intensifying, so that dimensions of Marlborouogh and Prives Glaciers almost equalled each other: in 2016 their areas were 0,083 and 0,083 km^2, correspondingly, and further on in 2018 they came to 0,062 km^2 и 0,060 km^2. Thus, Marlborough lost 33 per cent of its area during the last 14 years, its contours shrinking more or less uniformly along the perimeter. The Prives Glacier area after 2004, however, reduced stronger than that of its neighbour, that is, by 45 per cent. Separation of a huge glacier fragment in 2017 contributed considerably to this reduction. In general, the present degradation of both reference glaciers is ongoing continuously. Marlborough and Prives Glaciers became smaller by a factor of 2,4 and 2,7, correspondingly, over the 45-year-long period since 1973.

Glacier response to the global change of the glaciosphere becomes apparent much more dramatically in the provinces with small glaciers like the Putorana Plateau. Moreover, settling and maintaining measurements of main components of water and ice balance for glacier basins seem easier just in such regions. Therefore, investigations undertaken on the Putorana Plateau are of both theoretical and methodical interest. They should be continued with establishing regular water- and heat-balance monitoring on 2-3 representative glaciers in Putorana.

The research was fulfilled with the support of RFBR (grant No.18-05-60080_Arctic).

Avalanche hazard zoning for the land use planning in the Russian Arctic

Alla Turchaninova A., Seliverstov Yu.G., Sokratov S.A., Komarov A.Yu.
Research Laboratory of snow avalanches and debris flows, Lomonosov Moscow State University, Moscow, Russia
alla_wave87@mail.ru

In the Russian Arctic, the avalanche hazard territories occupy significant areas. Snow avalanches are the most significant natural hazards in the most highly developed Khibiny Mountains and some areas of Magadan region. In recent years, the attention to the land-use of the Russian Arctic has been considerably increased. The legislation on the land-use planning in Russian Federation requires the natural hazards and their characteristics to be accounted for and available in the form of maps. For the sustainable development of the Russian Arctic mountain regions it is critically important to know which areas are endangered by snow avalanches and what characteristics they may reach.

There is a long-term practice of the large-scale avalanche hazard zoning in different countries, presenting areas endangered by avalanches of different intensity. Avalanche zoning plans are used by land planning authorities to prevent or restrict the construction of buildings in avalanche hazard zones, for

avalanche protection planning and assessing risks. Despite the wide experience in the avalanche hazard assessment and mapping accumulated so far in Russia, the practice of avalanche hazard zoning is not yet used by land planning authorities in our country.

In this research, the importance of the avalanche hazard zoning implementation in Russian Arctic mountain regions is discussed on the example of Khibiny Mountains. First, we applied internationally-accepted Swiss avalanche hazard zoning approach (BFF/SLF, 1984) when avalanche hazard zones were indicated according to avalanches return period and impact pressures. Second, avalanche risk in the large scale was assessed using the approach developed by Komarov et al. (2016).The avalanche hazard zoning and risk maps was developed through the following steps: (1) analysis of terrain using large-scale topographic maps and DEMs; (2) analysis of climate and snow data; (3) analysis of historical and recently obtained avalanche events since 1930th; (4) analysis of remote sensing data (5) winter and summer field work: detailed topographical and forests structure and state check; identification of snow conditions and avalanche activity; (6) avalanche release zones and the corresponding avalanche fracture height indication depending on the avalanches return period; (7) analysis of applied avalanche protection measures and their reliability; (8) numerical simulations of snow avalanches using avalanche dynamics program RAMMS; (9) avalanche hazard and risk zones indication depending on the avalanches frequency and intensity, type of the land use. The numerical simulations were performed for understanding the avalanches dynamics (runout distances and impact pressures) and were applied as a basis for the avalanche hazard zoning.

The developed large-scale avalanche hazard zoning and risk maps were analyzed in respect to already constructed infrastructure and applied avalanche protection measures. The criteria for determination of the boundaries between the zones with different level of avalanches hazard and risk can be discussed. However, incorporation of avalanche hazard and risk zoning as a component of land use planning in Russian Arctic fulfills the requirement of legislation and helps to increase safety of people and decrease avalanche risk and consequences of emergency situations.

The research was supported by the RFBR grant № 18-05-60080 “Dangerous nival-glacial and cryogenic processes and their influence on infrastructure in the Arctic”.

Geophysical and glaciological investigations for safety arrangements in the area of Progress and Mirny stations and the Bunger Oasis field base (East Antarctica) during the field seasons of the 63-64 RAE (2017/2019)

Anastasia Sukhanova[1], Popov S.V.[2,1], Polyakov S.P.[3], Kashkevich M.P.[1]