

Environmental Geosciences and Engineering Survey for Territory Protection and Population Safety

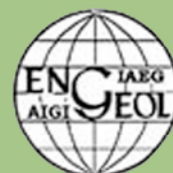


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In the mining area, almost all the plane displacement vectors pointed at the underground goaf, which were changed with the distance from the monitoring points to the subsiding center. In the mine area, many open pit steps were occurred various degrees of collapses, and a large number of ground fissures developed on the surface. The maximum 3D displacement reached 951.7 mm in the hanging wall, while the maximum 3D displacement reached 952.1 mm.

5. Conclusions

After a long-term and large-scale underground mining, the open pit slope occurred evident movement and deformation. Based on the advanced GPS monitoring technology, the primary characteristics and regularities of the ground movement and deformation were clarified.

Generally, there formed two subsiding center on the ground. These two subsiding centers were located in the upper surface of the ore body and the lower surface of the ore body, respectively. Besides, what outstandingly is that there was an uplift phenomenon at the bottom of the pit due to the compressive effect of the high slopes and underground mining. Until 2008, the largest upheaval displacement reached 458.1 mm.

Finally, this study also shows that the long-term GPS monitoring is a good method for the studying of mining-induced ground movement and deformation.

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ANALYSIS OF ACTIVITY OF HAZARDOUS NATURAL PROCESSES ON THE RUSSIAN TERRITORY ON THE BASIS OF THE INVESTIGATED ATMOSPHERE CIRCULATION IN THE NORTHERN HEMISPHERE

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Abstract: The paper discusses the changes in the atmospheric circulation of the Northern Hemisphere in the classification of B.L. Dzerdzhevskii, their influence on the weather in different regions of Russia and on activity of hazardous processes (landslides, mudflows, etc.), as well as the current tendencies of their development.

1. Introduction

Global changes in climate of the recent time cause activation of natural catastrophes, including hazardous exogenic processes (landslides, mudflows, etc.) bringing destructions and death of people. The

activization is connected with the current character of the atmospheric circulation forming hydrometeorological extremums. North Caucasus and Pacific region (Kamchatka, Sakhalin, Kuril Islands) are referred to the most hazardous territories in Russia. Of the highest hazard in these regions are landslides and mudflows, which are most sensitive to changes in weather conditions. On the example of the most considerable catastrophes, connected with them, there are discussed in the paper the reasons of origination of landslides and mudflows, caused by interactions of the factors in the complicated natural system.

2. Initial data

The authors have collected and analyzed the data on landslides and mudflows, including catastrophic ones, in different mountainous regions of Russia and CIS-countries where they present especially a high hazard. There are determined dates and places of these processes and populated settlements suffered from them. For each case the elementary circulation mechanism (ECM) in the classification of B.L. Dzerdzhevskii [1] was indicated, which was registered on the day when mudflows happened and while activization of landslides. For this purpose the authors used the Calendar of successive shift of ECM, as well as the estimates of monthly and annual duration and frequency of elementary circulation mechanism and ECM groups. The data of the classification for the period of 1899 to 2010 can be found in the Internet on website www.atmospheric-circulation.ru. The data up to the year 2008 are published in the work [2] and continue to be published by presently. It gives the possibility to determine the conditions of appearance of any meteorologically-caused hazardous process and reveal the elementary circulation mechanisms, at which formation of these processes is most possible (process-hazardous ECM).

3. Content of investigations

Influence of the weather on activity of landslides, mudflows and other hazardous exogenic geological processes (EGP) is analyzed from the positions of its integrated action upon different components of the geological environment. The especially great importance of the weather as a factor, characterizing the regime of heat and humidity in combination, is for rocks.

The mechanism of influence of the atmospheric circulation on development of hazardous processes lies in that a certain regime and degree of humidity of territory and temperature regime correspond to the weather type at an appropriate ECM. Here, for each exogenic geological process, a certain type of the weather is characteristic, which favors the growth of its activity [6].

The basis of the used classification, developed on the basis of analysis of daily synoptic maps, were the direction and quantity of arctic invasions and comings of southern cyclones over the entire North Hemisphere. B.L. Dzerdzhevskii have defined 13 types of circulation, which are designated by Arabic numerals from 1 to 13. Variants of each type (they can be several) are designated by the first letters of the alphabet (a, b, c, d). There are distinguished summer (s) and winter (w) kinds of ECM, characterized by seasonal differences in the state of the underlying surface. Totally 41 elementary circulation mechanisms were distinguished. According to the number of blocking processes in the North Hemisphere and comings of southern cyclones, they are combined into 4 groups: (1) zonal circulation (types 1-2); (2) disturbance of zonal circulation (types 3-7); (3) meridional northern group (types 8-12); (4) meridional southern group (type 13). Action of a single macro-process lasts, on the average, 3.5 days, varying from 1 to 11 days and longer. In the current period the elementary circulation mechanisms began replacing each other more frequently. This is connected with sharp variations of the weather leading to activation of hazardous natural processes.

Multi-year investigations of development and activization of different ECM (landslides, mudflows, etc.) in different regions of Russia and adjacent countries made it possible to define the elementary circulation mechanisms 13s, 13w, 12a and 9a as the most process-hazardous.

At ECM 13, which determines hazardous phenomena over a large territory, 4 comings of southern cyclones in the North Hemisphere are registered with three among them on the territory of Russia. During short duration of the cyclone (1-2 days) large amounts of precipitation fall out having a provision of less than 1 % often in the forms of intensive rainfalls. This leads to activization of processes of landslides, mudflows, erosion and others. As a rule, ECM 13s is connected with an increase of air temperature.

Unlike ECM 13s as a macro-process of summer period, ECM 12a develops usually in intermediate seasons. At this mechanism one observes a high instability of atmosphere, increased turbulence and aggravation of atmospheric fronts. In the conditions of peculiar "struggle" of northern and southern air masses, at ECM 12a frequent changes of the weather can occur during several days, which favors, to a considerable degree, formation of mudflows and appearance of avalanches.

The schemes of the above-mentioned ECM are presented in Fig.1.

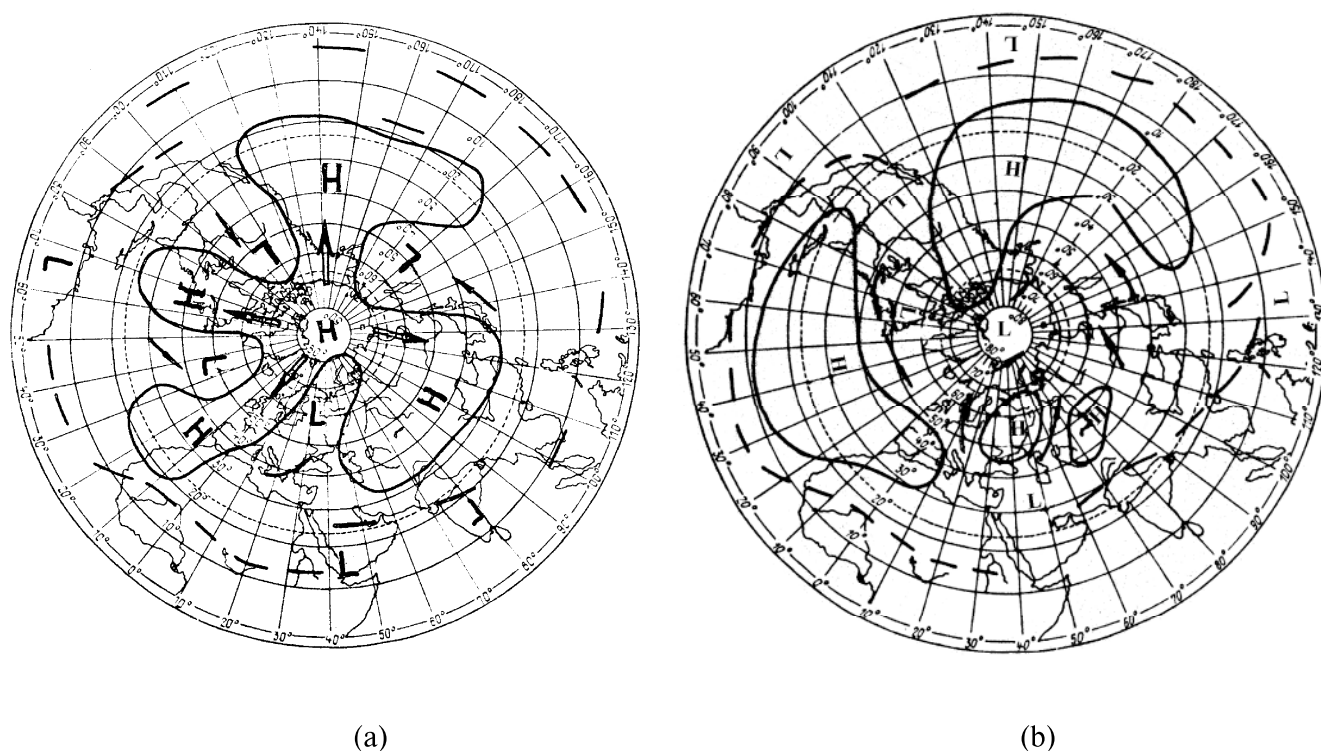


Fig. 1. Dynamic schemes of ECM: (a) 12a, (b) 13s
 Letters ‘H’ and ‘L’ denote correspondingly high atmosphere pressure (anticyclone) and low one (cyclone)

The given types of circulation are connected with strong catastrophes in the end of XX century and beginning of XXI century.

So, for example, the catastrophic activation of landslides in 1989 in the Chechen Republic, having covered almost all its mountainous areas and affected thousands km² of the territory and tens of populated settlements, was caused by the anomalous meteorological conditions of 1988 and winter of 1989. Beginning of this activation should be referred to the summer of 1988. After intensive rains in June-July (precipitation amount exceeded the norm by a factor of 1.8 to 2.2) in a number of populated settlements of the Nozhai-Yurtovsky Region there were observed land sliding motions. During January-February 1989 the precipitation was equal to the 5-norm amount, which finally led to mass activation of landslides. It should be noted that the period under consideration was characterized by the extremely high duration of ECM 13s and 13w. Thus, in June 1988 the duration of ECM 13s was 19 days, and in July – 14 days. The hot and rainy weather at ECM 13s prepared the sliding slopes to activation, and the weather in January-February 1989 caused this activation. In January-February 1989 the analog of the summer ECM 13s was predominant. This is also the very hazardous ECM 13w. The weather was changeful, thawing days with abundant precipitation alternated with frosty days.

ECM 13s was observed during the catastrophic mudflow passing along the river Gerhozhansu (North Caucasus) in July 2000, when the town of Tyrnyauz was considerably destructed with death of inhabitants. Before the mudflow happened, in July for a long time the weather was unusually hot and dry at ECM 13s. It caused intensive melting of glaciers. At this weather type considerable changes occurred in icy-moraine complexes, the consequence of which just was the catastrophic activation of mudflows [4]. The same ECM prevailed also in June 2002 during flooding in North Caucasus and the related manifestation of landslides and mudflows. It was established that in North Caucasus in the basins of rivers of Baksan, Chegem, Cherek in 22% of cases of mudflows during over 50 years were connected with ECM 13s, and in 47% of cases it prevailed there and in those months when catastrophic mudflows were being formed.

On the Sakhalin Island in all the cases of landslide activation and manifestation of mudflows, connected, in the first turn, with typhoons, of a great importance is the type of weather observed during the entire preparatory period of activation of these hazardous processes. In this case the type of weather is also connected with ECM 13s and 12a. Hazardous exogenic processes are developing often at the same time in

Caucasus and Far East. In the beginning of XXI century the highest activity of the above-mentioned processes was observed, like in Caucasus, in 2002. It is explained by the extreme wetting of the territory – both by high degree of wetting and its regime. The sandy-clayey and other rocks, that prevail on the Sakhalin Island in the areas of originating mudflows, do not have a high strength (shales, aleurolites, sandstones of Cretaceous and Paleogene). They are quickly eroded, especially at sharp changes in the wetting regime, connected with the above-named ECM. This is an important factor of development of landslides and mudflows. The strong activation of landslides and mudflows occurred also in 2009.

In East Siberia and Far East the activity of landslide and mudflow-originating sources depends on specific features of the permafrost. Activation of these processes on territory of solid permafrost is caused directly by two reasons: (a) overwetting of rocks and (b) thawing. Conditions, necessary for this, are created at the weather regime forming over the Baikal territory with prevailing of certain ECM in the atmospheric circulation of the Northern Hemisphere. Comparison of the data on the mudflows with the total annual duration of ECM, both observed and obtained by dendrochronological investigations, has shown that in the mudflow-hazardous years (since 1962 till 1976) the number of days with ECM 13l amounts to 300 – 600% of the norm, with ECM 9a – in the years of 1952, 1957, 1959, 1973 – 160 – 250% of the norm, 12 – twice higher than the norm in the mudflow-hazardous years of 1927, 1933, 1975, 1976. Here, there are used the data on the mudflows on the south-eastern slope of the Barguzin Ridge, in the basin of River Angarakan and on the Baikal slope of the Kichersky Ridge [5].

In the beginning of August 2006 the prevailing ECM 13s provided in the highlands of Central Caucasus the very hot weather; maximum daily air temperatures during several days exceeded 30°C. As a result of intensive ice melting on 11th August of this year a powerful glacial mudflow happened in the headstream of River Malka. In August 2007 under the similar meteorological conditions a catastrophic glacial mudflow descended in the village Bulungu in the valley of River Chegem (Central Caucasus). On 3rd June 2007 the Valley of Geysers in Kamchatka was crushed.

In spring 2010 at the increased duration of ECM 12a and 13s, the considerable activation of landslides and mudflows in the lowlands of Tadjikistan in the basin of River Vahsh where, unlike the European Russia, an anomalous amount of precipitation fell out.

In conclusion, it should be noted that at the present time the tendency of atmospheric circulation development is changing. The duration of the southern meridional group (ECM 13w and 13s) is decreasing, though still it exceeds the average value for 1899-2010, whereas of the northern group, including ECM 9a and 12a, is increasing and already exceeds the average value. This means that in the nearest decade one cannot expect a decrease in frequency of meteorologically caused hazardous natural processes (Fig. 2).

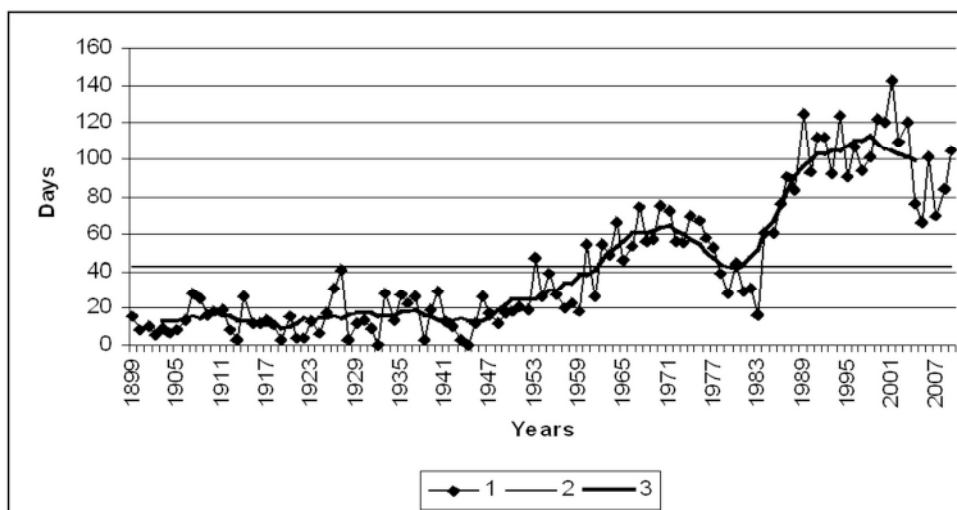


Fig. 2. Total annual duration of ECM 12a and 13s.

1—annual duration, 2—average for 1899 – 2009, 3— annual duration smoothed by a sliding 10-years.

Dynamics of duration of the circulation groups in the present-day period leads to formation of the regime that was observed in 1960s of XX century: the northern meridional group again turns out to be the

longest, whereas durations of the southern meridional and zonal groups are becoming similar. This period was characterized by a slight temperature decrease in the North Hemisphere as a whole after the warming of 1930-1940 and the largest (beginning since the end of XIX century) precipitation amounts. Precipitation helps forward an increase in the activity of landslides and formation of the liquid component of mudflows. At the same time the duration of southern meridional processes is still sufficiently long, at which there is a possibility of increasing temperature, intensive melting of glaciers and buried ice, moistening of the moraine at the expense of melted ice waters.

Conclusions

The present-day changes of climate are accompanied by an increasing frequency of meteorological extremums, which, in turn, lead to an increase in frequency of hazardous natural processes on different territories.

If changes in the atmospheric circulation will be occurring in future in the same way like presently, then with a further growth of duration of the meridional northern circulation, the number of glacial mudflows in North Caucasus can decrease, but the number of heavy and glacial-heavy rainfalls will grow as it has been in 1960s-1970s. An increase will occur in the hazard of landslide activization, in particular, in the area of Sochi and Krasnaya Polyana – the area of conducting the Olympic Games of 2014. A high hazard of landslides and mudflows is probable also in Altai, in Baikal Lake area and Sakhalin Island. One should be ready for a high probability of manifestations of hazardous natural processes, caused by weather at the above-indicated ECM. Frequent changes of weather, extreme droughts and floods (in case of coming southern cyclones) are possible.

To prevent possible catastrophic events is impossible, but by means of systematic monitoring of hazardous exogenic geological processes their negative consequences can be minimized.

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TEST STUDY OF VERTICAL DRAINAGE IN CRYOPEG-CONTAINING SALINE SOILS AT YAKUTSK

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Abstract: *This article contains empiric results of infiltration experiments at Yakutsk standard site with local cryopeg formation. It is also shown possibility of pumping; water discharge is proposed as an efficient soil dewatering method. We also proved the necessity of including field empiric results in engineering and geological research in order to quantify filtration possibilities of soils.*