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TECHNICAL REPORT

BAIKAL BASIN TRANSBOUNDARY DIAGNOSTIC ANALYSIS

NATURAL DISASTERS

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SUMMARY

The Baikal Lake is located in the middle part of the Baikal Lake rift zone, which started its formation process about 40 million years ago. The Baikal hollow is the central link of the rift zone. The Baikal rift zone is the largest in Russia and the second-large one on the Earth. The rift structures are 2500 km long from northwest of Mongolia to the southern area of Yakutia [Earthquakes in the Baikal Lake Area/ IRKIPEDIA.RU – Everything about Angarski Krai, 8/20/2012. http://ir kipedia.ru/content/zemletryaseniya_na_baykale].

Process of the Baikal rift formation is going on even now, showing an increase in seismic activity and horizontal stretching of the earth crust. It has been found that the Baikal Lake shores are moving apart at 5 mm per year in the direction Irkutsk-Ulan-Ude cities.

Figure 4.8.1. presents a map of fractures in the Baikal Lake rift zone. Since 1902 instrumental observations, carried out in the Baikal Lake area, have registered more than 231 thousand earthquakes [the State Report «On the Status of the Baikal Lake and Measures for its Protection in 2011; RF Ministry of Natural Resources, M. 2012. – p.119].

Fig. 4.8.1. Active fractures in the Baikal rift zone

[Documents of the Institute of the Earth Crust, Siberian Branch of the Russian Academy of Sciences]

The area around the Baikal Lake is characterized by a wide propagation of dangerous exogenous geological processes – abrasion, erosion, karst, thermokarst, mudflows, slumps, land-slides, taluses, avalanches, ground icings, ice jams on the Baikal coast, etc.

There is an interrelation between intensive mudflows with earthquakes of magnitude 8 or even 10-11, which took place in the warm period of a year when soil thaws. Extraordinary intensive mudflows are to be expected when catastrophic earthquakes and abnormal intensive storm rains coincide in time [Makarov S.A. Mudflows in the Baikal Lake area. – Irkutsk: Publishing house of the Institute of Geography named after V.B.Sochavy; Siberian Branch of the Russian Academy of Sciences, 2012. - pp. 43-44].

An earthquake strongly impacts course and rate of geocryological processes: solifluction processes accelerate, taluses move more freely, and mass-scale transfer of active layer results in violation of the permanent thermal regime in the upper horizons of permafrost. And that causes its degradation and contributes to ground avalanches formation.

Land-slides, widely-spread in the Baikal Lake area, are subdivided into endo - and exokinetic by nature. Endokinetic land-slides are the result of strong earthquakes. They are, as a rule, characterized by enormous volumes (more than million м^3). Exokinetic land-slides, on the contrary, occur constantly and take place mainly in bald zone of steep mountain slopes.

4.8.2. Earthquakes

Fig. 4.8.2. presents a map of epicenters of historical and prehistoric earthquakes, and fig. 4.8.3 shows a map of earthquake epicenters since 1950.

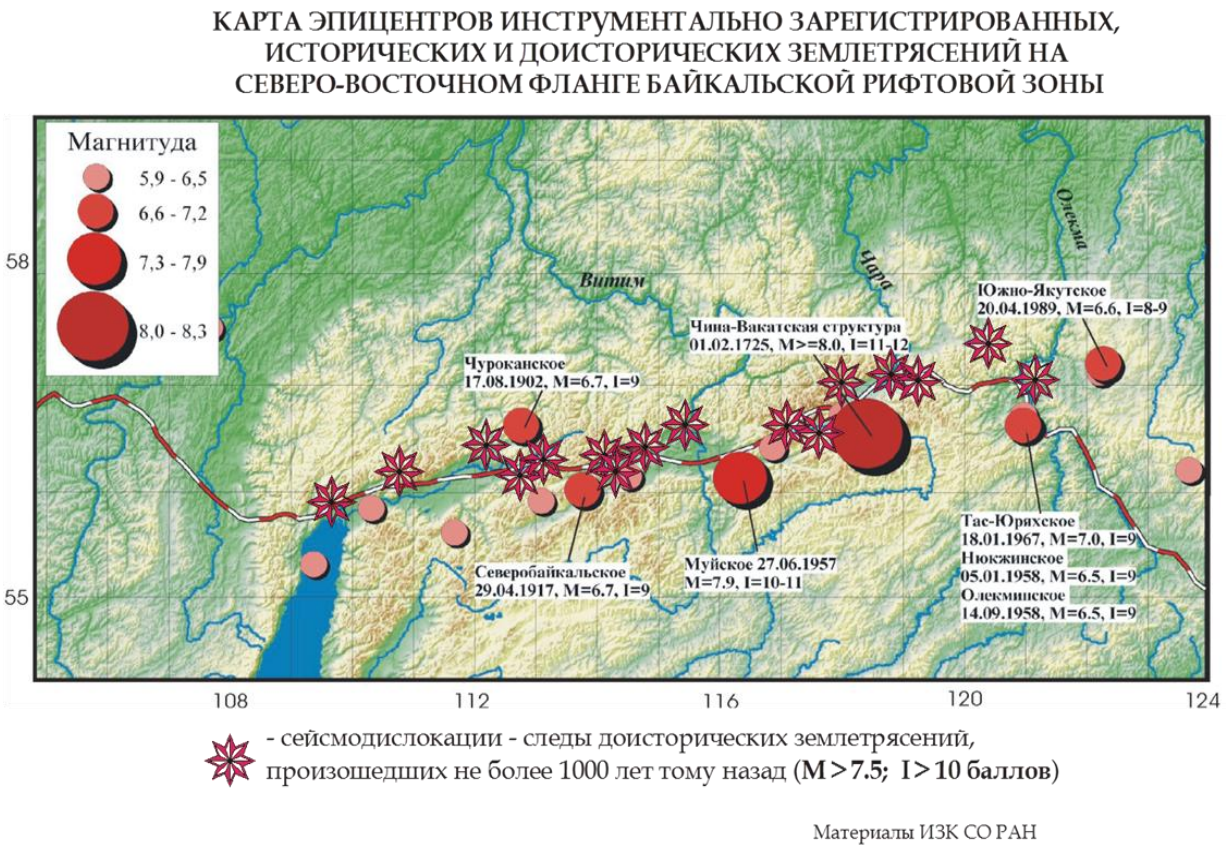

Fig. 4.8.2. A map of epicenters of historical and prehistoric earthquakes

[Documents of the Institute of the Earth Crust; Siberian Branch of the Russian Academy of Sciences]

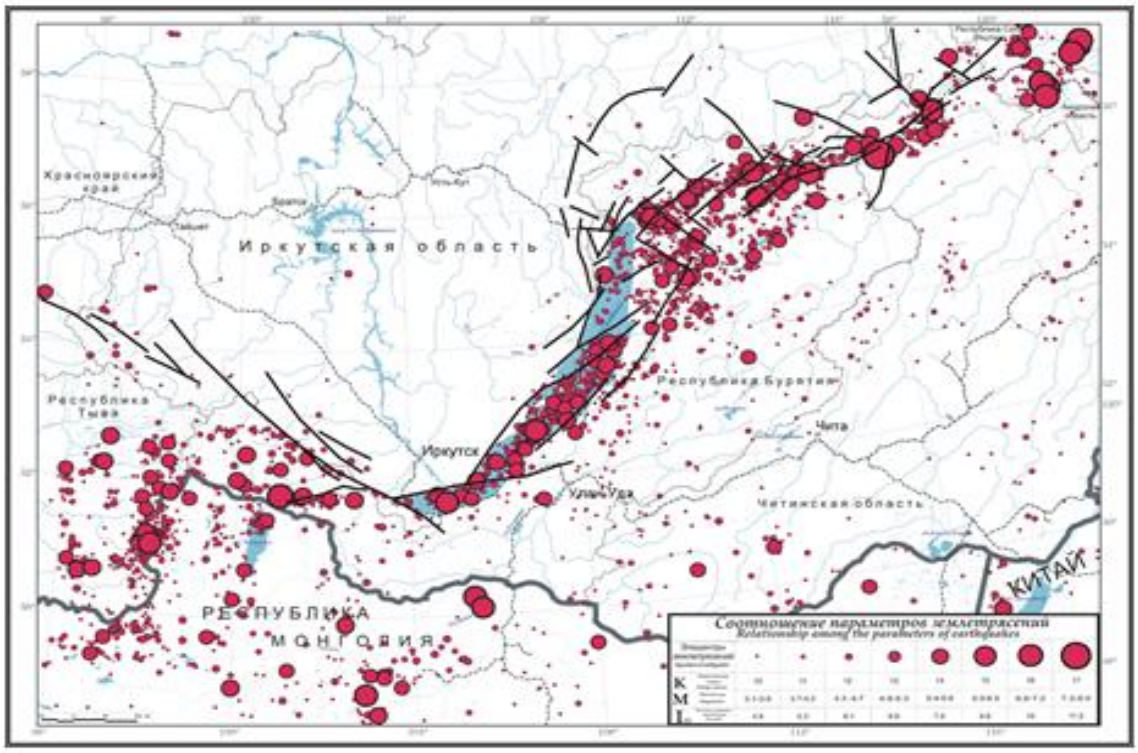

Fig. 4.8.3. A map of earthquake epicenters in the Eastern Siberia, occurred since 1950г. [Documents of the Institute of the Earth Crust; the Siberian Branch of the Russian Academy of Sciences]

Nowadays the international level of the science dealing with earthquakes always presents some risk, but it should be professionally estimated and reduced to minimum.

The territory of the Baikal Lake rift zone is the most active in respect of seismic intensity region of the Russian Federation. Earthquakes with a magnitude of 9-10 and stronger has repeatedly taken place and will occur in future in this area.

The earthquakes impact vast territories: figures 4.8.4. and 4.8.5. present isoseismic schemes of Sredne-Baikal and Mujsky earthquakes, occurred in 1959 and 1957 correspondingly.

Fig. 4.8.4. The isoseismic scheme of the Sredne-Baikal earthquake (1959)
[Documents of the Institute of the Earth Crust; the Siberian Branch of the Russian Academy of Sciences]

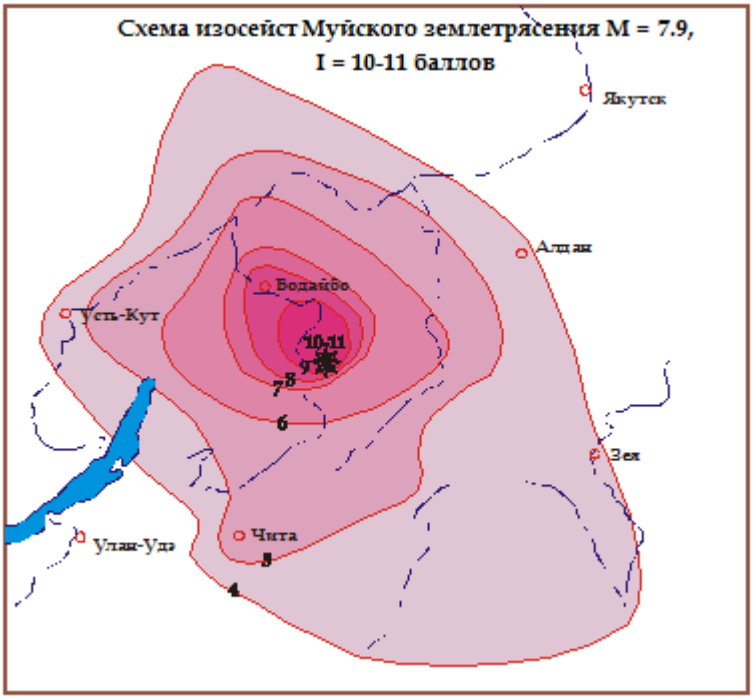

Fig. 4.8.5. The isoseismic scheme of the Mujsky earthquake (1957)
[Documents of the Institute of the Earth Crust; the Siberian Branch of the Russian Academy of Sciences]

4.8.2.a Present and predictable impacts

In the Baikal Lake area earthquakes occur rather often: seismographs register about 3-8 thousand seismic events annually. Earthquake epicenters are localized at a depth of 12-22 kilometers. Table 4.8.1. shows the most severe earthquakes occurred in the Baikal Lake area in the last 300 years [Earthquakes in the Baikal Lake area / IRKIPEDIA.RU All about Angarski Krai, 8/20/2012. http://irkipedia.ru/content/]. On the average in the Baikal Lake area every 1 or 2 years there is an earthquake with magnitude of 7, every 5-10 years – with magnitude of 8, every 50 – 100 years – with magnitude of 9 in epicenter. Severe earthquakes with magnitude of 10 and even more are observed once in 150–200 years.

Researches of seismic process in the Mongolo-Baikal region since 1742 [Levi K.Г, Chechelnitsky V.V. Problems of Seismosafety of the Baikal region – 2011 / Scientific magazine «Bulletin of the BSC the Siberian Branch of the Russian Academy of Sciences», Publishing house BNTS of the Siberian Branch of the Russian Academy of Sciences, Ulan-Ude, 2012, № 1 (5). – pp. 30-42] testifies that seismic intensification in the region is observed every 50-60 years. With a view of earthquakes forecasting, the Mongolia-Baikal geodynamic range has been created under the Institute of the Earth Crust of the Siberian Branch of the Russian Academy of Sciences; the findings of investigation contributed, in particular, to preparedness for a severe earthquake to be expected near settlement of Kultuk (it has occurred on August, 27th, 2008).

When it comes to earthquakes in the Baikal Lake area, they usually recollect the Tsagansky earthquake of 1861 which led to formation of one of the largest gulfs of the Baikal Lake – a gulf of Proval. The Tsagansky earthquake epicenter was in the northeast part of the Selenga river delta.

Table 4.8.1.

The most severe earthquakes in the Baikal Lake area for the last 300 years

Date	Title	Epicenter	Magnitude	Intensity in epicenter
On January, 5th, 1967	Mogodsky earthquake	48.1°n 102. 9°e	7.8	10
On August, 29th, 1959	Srednebajkalsky earthquake	52.7 °n 107.0° e	6.8	9
On December, 4th, 1957	Gobi-Altay earthquake	45.1°n 99.4°e	8.1	11
On June, 27th, 1957	Mujsky earthquake	56.2°n 116.4°e	7.6	10
On April, 5th, 1950	Mondinsky earthquake	51.8°n 101.0°e	7.0	9
On July, 23rd (On July, 10th, Julian C. 1905)	Bolnajsky earthquake	49.3°n 96.2°e	8.3	11–12
On July, 9th (On June, 26th Julian C.) 1905	Tsetserlegsky earthquake	49.5°n 97.3°e	7.6	10–11
On November, 26th (On November, 13th Julian C.) 1903		52.7°n 107.6°e	6.7	8–9
On April, 12th (On March, 30th Julian C.) 1902		51.6°n 104.5°e	6.6	8–9
On January, 12th, 1885 (On December, 31st, 1884 Julian C.)		52.5°n 106.5°e	6.7	8–9
On January, 12th, 1862 (On December, 31st, 1861 Julian C.)	Tsagansky earthquake	52.3°n 106.7°e	7.5	10
On March, 8th		51.5°n	7.0	9

Date	Title	Epicenter	Magnitude	Intensity in epicenter
(On February, 24th) 1829		104.1°e		
On September, 2nd (On August, 22nd Julian C.)1814		51.8°n 102.4° e	6.4	9
On June, 27th (On June, 16th Julian C.) 1742	The big South Baikal earthquake	Southern Baikal	7.7	10
On February, 1st (On January, 21st Julian C.)1725	Great East-Siberian earthquake	56.5°n 118.5°e	8.2	11

Concussion was so strong that ice on the Baikal Lake was cracked, a tsunami was generated, its wave overcame a coastal shaft more than 3 meters in height and moved deep into the Tsagansky steppe for 2 kilometers. The earthquake was perceived on the area about 2 million sq. km, damage of buildings were observed for a distance of 600 km from epicenter. About 230 sq. km of the Tsagansky steppe together with Buryat Ulus area lowered several meters down and transformed into the Baikal Lake floor.

The Srednebajkalsky earthquake, which occurred on August, 29th, 1959, with a magnitude of 9 and the epicenter in water area of the Baikal Lake, resulted in lowering of the Lake bottom for 15-20 meters near the epicenter.

In recent years in the zone, supervised by seismic stations of the Baikal branch GS of the Siberian Branch of the Russian Academy of Sciences, there has been registered more than 8-9 thousand weak and intensive earthquakes a year (fig. 4.8.6) [the State Report «On the Status of the Baikal Lake and Measures for its Protection in 2011, M, 2012 - p. 124]. On July 16th, 2011, the most intensive earthquake with magnitude of 7 was registered in the Baikal middle area, in approximately 20 km from Turk settlement (Republic of Buryatiya).

Intensive earthquakes can present a severe threat to the Baikal Lake ecosystem and be accompanied by serious loss of water fauna as a result of gas emissions in water column.

Besides, this circumstance makes engineers to deal with lining of gas pipes within the Lake water area with greater attention and care.

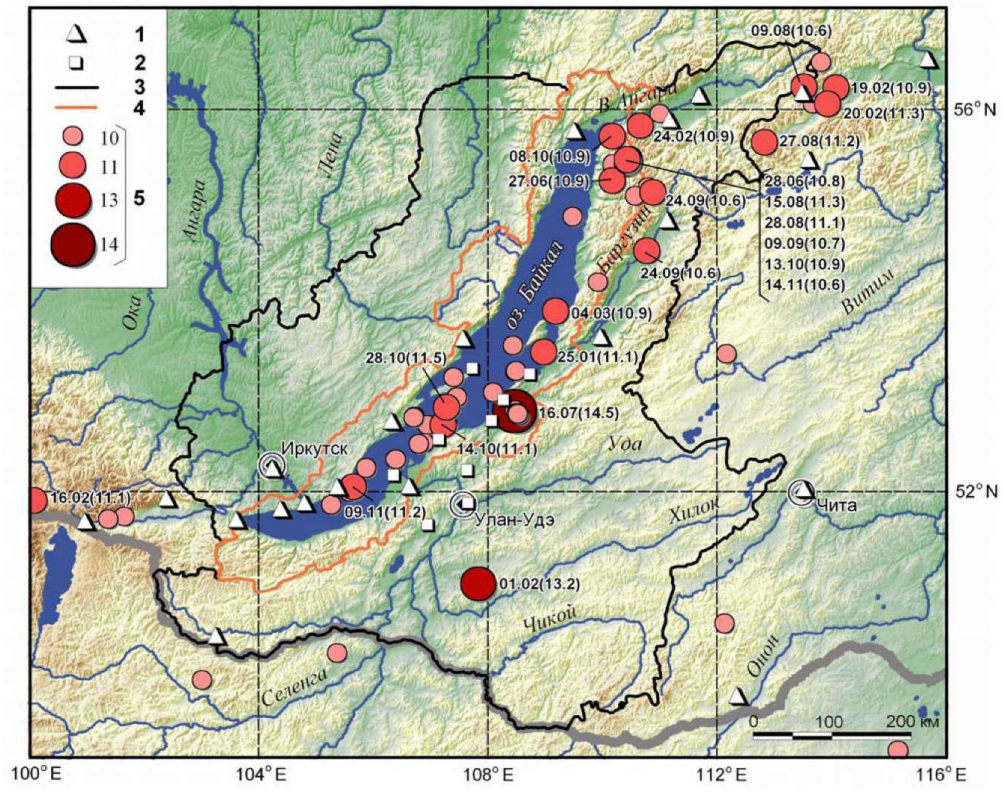

Рис. 1.2.2.1.3. Карта эпицентров землетрясений произошедших на Байкальской природной территории в 2011 году. 1 - сейсмические станции Байкальского филиала ГС СО РАН; 2 - сейсмические станции Бурятского филиала ГС СО РАН, 3 - граница БПТ; 4 - граница ЦЭЗ БПТ; 5 – энергетический класс, К

4.8.2.b Present and expected future social and economic consequences

In compliance with a decision of the Council of Ministers-RF Government dated 5/11/1993 № 444 «On the Federal System of Seismological Observation and Forecasting of Earthquakes», the Baikal regional seismic network of stations of Geophysical service under the Siberian branch of the Russian Academy of Sciences was created to carry out seismic observations and forecasting of earthquakes. The network is included into the global international system of seismic processes observation. As of 12/31/2011 the Baikal regional seismic network includes 34 permanent observation stations which are supervised by Baikal (25 stations) and Buryat (9 stations) branches of the Geophysical Service of the Russian Academy of Sciences (Siberian Branch). The scheme of seismic stations location is presented on fig. 4.8.6 (The State Report «On the Status of the Baikal Lake and Measures for its Protection in 2011, M, 2012 - p. 119].

The Baikal Lake region is one of the most dangerous in Russia as far as seismic situation is concerned, and consequently the risk caused by local seismicity should be estimated as 1 % within every 50 years. It is also necessary to keep in mind that in the potential seismic danger zone of the region over one and a half million people live.

For extremely important installations, such as power stations, radioactive burial places, large hydraulic engineering constructions, etc., OCP-97D map, corresponding to average recurrence period of seismic impacts once in 10.000 years (0.5%-level of seismic danger within 50 years) and meeting the International Atomic Energy Agency requirements, has been developed**.**

4.8.3 Mudflows

The Baikal Lake region is characterized by water-arbor-stone mudflows. They are typical both for the southern and for the northern mountain ridges framing the Baikal Lake rift hollows system. Spatial and temporal variations of the process are well studied. Intensification of these processes occurs to periodicity 10, 20-25 and 50-60 years. Mudflows are of a huge destructive force. For instance, in summer 1971 in the region under review catastrophic floods were attended with vigorous mudflows, which were full of arbor and bush vegetation, choked bridge spans of the Trans-Siberian railway and of the automobile road along the coast of the Baikal Lake. That led to their deformation and even shifting.

4.8.3.a Present and predictable impact

In the Baikal Lake region mudflows fall into channel and slope mudflows by their formation. Movement routes of channel mudflows are limited by an ordinary channel or by a river valley and that facilitates a choice of protection measures; while slope mudflows are the least predictable and the most dangerous as they are accompanied by a transfer of considerable volumes of soil during intensive storm rains (2-4 mm/min.).

Mudflows risk in various sites of the Baikal Lake region is different.

Maximum mudflow activity was registered in 1871 when more than 60 % of territory of the north parts of the region was endangered by mudflows. The Mujsky earthquake with magnitude of 10-11 occurred in 1957, and its affect was perceptible on the area of more than 2 million sq. km; the same year Mujakansky, Kalarsky, Kodar, Udokan, Ujakansky, Barguzinsky and Baikal ridges were captured by mudflows. In 1960 mudflows were registered in the regions of Verhneangarsky, North Mujsky, Mukansky and Kodar ridges.

There are examples of railways and contact-line supports which were destructed by mudflows, as well as of breakdown of normal bridges operation.

4.8.2.b Present and expected social and economic consequences

The developed forecast of mudflow risk in the Baikal Lake area testifies that intensification of its activity is expected from 2014 (fig. 4.8.7).

The developed territories along the Baikal Lake coast appear to be of a serious mudflow risk. There are drift cones generated ashore, which, on the one hand, represent optimum conditions for

the territory development, and on the other - a serious danger and risk. At present these conditions are typical for the territory near Baikalsk town, so the Baikal Lake coast is to be protected against abrasion – coast washout, and against mudflows and water flows from mountain side.

Fig. 4.8.7. Relative mudflow risk change in the Baikal Lake area, a forecast up to 2030 (documents of the Institute of the Earth Crust, the Siberian Branch of the Russian Academy of Sciences)

In valleys of some mud streams mud dams have been constructed to protect installations. For protection of the railway against abrasion (washout) artificial beaches are made annually of delivered boulders.

The most serious mudflow disaster was in 1971. Mudflow activity was not observed in the period between 1971 and 2011. Over the past 41 years jams of arbor and stone have been observed in the river beds. Break out of the jams can at times provoke mud formation, and at other times increase in their firm component. Considerable snow masses, available in mountains, can lead to formation of numerous snow and snow-stone avalanches.

Consequences of mudflows in July1971 in the Sljudjansko-Baikal site appeared to be extremely serious. Many rivers bridges were destroyed and damaged; according to the railway services, debris flow deposits blocked up more than 70 sites of the Krugobajkalsky railway, 30 roadbed sites were washed out, railways 4500 m long were destroyed; clearing of 25 river beds from mud blockages was required. The mudflow height reached 2 m 58 cm. The underground cable of communication, which was on depth of 1,5 – 1,8 m, was washed away and torn off. All that blocked channels of the rivers, creating dams with 3 – 3,5 m in height [Makarov S.A. Mudflows of the Baikal Lake Area. – Irkutsk: Publishing house of the Institute of Geography named after V.B.Sochavy, the Siberian Branch of the Russian Academy of Sciences, 2012. - p. 92-93].

In 1971 the most intensive mudflow activity was registered on the river of Harlahta and Krasny Klyuch stream. The city and the industrial complex were subjected to considerable material damage, federal transport highways were also damaged, the Eastern-Siberian railway was blocked.

Only the estimated damage, resulted from 1971 high water, made 80 million rbl. (at the rate of 1971). There were also human losses with no mentioning them.

In this connection measures on liquidation of wastes accumulated at the Baikal Pulp and Paper Plant (that is about 9 million tons) should be treated in the shortest terms. All of the wastes, in case of a serious mudflow formation, can be dumped in the lake; consequences of such accident are unpredictable.

It is established that in most cases intensification of exogenous geological processes is provoked by economic activities. Therefore the special attention should be focused on a substantiation of measures on seismo- and mudflow safety.

Fig. 4.8.2.

A map of epicenters of historical and prehistoric earthquakes registered instrumentally in the north-east area of the Baikal Lake rift zone

seismodislocations - traces of prehistoric earthquakes, occurred not earlier than 1000 years ago (M >7.5; I >10)

documents of IEC SB RAS

Fig. 4.8.4.

The isoseismic scheme of the Sredne-Baikal earthquake (1959)

(M = 6.8; I = 9)

Fig. 4.8.5.

The isoseismic scheme of the Mujsky earthquake (M=7.9; I=10-11)

Fig. 1.2.2.1.3.

A map of epicenters of earthquakes registered in the Baikal Lake

natural area in 2011

1- seismic stations of the Baikal Branch GS SB RAS

2- seismic stations of the Buryat Branch GS SB RAS

3- BNA border

4- CEE border of BNA

5 - energy class, k

Fig. 4.8.7.

(**расхождение в годе!!!!!)**

Relative mudflow risk change in the Baikal Lake area, a forecast up to 2030

4.8.4 Desertification

Pursuant to the UNCCD (1994) the term “desertification” means land degradation in arid, semi-arid and dry sub-humid areas resulting from various factors, including climatic variations and human activities.

The type of desertification in the Republic of Buryatia is determined with the following processes:

- wind erosion;
- water erosion;
- secondary salinization and swamping;
- degradation of vegetation; and
- technogenic desertification.

The modern desertification processes development factors in the region include: development of virgin lands in 1950s, when 500 th. ha of essentially unsuitable for tillage low-capacity, low humus, mainly dandy-loam chestnut soils at slopes of different layout with steepness of 3 and over degrees; utilization of this tillage in terms of low level of farming culture linked to mono-culture of grain and cereal crops resulted in intensive erosion, especially caused by wind.

Moreover, the negative factors of desertification processes development include irrational use of pastures. In 1980s without consideration of natural conditions the total number of sheep in the region was brought up to 2 mln. heads. Further activities resulted in overgrazing and further to the development of desertification processes on pastures.

The Baikal Natural Territory (BNT) ecosystems, especially of its southern part, are developing under the heavy natural climatic conditions (mountainous relief, extreme continental climate, operation of ecosystems in terms of simultaneously happened processes of cryodization and aridization). Extremity of ecological conditions and ever growing pressing of anthropogenic impact are causing the quite rapid processes of ecosystems degradation. In certain cases this resulted in emerging of areas with heavily destroyed landscapes, which even now could be identified as the desertificated.

4.8.4a Draughts

Draught caused by the prolonged periods of dry weather or insufficient amount of precipitation (period without rains when in 10 or more days there is completely no precipitation or their daily amount does not exceed 1 mm) results in the serious hydrological disbalance, has adverse effect on land resources productivity, and could be one of the reasons for desertification (especially if the draught longs for over a year).

Rotation of draughty periods and water-abundance periods is characteristic for the BNT, what is affecting the natural conditions and hinders the economic activity. The 10-12 year cycle is evinced mostly.

Lack of moisture

The main factor impacting the tilling in the region is water sufficiency during the vegetation period. The generally decreased provision of warmth during the vegetation period is stipulated with not so much northern location of the area, as with the significant elation above the sea level. The area in its humidification conditions belongs to relatively water provided areas (annual amount of precipitation – 385 mm), bigger part of which falls with June-July (138 mm), August-September (128 mm), in the period with the temperature over 10°C (200-300 mm). The territory of the region in terms of humidification dynamics of warm period is inside the zone of sufficient humidification. At the same time, in case use of humidification indicator for the driest months (June and July – vegetation period) will be used as the basis for the regional moisture provision than the area of the region will be referred to as the zone of **arid agriculture**.

According to long-term observations the annual average amount of precipitation in the region is 333 mm. Their biggest part falls in the north-western part, area adjacent to Baikal lake. Precipitation during the period with the air temperature over +5°C is within 236-253 mm, while in the period with temperature over +10°C – within 184-187 mm.

In April-June the relative air humidity varies within 61-73%. In May, when its minimal the average monthly amount is 55-63%.

The lower relative humidity and the drier air are the more intensive water evaporation from plants and soil is. The most significant fluctuations of the average monthly absolute air humidity is reported in the warm period of year, June through September. Further, the higher level of humidity deficit (or insufficiency in water provision) the more intensive water evaporates from the soil surface. The highest level of humidity deficit is observed in May through August.

Wind factor

The important cause of wind speed and change of direction is atmospheric air circulation, locality layout and surface character (vegetation, water bodies etc.). The winds of south-west are prevailing in the region, while winds of southern direction – at areas closer to Baikal.

North-western winds are prevailing at areas adjacent to Baikal during the fall-winter period, and winds of eastern and south-eastern directions prevail in the Selenga river delta in the same period. Average annual wind speed is 3.3 m/sec, during fall-winter time it increases from 3.2 to 6.4 m/sec. The number of days with strong winds (over 15 m/sec) during the year is 33-37. The number of days with dry winds during the warm period of low intensity is 11.3, average intensity – 2.2, and intensive – 0.3, making total – 13.8. As average in Russia in 2010 the average annual temperature of surface air exceeds the “norm” of 1961-1990 for 0.65°C. Climate conditions determined the Russian agricultural productivity in 2011 were in general favourable in compare to the draughty 2010. Hot May – Eastern

Siberia (+3.6°C), hot July in Eastern Siberia (+3.7°C). Load of Baikal with water in July 2010 was less than norm for 37%.

Pic. 1. Baikal was not full with water due to the draught in Buryatia in 2010.

Soil draught

Significant areas were impacted with the soil draught (soil draught – is drying out of soil connected to the atmospheric draught, *i.e.* with certain weather conditions during the vegetation period, and resulted in insufficient water provision of vegetation, for first turn agricultural crops, in its deterioration and decline or loss of crops).

In 2011 as for Russia in general the extremely warm spring (+2.56°C) and summer (+1.40°C) are distinguished among seasons. Spring was the second after the one in 1990 (+3.12°C), while summer – third after the unique year 2010 and was very close to 1998 (+1.78 and +1.45°C, respectively).

Early summer 2011 has brought draught to many regions of the eastern Siberia, including to Irkutsk oblast, Republic of Buryatia, and Zabaikalsky krai, to areas which the rivers flowing into Baikal are running across. In Buryatia 60 farms in 11 rural areas were affected by the draught. Farmers had lost crops at 40 th. ha of 455 th. ha. Direct loss from the draught was estimated as 140 mln. roubles (State Report on the State of the Baikal Lake and Measures for its Protection in 2011).

Pic. 2. Courtesy of www.photosight.ru.

There were no rains in Buryatia for exactly month – from May 20 through June 20, and from May 21 through early July there were no rains in 4 districts of Zabaikalsky krai. Atmospheric draught was observed in Orkutsk oblast as well. The absolute minimum for precipitation amount as average was reported for the region of near Baikal area and Trans-Baikalia since 1936.

According to observations made by the scientists the similar draught was reported in the recent 50 years only twice – in 1990 and 2003.

Land degradation

Land degradation means decrease or loss of biological and economic productivity and complex structure of bogharic arable lands, irrigated arable lands or pastures, forests and forest areas in arid, semi-arid and dry sub-humid regions results from land use or activity of one or several processes, including those connected with human activity and structures of settlement, such as:

- wind and/or water erosion of soils;
- deterioration of physical, chemical, biological or economic features of soils;
- long-term loss of natural vegetation cover (UNCCD, 1994).

Wind erosion

The main process that cause desertification of agricultural lands in the region is wind erosion. The main natural causes of its origination and development in the region – are light granulometric composition of soils, wind regime and dryness of climate in spring and early summer period, mountainous character of territory.

Pic. 3. Baikal, Kolokolny Cape area. Pines are sliding towards the lake due to erosion.

Anthropogenic factors may include ploughing up of low-capacity slope soils of light granulometric composition, utilization of moldboard tillage at slope landscapes, deforestation, lack of forest stripes, unsystemized use of and overload of pastures.

Index of agricultural lands degradation in the Republic of Buryatia within the BNT varies from 0 to 115. Degradation processes at tillage lands in areas of dry steppes on sand deposits have irreversible consequences (Kiakhtinsky, Selenginsky, Kurumkansky districts. Hayfields are lesser degraded. However, in some districts – Mukhorshibirsky, Tarbagataisky, Barguzinsky, and Kiakhtinsky – 39.7-67.7% of pastures are eroded, with 26.8-37.9% of total pasture area – in middle and high degree. Pastures are subject for this adverse process in many other districts of Buryatia.

Agricultural lands of buffer zone, especially in Bichursky, Barguzinsky, Mukhorshibirskyand Zaigraevsky districts are involved into the erosion processes to the biggest degree. Deflation and water erosion are widespread in Kizhinginsky, Kurumkansky, Kiakhtinsky, Selenginsky, Tarbagataisky, and Khorinsky districts – their manifestation in various degrees is detected at 50-60% of total area of agricultural lands. At this, in all aforementioned 10 districts of the Republic the share of averagely and highly eroded soils is big. In the central ecological zone mostly agricultural lands of Kabansky district are subject for erosion processes: 25.6% of tillage lands, 1% of hayfields and 2.7% of pastures are referred to as the eroded.

The tillage lands in Bichursky, Kiakhtinsky, Kurumkansky, Kizhinginsky, Mukhorshibirsky, and Khorinsky districts are under the erosion processes for the highest degree, share of eroded soils there reaches 70-81%. Tillage in Djidinsky, Ivolginsky, Selenginsky, Tarbagataisky and other districts is destroyed actively (60-70% of total area). Due to inappropriate and over-grazing the state of pastures is deteriorated.

Table 1

Summary indices of agricultutral lands degradation

Desertification zones of the Republic of Buryatia within the BNT

Administrative districts	Summary indices of desertification of		
	tillage	hayfields	pastures
Central zone			
1. Barguzinsky	65,5	1,5	79
2. Kabansky	Less than 20	-	-
3. Pribaikalsky	20,4	12,1	27,6
4. Severo-Baikalsky	110,7	-	-

Buffer zone			
5. Bichursky	68	34	70
6. Djidinsky	61	43,6	22,1
7. Zaigraevsky	68	34	70
8. Zakamensky	-	-	-
9. Ivolginsky	65	45	34
10. Kizhinginsky	101	35	43
11. Kurumkansky	79	49	64
12. Kiakhtinsky	115	18	98
13. Mukhorshibirsky	75	60	31
14. Selenginsky	84	9	29
15. Tarbagataisky	73	40	30
16. Khorinsky	69	23	15

Geoecological aspects of land use in the Republic of Buryatia / B. Raldin, L. Ubugunov, V. Khertuev, K. Shagzhiev. Ulan-Ude, 2003.

Water erosion

Water erosion is also wide spread in the region. The natural factors of its origination include: mountainous layout, atmospheric precipitation in form of shower rains during the July-August period, low projective cover degree and light granulometric composition of pedogenic rocks and soils.

Anthropogenic factors may include tillage of steep and slanting slopes without compliance with the soil-protective anti-erosion technologies and excessive grazing at slopes low protected with vegetation. The water erosion is prevailing in valleys of rivers Selenga, Khilok, Chikoy, Kuitunka, and Djida.

The ravines, holes, and other erosion forms with lack of soil and vegetation cover are forming as a result of linear erosion. The highest density of holes and ravines is characteristic for forest-steppe areas. The speed of linear growth of erosion forms as average is 0.3-0.5 m/year, in the rainiest years could achieve 17-25 m/year.

Sheet erosion, or soil washout, is widely distributed. Formation of soils with shortened profile is the result of its manifestation. The fertility level is significantly reduced in eroded soils.

Pic. 4. Transbaikalia, water erosion at the Kodar ridge.

It should be noted that the natural soil cover of the Baikal basin had changed noticeably, especially in agricultural areas.

The majority of soils in their characteristics are short-profiles, low in humus, and of light granulometric composition. Therefore, the vulnerability of soils is increasing annually along with the intensification of agriculture, as well as areas of highly eroded lands are growing. Re-orientation in agriculture significantly damaged the existed natural-economic livestock-agricultural complex and resulted in wide development of erosion and deflation, which are progressing in recent two decades.

Degradation at sandy rocks achieved the irreversible character, what was followed with generation of driving sands.

The erosion and deflation processes considered are one of the main causes of deterioration of ecological situation in the region.

Moreover, the agro-amelioration methods of soil protection against erosion did not receive the sufficient distribution in agricultural areas, although it is known that positive protective functions of forest stripes are appear in already 10 years.

There is a lack of protective planting at pastures, the forestation of ravines, gullies and other uncomfortable lands is not taking place, and the amount of work on forestation of sands is not sufficient. The agro-technique for forestation in heavy soil-climatic conditions is not enough developed, there are mistakes in selection of tree species, damage by cattle, loss of plantings from fires, and their nursing is performed at the poor level. Survival rate drops down to 20-30% in dry years.

According to data from the State Report made by the Ministry of Natural Resources and Environment of the Russian Federation “On the State of Lake Baikal and Measures for its Protection in 2011”: “In 2nd quarter of 2010 the activation of coastal erosion process resulted in washout of roads and protective constructions in the Republic of Buryatia during the spring high water period. Development of abrasive processes is reported at the Baikal lake coasts. The sliding and erosion processes are significantly stipulated by the motor roads impact”.

Also, mudflows are characteristic for Irkutsk oblast and the Republic of Buryatia.

Secondary salinization

The soil salinization factor, as one of desertification types, is manifested in arid climatic conditions, when amount of evaporation is multiply exceeding the amount of atmospheric precipitation. It is promoted by the heavy mechanical soil composition, infiltration loses from channels, not deep bedding of mineralized ground waters. The most varied chemism of salinization is reported in the region, while sulfate-chloride and sulphate-soda prevail.

Sands and light sandy loam due to their good water permeability usually do not contain significant concentrations of salts under the periodic washing type of water regime. In case of appearance in cut of clay, loamy clay and even light loam the degree of their salinization increase drastically.

The processes of secondary salinization and swamping are developed in the Republic of Buryatia within the BNT in intermountain troughs with close bedding of mineralized ground waters.

Pic. 5. Alkaline lands near lake Sulfatnoye, Selenginsky district.

Operation of Khalutinsky irrigation system without good drainage system resulted in the secondary salinization od soils in Ivolginsky kettle. Also the secondary salinization is developed most strongly in Tugnuisky kettle.

Halophytic vegetation is prevailing at salinized soils. Floral composition of communities is not rich (9-15 species). Amount of weedy and unedible species is 10-15 %. Productivity of surface phytomass is 19 centner/ha. The hay from feeding lands of halophytic communities does not correspond to zootechnical norms of feeding in mineral elements ratio.

Pic. 6. Steppe in Chikoy river area.

Technogenic desertification

Destruction of lands is also taking place under the subsoil development. There are around 437 pits counting in the Baikal region. The area destructed with mining works (heavy transport, drilling and digging works, industrial water construction) is 1,550 ha. Works on restoration of soil fertility are performed insufficiently intensive. Technical reclamation is made at only 423 ha.

Currently the large not-reclamed treated dumps within the BNT are located at the Kholbol'djinsky coal strip mine (2,000 ha) and Tarbagataisly brown-coal strip mine. The complete loss of biodiversity of ecosystems is reported at the technogenic wastelands, and their productivity is significantly declined.

The destroyed lands (technogenic deserts) are reported on the special-purpose lands of the Ministry of Defense of the Russian Federation. Impact of motor transport is stipulating the existing degradation of vegetation and soil cover and facilitates the processes of deflation and water erosion.

The technogenic desertification is also observed as the result of forest fires and unauthorized clear felling.

Pic. 7. Truck with illegal timber.

According to Greenpeace Russia data over 3 mnl. m^3 of timber is produced in the Baikal catchment basin annually. Punishments for illegal felling are extremely soft, even sometimes are not used at all. In recent years and nowadays the forest fires become more and more often, mostly as a result of carelessness with fire. Also there is no permanent observation for and control of legal felling.

Another cause of pastures degradation expansion – unsystematic grazing of cattle, its high density, lack of rational hay rotation. The pasture lands of dry steppe zone are subject for this type of desertification most of all.

The serious ecological disbalance is reported in the near border areas of Zabaikalsky krai more often. The modern processes of commercialization and urbanization affected the natural areas included into the list of protected areas. Carrying out of explosive works in mountains, felling and deforestation, damage to vegetation cover resulted in the serious problem of soil erosion.

Impoundment. Flooding

The floodings in the region usually are of the cyclic character and occur once a decade. They are often linked with the earthquakes.

The most powerful and monstrous earthquake was in January 1862, named Tzagansky after the inundation of Buryat steppe. When the earthquake took place, with aftershocks gradually faded away in a more than a year, the part of the Baikal coast was covered with water with five Buaryat settlements located in Tzagan (Saghan) steppe. What happened in January 1862 in the north-eastern part of the Selenga delta was named as the Selenga downfall.

Pic. 8. Proval Bay is located at the south-eastern coast of the Baikal lake.

Courtesy of http://www.223-223.ru/baikal/1.

In 1960 scientists from Irkutsk V. Solonenko and A. Treskov when considered in details the powerful mid-Baikal earthquake of August 29/30, 1959, had declared the Selenga river delta area as the most active part of the Sayan-Baikal seismic zone. The scientists considered that the Proval Bay development is not yet completed. To this end, the whole part of Baikal coast limited in the south-east with line Oymur river mouth – Maliy Dulan – Aenkhaluk was proposed to acknowledge as unsustainable. There is still a chance for its downfall under Baikal during the further powerful earthquakes; therefore construction of any buildings here but temporary should be restricted.

The change of the Baikal level after the construction of Irkutsk hydro power plant in 1956 resulted in washout and destruction of coastal line (12 through 120 m), some 230 ha of Baikal beaches, roads, and certain parts of railroad were inundated. With normal headwater level the area of around 350 km^2 in the Selenga delta is inundated and some more 120 km^2 in the Upper Angara delta, as well as 50 km^2 – in small rivers' deltas.

The water level in rivers had risen for a few hours in July 1973.

In August 1993 the strong flooding at the Selenga river resulted in impoundment of 30 th. ha of agricultural lands, 10 th. of household and country-house plots, over 8 th. of houses, and the roads were washed out.

In 1998 the abundant rainfalls resulted in impoundment of 19 districts in Buryatia and of Ulan-Ude. Due to thus 12 persons were killed, and over 10,000 persons were damaged. Over 3,000 families were in the impoundment area, the downtown Ulan-Ude was completely flooded, including the bus terminal.

In 2001 the Irkut and Oka rivers level surpassed the critical mark from 3 to 5 meters. Twenty houses in 6 settlements were impounded, 13 houses were completely destroyed and 3 persons were killed.

In 2006 during the high water parts of roads were impounded in Djidinsky, Zakamensky, Tunkinsky and Okinsky districts. Around 3,000 people suffered. The damage was estimated as 162 million rubles.

Pic. 9. Flooding at river Kitoy near Razdolie.

In summer 2012 the incessant showers were again reported in the Republic of Buryatia. The first part of powerful precipitation came to Ulan-Ude on July 6-8. The half-monthly norm of precipitation falls during the first day. The main strike of water element was on Sovetsky (3,229 houses) and Oktiabrsky (2,000 houses) districts.

Currently in Ulan-Ude over 5 thousands of houses located in the Selenga and Uda rivers valleys, as well as along the coasts of rivers Vorovka, Baydonov Kluetch, Ivolginka and Upper Berezovka, are in the area of possible impoundment.

Pic. 10. Flooding in Ulan-Ude.

Near Zabaikalsk town the road was so strongly washed out that the cars were falling down into the giant cracks.

Pic. 11. Washout of road.

The unauthorized construction in impounded areas and unsatisfactory condition of water-work facilities poses the threatening situation. In case the flooding will repeat today its consequences could not less sad in compare to previous cases.

4.8.4.b SITUATIONAL ANALYSIS

- The considered erosion and deflation processes are one of the major causes for deterioration of environmental situation in the region.
- The forest felling continues in significant amounts in agricultural areas, as well as their systematic burnout.

- Insufficient attention is paid to reforestation; being occupied with mostly timbering, there is a lack of arboretums in areas of agro-forest-amelioration in dry-steppe and steppe zones.
- Insufficient dissemination of agro-amelioration methods for soil protection against erosion is reported in agricultural areas, and ravine forestation is lacking.
- Technogenic desertification is progressing.
- Works on fertility restoration of soils destroyed in mineral development are insufficiently intensive.
- Extremeness of environmental conditions and raising press of anthropogenic impact stipulate enough rapid processes of ecosystems degradation.

The following is necessary to address desertification problems and related adverse effects on human and the environment, as well as catastrophic natural phenomena in BNT:

- Establishment of determined totality of institutional, legal and economic factors that provide for the effective operation of subjects of legal-land relations and sustainable ecological landscape environ.
- Correct organization of natural resources exploitation that would allow providing of industry with raw and secure economic objects from mud flows.
- Organization of long-term environmental monitoring of desertification processes, including stationary observations at hydrometeorological, biological, hydrological stations, periodic area surveys.
- Phyto-amelioration of pastures, especially – current desertification hot spots, utilization of plants that fox sands with further their inclusion into pastures turnover.
- Utilization of socio-economic mechanisms for combatting desertification, state control of nature consuming use, fostering of nature protection productions.
- Increase of role of inter-regional and international collaboration in combatting desertification, including the state border construction, strengthening of customs and border control.

To the present time the Ministry of Agriculture and Food of the Republic of Buryatia has developed the sub-programme to support the soil fertility by 2020, which is part of the programme “Development of agricultural complex and rural areas in the Republic of Buryatia for 2011-2017 and for the period by 2020”. This document is focused on the substantial increase of soil fertility, environmental protection, and stabilization of plant-cultivation production.

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