INTEGRATION OF LANDFORMS, DEPOSITS AND PALEOSOLS ANALYSIS FOR RECONSTRUCTING HOLOCENE DEBRIS FLOW ACTIVITY IN THE LOW MOUNTAINS OF KOLA PENINSULA

E.V. GARANKINA, V.R. BELYAEV, Y.R. BELYAEV, A.L. GURINOV, M.M. IVANOV, N.V. KUZMENKOVA, F.A. ROMANENKO, A.I. RUDINSKAYA and E.D. TULYAKOV

[1] Faculty of Geography, Department of Geomorphology and Palaeogeography, Laboratory for Soil Erosion and Fluvial Processes, Lomonosov Moscow State University, Moscow, 119991, Russia

Keywords: DEBRIS FLOW, MOUNTAIN VALLEY, PALEOSOL, HOLOCENE.

INTRODUCTION

Medium magnitude debris flow phenomena are widespread in the Kola Peninsula Mountains. Most frequently observed types are snowmelt period slushflows and rainfall-induced debris flows. Similar sets of hazardous events are reported for mountainous areas of Scandinavia, Japan and Northern America. Investigation of such events in the Khibiny Mountains over the last 50 years produced a unique dataset of >200 slushflow-affected catchments that have been active at least once. Large-scale bottom features and piedmont fans found in the majority of small valleys indicate periods of much higher debris flow activity in the past. However, those surveys concentrated largely on monitoring the consequences of presently observed events while reconstructions of their magnitude and frequency in the past remained beyond the scope of investigations. In addition, other Kola Peninsula mountains remain practically unstudied in terms of spatial distribution, magnitude and frequency of these hazardous processes.

METHODS

Reconstructing debris flow activity through the Holocene involved detailed description of associated landforms and correlated deposits in several mountain valleys of Khibiny and Lovozerskiye Tundry. Grain size analysis and radionuclide fingerprinting of ^{232}Th content in the finer-grained sediments were applied. Limited geochronological framework was established by ^{14}C dating of buried humic and peat layers between superimposed slushflow deposits using scintillation and AMS methods. Our dates were compared to the previously published chronology of slope processes intensification during the Holocene. Geomorphic interpretation of aerial and satellite imagery and topographic maps presented widespread evidences of debris flow phenomena. High-resolution aerial photography of the key field sites using UAV helped distinguishing the topography and distribution of debris flow landforms of different ages.

RESULTS AND DISCUSSION

Large and still non-vegetated debris flow fan of the Alyavumjok valley is at least 90 years old. Interval between extreme events in the Mannepahkuaj valley causing debris fan formation in forested piedmont zone does not exceed 500 years. There are also evidences of much older and intensive events, e.g. in the Sengisjok valley, dated to Mid-Holocene (4640±70 ^{14}C years, LU-8763). The greatest debris flow landforms such as high (5-10 m) terraces and vast (up to 4 km^2)

debris fans usually lack organic content and should be associated with stages of last deglaciation and, specifically, outbursts of moraine-dammed lakes.

CONCLUSIONS

Available results for >10 studied mountain valleys suggest slushflows and, possibly for some valleys, typical debris flows with lower frequency as a leading mechanism of downstream sediment delivery and valley floor topography formation. Recurrence interval of medium-magnitude slushflows does not exceed 10-30 years in agreement with the published monitoring data. Even more frequent low-magnitude events may occur in the headwaters and tributaries of certain valleys (up to every 1-2 years). Fluvial topography is extremely suppressed or nonexistent under such conditions, as stream channels are unable to rework slushflow deposits and forced to passively adjust. Much lower frequency of extreme events can be estimated as at least twice per millennia. In general, debris flow magnitude has significantly reduced since the last deglaciation. During the second half of the Holocene several periods of increased activity of slope processes and debris flows were distinguished in 4100-3800 and 2760-2120 BC, 400 BC – 300 AD, 790-1560 AD indirectly by dating ephemeral paleosols in colluvial and debris flow fans correspondent to relative stability periods separating those. Additionally, slope and debris flow processes are assumed to be highly active during the Holocene climatic optimum (7500-4800 BP) though direct geochronological evidences of that are still lacking. Thus, reliable chronology of those stages and events is yet to be obtained and represents the most challenging problem for future research in the area.

ACKNOWLEDGEMENTS

This work was supported by RFBR project №17-05-00630 and GM AAAA-A16-11632810089-5.