

# **The Estimation of Mud Flow and Landslide Hazard on the Island Sakhalin in the Next Decade**

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## **Abstract**

Conditions of the shaping and development of landslide and mud flow on the Sakhalin are considered. Probability of the high frequency of these processes in the next years has been revealed. The classification of the Northern Hemisphere atmospheric circulation by B.L. Dzerdzeevskii is used at estimation of the dangers. The circulation types, with which on Sakhalin island are bound typhoons and activity of landslide and mud flow are raised have been revealed.

**Keywords:** *landslide, mud flow, typhoon, ECM, danger*

## **1 Introduction**

In present time the estimation of mud flow and landslide hazard on the Sakhalin island is very actual in connection with increase of the natural extremes frequency. More than 100 towns and villages subject to influence these processes. The landslides annually remove from building group of ten kilometer iron and road roads, complicate the construction many objects, usage of useful fossilized. Only direct damage from the mud flow annually at destruction them car and road roads is numbered group of ten and a hundred of a thousands rubles, but indirect damage, connected with multiple breaches of the transport message, appearing complications at construction and etc in general does not subject to calculus.

## **2 Methods and data**

When evaluating mud flow and landslide danger there were used the data of the Sakhalin hydro-geological expedition and other organizations as well as meteorological data on the air temperature and atmospheric precipitation. The elementary circulation mechanism (abbreviated to ECM) is indicated for each case of mud flow passing and landslide activity in the classification of circulation processes in the atmosphere of the Northern Hemisphere by B.L. Dzerdzeevskii. There was used History of the alternation of ECM from 1899 to 2005 years (<http://igrankononova.narod.ru> и [www.atmospheric-circulation.ru](http://www.atmospheric-circulation.ru)).

## **3 The results of the investigation**

### **3.1 Geological construction**

The main characteristics, whereby the degree of danger is estimated, represent: the intensity of the process evolution on a given area (destruction) and the activity of the process display in time. The area destruction by mud flow and landslide is a constant, their activity derives from meteorological factors, seismic factors and human activity (Sheko, Malneva, 2002).

High defeat of Sakhalin island territory by landslide and mud flow processes are conditioned by geological construction of the territory, significant tectonic breaches, in near fracture zone particularly, as well as active economic activity of the person. In geological construction of the territory dominate the sleazy sorts: argillite, clays, aleurolite. Argillites practically all easy become soggy. The clays also easy become soggy and particularly quickly lose toughness when change the mode of the moistening. Dominating on given territory of the sort are by leaps and bounds aired, when the temperature fluctuation cutting of the air particularly, typical of Sakhalin island at spring time. The reduction to toughness of the sorts and growth of their weight as a result of moistening promotes the activations of landslide process.

### **3.2 Weather conditions**

The High activity of landslide and mud flow processes are conditioned, first of all, by meteorological factors: atmospheric precipitation, the temperature of the air. So from the last years (2001 - 2005) the highest activity was in 2002 that is the territory conditioned by extreme moistening: both high degree of the moistening, and its cut.

The Weather conditions, providing optimum mode for landslide and mud flow activity on Sakhalin, are conditioned corresponding to nature to atmospheric circulation. The Relationship to atmospheric circulation and activities of the dangerous natural processes was repeatedly considered by us for different region of the Russia (Kononova, Malneva, 2003; Methods of permanent forecast, 1984).

For analysis of the change to atmospheric circulation is used classification of elementary circulation mechanisms (ECM), designed by B.L. Dzerdzeevskii (Dzerdzeevskii, 1962, 1968). In base of classification as one should direction and amount blocking processes and output southern cyclone on all Northern Hemisphere. Alternation of ECM is fixed in the History of ECM alternation from 1899 to the current year (History..., 1987; Kononova, 2003). The tables of ECM duration per month and year for the same period were submitted for specified above site in network Internet. This enables to define the condition of the origin of any dangerous natural process at concrete moment of time and reveal ECM, under which shaping of these processes most likely, as well as track change to their frequency in the course of time. They were chosen ECM, with which are bound extreme air temperature and precipitation on Sakhalin. The most significant precipitation on territory of Sakhalin and in the other parts of the Far East region are connected with ECM 13s (Viakhtu, 16.09.52 - 33,8 mm per day, Holmsk, 23.07.57 - 25,8 mm); 9a, as well as ECM types 8 and 12. The frequency of these ECM increases at present.

The typhoon output frequency on Sakhalin increase under ECM 13s. The calculations called on weather maps show that in the last decennial events frequency of typhoons near Sakhalin increases. The most powerful typhoons on Sakhalin for the last decennial events and types of atmospheric circulation, existed in this time, are presented in table 1.

Table 1. The most power typhoons in Pacific and ECM in the period of its action over Sakhalin.

Year	Date	Name of typhoon	ECM in the period of typhoons activity
1961	September 16-17		5d
1972	September 12-16	«Maria»	13s, 12a
1981	August 5-6	«Fillis»	13s
1992	August 14-17	«Robin»	13s
1996	September 23-26	«Violetta»	9b, 13s
2000	September 5-6	«Saomai»	13s
2002	July 11-15	«Chataan»	13s, 3
2002	September 2-3	«Rusa»	13s

As defined earlier, very dangerous for mud flow and landslide processes is also weather under ECM 12a. Under this ECM Sakhalin occurs part a change the weather that to a considerable extent promotes shaping a mud flow. Under all cases of the activity of landslide and mud flow on Sakhalin, bound, first of all, with typhoon, is of great importance weather patterns, existed for the whole period of preparation to activity these dangerous processes. For clay sorts in mud flow centre of Sakhalin the most dangerous weather is under ECM 13л, when occurs intensive moistening the sorts and preparation hard forming of mud flow. Change of landslide and mud flow activities per year is shown on figure 1.

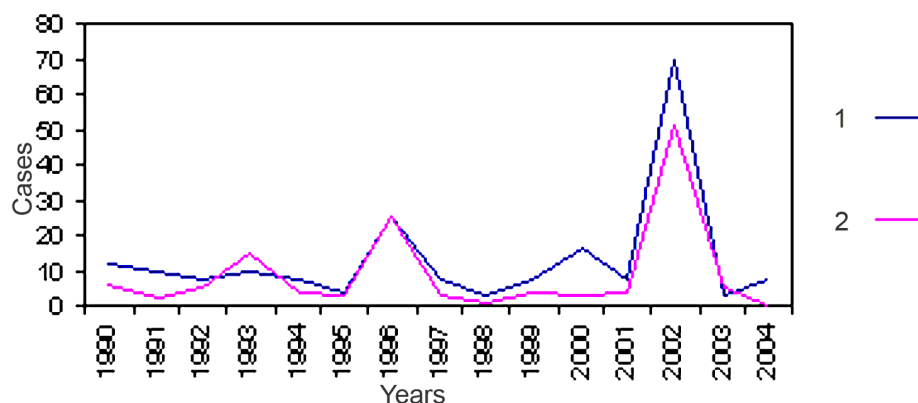


Figure 1. Mud flow and landslide processes activity in Makarov's place during 1990 – 2004.  
1 – landslide, 2 - mud flow

In connection with modern nature of the atmosphere circulation continuing growing of the number of the days with the most dangerous ECM possible conservation to high frequency of typhoon in the next years and, consequently, conservation to high frequency to activity of the disastrous natural processes on Sakhalin (figure 2).

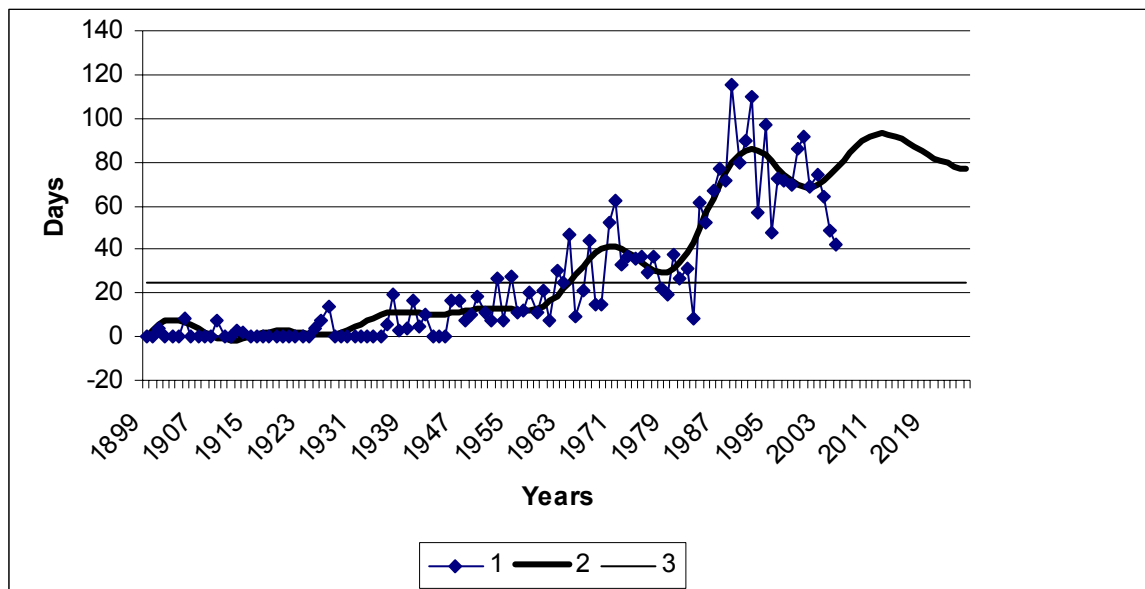


Figure 2. Long-term changes of annual ECM 13s duration for 1899-2005.  
1 - data, 2 – forecast, 3 - average

Herewith possible expect that possible it is enough strong of landslide and mud flow activity in 2007 – 2009 practically on the whole territory of Sakhalin. This corresponds to on time probable minimum of 11-year solar cycle, during which possible also the most outraging conditions of atmosphere circulation. The activity will conditioned by significant anomaly of meteorological factor at mode of the weather, caused first of all by ECM 13s (refer to figure 2).

The estimation to dangers of landslide and mud flow is produced apart for each time zone under which is understood territory with alike perennial cut considered process. Each temporary zone is characterized by determined set period to activity of different degree (power).

The Degree to activity (the category to dangers) depends on mode of quickly change factors, as well as on intensities of the manifestation (defeat of territory) of forecasted process. The mode of factors is characterized by their supply, presented three gradations: 10 % (the strong activity), 10 - 50 % (average activity), >50 % (weak activity). The intensity of the manifestation of exogenic geological processes is characterized by area defeat of the territory by forecasted process in percent and has a following gradations: strong defeat (>50 %), average defeat (10 - 50 %), weak defeat (< 10 %). Estimation to dangers of landslide and mud flow is produced on each time zone.

As a result of the executed studies it is installed that validity earlier issued forecasting estimations to activity of landslides and mud flows for period 2000 - 2005. has been formed 60 - 80 % with inaccuracy 1 year, in connection with than proposed estimations follows to consider as background forecast to trends of the development of the dangerous processes. For Sakhalin as a whole in the next years the high activity of landslides and mud flows and other dangerous geological processes is keep. The periods to high activity of landslides for most of the temporary zones are close. With provision for the inaccuracy of forecast it is possible to say that the most dangerous period will be 2007- 2009. Average activity of landslide process will be in the period 2010 - 2012 with some reinforcement to 2014 - 2015 though for separate temporary zones (VII and X) strong activity is expected in 2011 - 2012.

Strong activity of mud flows is expected in 2007 - 2009, average activity may be in 2010 - 2012 and 2014 - 2015 moreover within Susunaysky ridge activity of mud flows in 2015 can be strong.

All said above shows that necessary to keep a check on development the most dangerous, often disastrous processes - of landslides and mud flows - on Sakhalin. For this necessary to realize the complex studies in system of the monitoring of the environment that will allow in time to warn about possible manifestations of the dangerous processes and reduce before minimum their negative influence.

#### 4 Conclusions

In connection with present nature of the atmosphere circulation and high frequency of south cyclone and typhoon outlets in the years ahead the high danger to activity of the landslides, mud flows and other disastrous natural processes in Sakhalin island is keep. The Strong activation is expected in 2007 – 2009. Emphases follows to turn on Makarov’s area, where on background maximum defeat of territory by the landslides and mud flows can occur the strong activity of these processes in the years ahead.

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## References

- Dzerdzeevskii, B.L., 1968. Circulacionnye Mechanizmy v Atmosphere Severnogo polusharia v 20-m stoletii, Materialy meteorologicheskikh issledovaniy. Mejdunarodnyi geofizicheskii god. (Circulation Mechanisms in the Atmosphere of the Northern Hemisphere in the 20th Century). International Geophysical Year, Meteorological data Inst. of Geogr. Acad. Sci. USSR, Moscow, 240. In Russian.
- Dzerdzeevskii, B., 1962. Fluctuation of climate and of general circulation of the atmosphere in extra-tropical latitudes of the Northern Hemisphere and some problems of dynamic climatology - *Tellus*, 14, 328-336.
- History of the alternation of ECM for 87 years (1899-1985), 1887. Meteorological data № 13, Inst. of Geogr. RAS, Moscow, p.29-116 (In Russian).
- Kononova, N.K., 2003. Issledovaniya mnogoletnih kolebanii cirkulycii atmosfery Severnogo polusharia i ish primeneniye v glyaciologii. Prilozenie: Kalendar posledovatelnoy smeny ECM za 1986-2002 gody (Studies of long-term variations of atmosphere circulation in Northern Hemisphere with application in glaciology. Supplement: History of alternation of ECM for period 1986-2002). *Data of glaciological studies*, 95, 45-65. In Russian.
- Kononova, N.K., Malneva, I.V., 2003. Tendency of the natural dangerous process frequency in Russia with connection to dynamic of atmosphere circulation. Natural risks assessment and management. The proceedings of the All-Russian conference "RISK-2003" Moscow, Russian university of friendship of the peoples, vol. 1, 153-157.
- Methods of permanent forecast of exogenic geological processes, 1984. Edit. A.I. Sheko and V.S. Krupoderov. Moscow, "Nedra", 188. In Russian.
- Sheko, A.I., Malneva, I.V., 2002. Mud flows. Natural dangers of Russia (in 6 volumes). Volume 3. Exogenic geological dangers. . Edit. V.I. Kutepov and A.I. Sheko. Moscow, 65-87. In Russian.