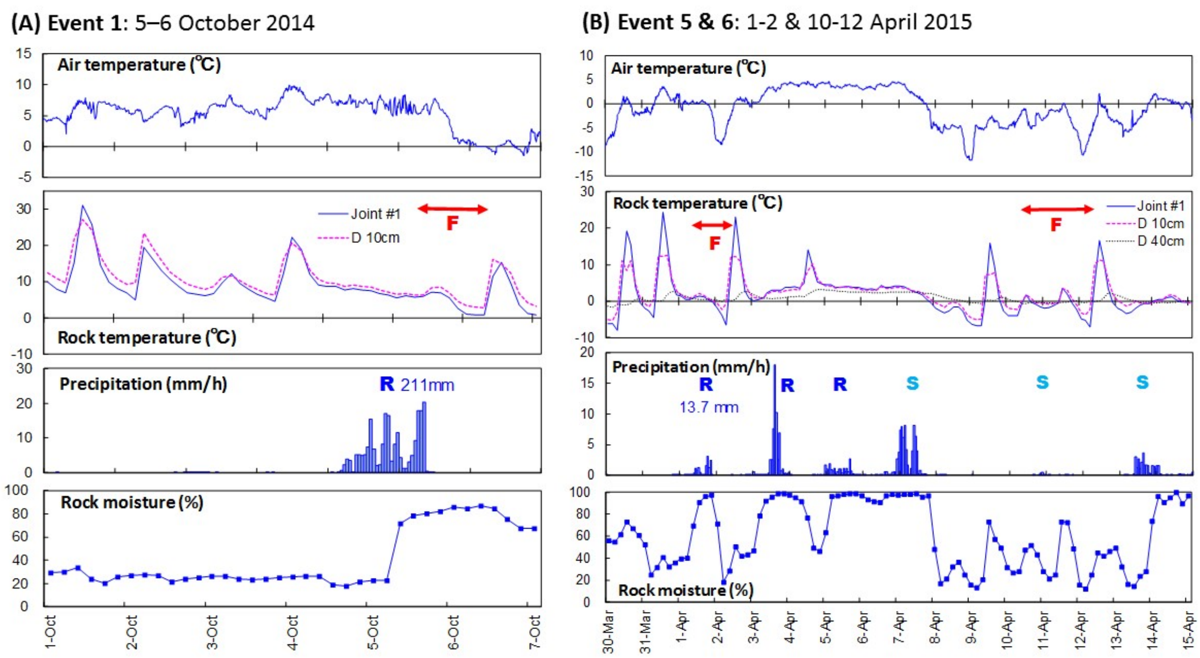

Fig. 1. Examples of rockfall events (F) and corresponding environmental conditions in the 2014-2015 period. Symbols: R=Rain, S=Snow, D=Depth.

Natural and artificial factors controlling 275-day flow in the Japanese Alps region

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City dwellers living at low-lying flat lands depend heavily on water resources supply from mountainous areas. At the same time, they are put at risk of flood due to heavy rains. For assuring river flow at drought periods and reducing a sudden increase in flood runoff, it is fundamentally important to maintain or improve water storage function, especially groundwater storage function, in watersheds. However, it has not yet been established to diagnose/evaluate quantitatively such a function. The objectives of the present study are to identify natural/artificial factors controlling groundwater storage function and to quantify their impacts, through a multivariate analysis based on flow regime and geographical information. We used river flow and dam-inflow data at 170 stations across the Japanese Alps region. As data sets of natural/artificial factors, we used mesh (i.e., raster) data of climatic normal, surface geology, terrain classification, and land use pattern, all of which are provided by Ministry of Land, Infrastructure, Transport and Tourism. Multiple regression analysis for the 95-day flow (i.e., high flow condition) with stepwise variable screening revealed statistically significant factors including annual total precipitation amount, annual mean temperature, annual maximum snow depth, upland area, volcano area, and quaternary rock area. On the other hand, for an analysis of the 275-day flow (i.e., low flow condition), impact of precipitation and temperature were not significant. This indicates that the 275-day flow is a good index reflecting water storage as snow or groundwater. Partial regression coefficients of a multiple regression equation clarify large negative impact of golf course, ski slope, and wilderness (above the timberline); 275-day flow decreases with increasing areas of these types of land use. In contrast, uplands (mainly alluvial fans) and paddy fields had a positive impact. Also, forest have a slight positive impact. Consequently, construction of golf courses and ski slopes with forest cutting and land reclamation have likely reduced water storage function of watersheds. It is particularly important to properly manage alluvial funs and paddy fields for maintaining the function. Such a function should be revisited as geo-ecological service and considered for watershed management and national land policy.

Keywords: Flow regime, Japanese Alps region, geo-ecosystem service

The thickness and flows of an ice mass of the Kakunezato perennial snow patch, Mt. Kashimayari, the northern Japanese Alps

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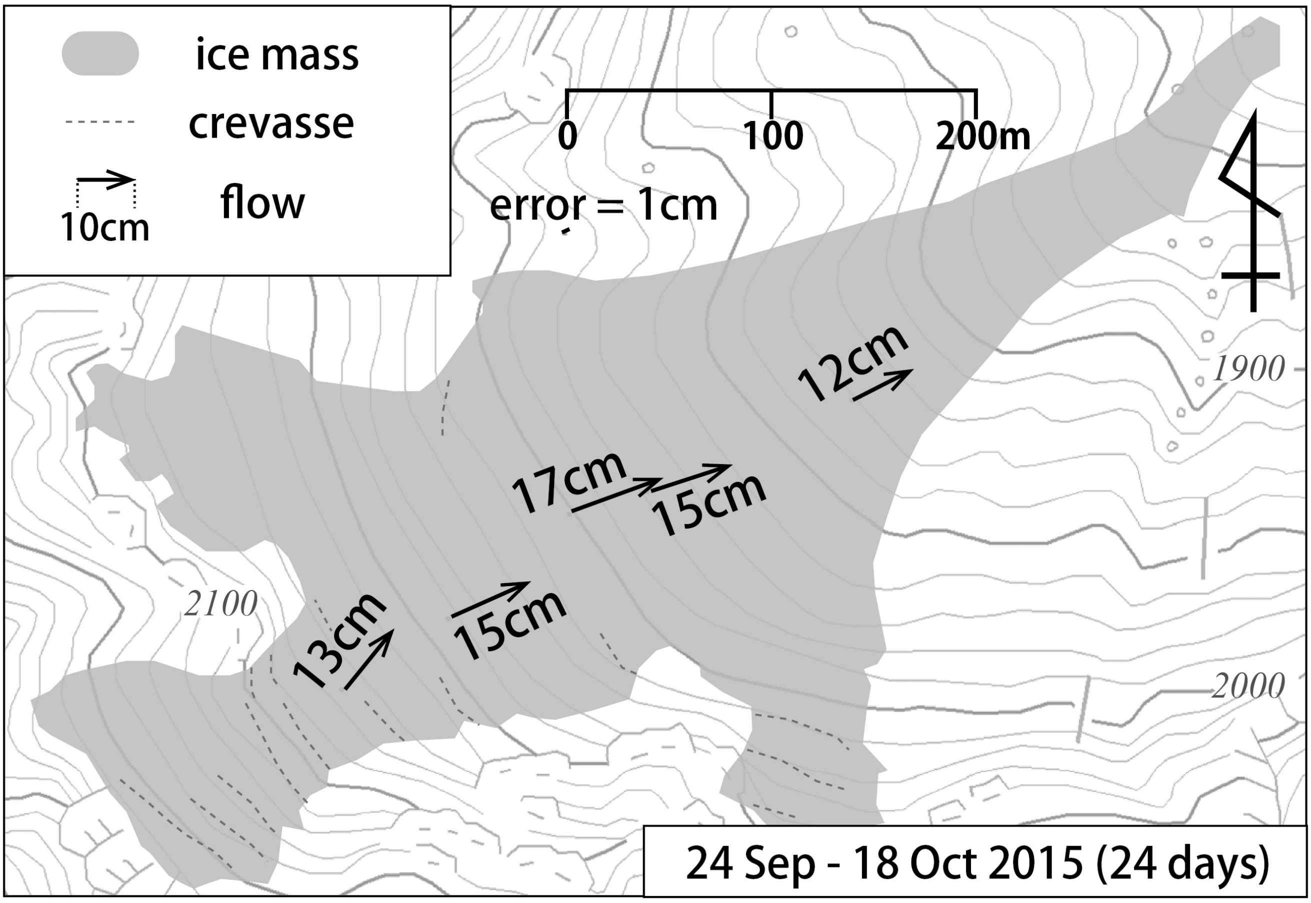
We describe field measurements (ground penetrating radar (GPR), geodetic survey and crevasse observation) to provide new information on the surface flow velocity, the ice thickness and the snow density profile of the Kakunezato perennial snow patch in Mt. Kashimayari (2889 m asl) in the northern Japanese Alps, central Japan.
We found the thick ice mass (over 40 m in thickness) in the central part of the Kakunezato perennial snow patch. The snow density is > 820kg/m^3 below 1 m in depth from the surface in October 2015. The ice mass had flowed 12 - 17 cm / 24 days in the autumn of 2015. Thus, we regard the snow patch as small active glacier.

Keywords: glacier, perennial snow patch, flow, Japanese Alps



The flow of the Kakunezato perennial snow patch